Appendix A17.3 Site Investigation Borehole Locations and Report

CAUSEWAY GEOTECH

FINAL FOR ISSUE

Greater Dublin Drainage Ground Investigation – Phase II Terrestrial Investigation

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Client:	Irish Water
Client's Representative:	Tobin Consulting Engineers
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APPENDICES

Document Control Sheet

Report No.:	14-645
Project title:	Greater Dublin Drainage Ground Investigation Phase II Terrestrial Investigation
Client:	Irish Water
Client's Representative:	Tobin Consulting Engineers

Revision	Status	Report prepared by:	Report reviewed by:	Report approved by:	Issue date
A01	Final	Matthew Gilbert MEarthSci FGS	Darren O'Mahony BSc MSc	Paul Dunlop BEng PhD CEng MIEI	10 April 2015

The works were conducted in accordance with:

Site Investigation in Construction Part 3: Specification for Ground Investigation, Site Investigation Steering Group, published by Thomas Telford Ltd (1993)

British Standards Institute (2010) BS 5930:1999 + A2: 2010, Code of practice for site investigations. Incorporating Amendment Nos. 1 and 2, as partially replaced by:

- BS EN 1997-2:2007: Eurocode 7. Geotechnical design. Ground investigation and testing
- BS EN ISO 22475-1:2006: Geotechnical investigation and testing. Sampling methods and groundwater measurements. Technical principles for execution
- BS EN ISO 14688-1:2002: Geotechnical investigation and testing. Identification and classification of soil. Identification and description
- BS EN ISO 14688-2:2004: Geotechnical investigation and testing. Identification and classification of soil. Principles for a classification
- BS EN ISO 14689-1:2003: Geotechnical investigation and testing. Identification and classification of rock. Identification and description
- BS EN ISO 22476-2:2005: Geotechnical investigation and testing. Field testing. Dynamic probing
- BS EN ISO 22476-3:2005: Geotechnical investigation and testing. Field testing. Standard penetration test

Methods of describing soils and rocks

Soil and rock descriptions are based on the guidance in Section 6 of BS 5930: 1999 + A2: 2010, The Code of Practice for Site Investigation. The amendments revised the Standard to remove text superseded by BS EN ISO 14688-1:2002, BS EN ISO 14688-2:2004 and EN ISO 14689-1:2003 and refers to the relevant standard for each affected subclause. However, the following terms are used in the description of fine-grained soils, where applicable:

- soft to firm: fine-grained soil with consistency description close to the boundary between soft and firm soil (Table 13 of BS5930).
- firm to stiff: fine-grained soil with consistency description close to the boundary between firm and stiff soil (Table 13 of BS5930).

Abbreviations used on exploratory hole logs	
U	Nominal 100mm diameter undisturbed open tube sample
P	Nominal 100mm diameter undisturbed piston sample
B	Bulk disturbed sample
D	Small disturbed sample
W	Water sample
ES / EW	Soil sample for environmental testing / Water sample for environmental testing
SPT	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 44.4.4 of BS 5930: 1999	
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.

Greater Dublin Drainage Ground Investigation Phase II

1 AUTHORITY

On the instructions of Consulting Engineers, Tobin Consulting Engineers ("the Client's Representative"), acting on the behalf of Irish Water ("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 17km long pipeline from Blanchardstown to Portmarnock.

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 measured during the investigation.

This report was prepared by Causeway Geotech Ltd for the use of the Client and the Client's Representative in response to particular 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 and rock core sampling, in-situ and laboratory testing, geophysics survey, and the preparation of a factual report on the findings.

3 DESCRIPTION OF SITE

The Greater Dublin Regional Drainage Scheme consists of a waste water treatment works (WWTW) plant and accompanying pipeline with a marine outfall in North County Dublin. This phase of works focussed on the inland section of the pipeline, covering an area some 17km in length.

The route commences at the M50-N3 junction in Blanchardstown and progresses in an north-easterly direction, parallel to the northern side of the M50. The route diverges slightly to the north of the M50. The route continues easterly towards the southern side of Silloge Golf Club and the M50-R108 junction at Ballymun cross. The pipeline then runs towards Collinstown Business Park and heads to Clonshaugh, the site of the proposed WWTW. This is located approximately 2.2km southeast of Dublin Airport and between the M1 and Malahide Road. The pipeline from Clonshaugh to the marine outfall progresses in a northerly direction before then turning east and running past Kinsealy. The pipeline then turns south briefly, then finally east, crossing under the Dublin-Belfast railway line to the south of Portmarnock and north of Mayne Bridge.

The site use is a mix of agricultural lands and residential areas. Primarily, site operations were carried out in agricultural lands.

4 SITE OPERATIONS

Site operations which were conducted between 24th November 2014 and 12th February 2015, included:

- six percussion boreholes
- thirteen percussion boreholes with rotary follow-on
- one percussion borehole with Geobor S wireline rotary coring follow-on
- twelve rotary only boreholes
- thirteen trial pits.

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.

4.1 Boreholes

A total of thirty-two boreholes were put down through soils and rock strata to their completion depths by a combination of methods, including light cable percussion boring by Dando 2000 and 3000 rigs, and rotary drilling by Comacchio 205, Comacchio 405 and Beretta T41 rotary drilling rigs.

The borehole logs state the methodology and plant used for each location, as well as the appropriate depth ranges.

A summary of the boreholes, subdivided by category in accordance with the methods employed for their completion, is presented in the following sub-sections.

4.1.1 Light cable percussion boreholes

Six boreholes (BH117, 120, 122, 134, 135 and 138) were put down to completion in minimum 200mm diameter using Dando 2000 and Dando 3000 light cable percussion soil boring rigs. All boreholes were

terminated either at their scheduled completion depths, or else on encountering virtual refusal on obstructions, including large boulders and weathered bedrock.

Hand dug inspection pits were carried out between ground level and 1.2m 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 (UT100 and U100) were taken where appropriate and as directed within cohesive soils. Environmental samples were taken at standard intervals, as directed by the Client's Representative.

Standard penetration tests were carried out in accordance with EC7 at standard depth intervals using the split spoon sampler (SPT) or solid cone attachment (SPTc). 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 G. Details of the SPT hammer used are provided on the individual borehole logs.

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

Where water was added to assist with boring, a note has been added to the log to account for same.

4.1.2 Boreholes by combined percussion boring and rotary follow-on drilling

Fourteen boreholes (BH118, 121, 123-128, 130-133, 137 and 139) were put down by a combination of light cable percussion boring and rotary follow-on drilling techniques in bedrock. The boreholes were put down initially by Dando 2000 or Dando 3000 soil boring rigs until refusal was met, and they were then continued using a Comacchio 205, Comacchio 405 or Beretta T41 drilling rig.

Hand dug inspection pits were carried out between ground level and 1.2m depth to ensure boreholes were put down at locations clear of services or subsurface obstructions.

During percussion boring, disturbed (bulk and small bag) samples were taken within the encountered soil strata. Undisturbed (UT100 and U100) were taken where appropriate and as directed within cohesive soils.

Standard penetration tests were carried out in accordance with EC7 at standard depth intervals using the split spoon sampler (SPT). 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 G. Details of the SPT hammer used are provided on the individual borehole logs.

Where the cable percussion borehole had not been advanced onto bedrock, rotary percussive methods were employed to advance the borehole to completion/bedrock. Symmetrix cased full-hole drilling was used in some cases (if so, it will be detailed in the individual borehole log) with SPTs carried out at standard intervals as required.

Where coring was carried out within bedrock strata, conventional coring methods were used with a metric T2-101 core barrel, which produced core of nominal 84mm diameter, and was placed in triple channel wooden core boxes. One borehole (BH139) was taken to a depth of 78.4m using a Beretta T41 drilling rig. Core was recovered in a metric SK6L core barrel, producing core of nominal 102mm diameter.

The core was subsequently photographed and examined by a qualified and experienced Engineering Geologist, thus enabling the production of an engineering log in accordance with *BS 5930:1999 + A2: 2010, Code of practice for site investigations* (Incorporating Amendment Nos. 1 and 2). Core logging was carried out off site by the Causeway Geotech Engineering Geologist.

Appendix B presents the borehole logs, with core photographs presented in Appendix C.

4.1.3 Rotary drilled boreholes

Twelve boreholes (BH106-116 and BH119) were put to their completion by rotary drilling techniques only. The boreholes were completed using a Comacchio 205, Comacchio 405 or a Beretta T41 drilling rig.

Symmetrix-cased full hole rotary percussive drilling techniques were employed to advance the boreholes to bedrock. SPTs were carried out at standard intervals throughout the overburden, with small disturbed samples obtained where possible through the soils strata. In selected boreholes, rotary coring was employed to recover core samples of the bedrock.

The core was extracted in up to 1.5m lengths using a metric T2-101 core barrel, which produced core of nominal 84mm diameter, and was placed in triple channel wooden core boxes. At borehole BH139, rotary coring was carried out by Geobor S triple-tube wireline coring techniques, with core of nominal 102mm diameter produced.

The core was subsequently photographed and examined by a qualified and experienced Engineering Geologist, thus enabling the production of an engineering log in accordance with *BS 5930:1999 + A2: 2010, Code of practice for site investigations* (Incorporating Amendment Nos. 1 and 2).

Core logging was carried out off site by the Causeway Geotech Engineering Geologist.

Appendix B presents the borehole logs, with core photographs presented in Appendix C.

4.2 Standpipe installations

Groundwater monitoring standpipes were installed in all the boreholes.

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

4.3 Trial Pits

Thirteen trial pits (TP100-TP106, TP108-110 and TP112-114) were excavated using a 7t tracked excavator fitted with a 600mm wide bucket, to maximum depth of 4.5m.

Disturbed (bulk bag) samples were taken at standard depth intervals and at change of strata. Environmental samples were also taken at regular depths in each trial pit.

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

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.

Laboratory testing of soils comprised:

- soil classification tests: moisture content measurement, Atterberg Limit tests and particle size distribution analysis.
- rock strength testing: point load index and unconfined compressive strength tests
- soil chemistry tests (conducted by Chemtest): pH, water soluble sulphate and chloride content, and organic matter content
- environmental testing: carried out on selected environmental samples, this included metals, TPH and waste acceptance criteria (WAC) testing.

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

The test results are presented in Appendix F.

6 GROUND CONDITIONS

6.1 General geology of the area

Superficial deposits of the area consist of glacial tills, with localised marine deposits in the Portmarnock area. The line of the site crosses several geological formations, all of Carboniferous age, and all dominated by limestones (typically argillaceous, sometimes carbonaceous) with occasional interbedded clastic sedimentary rocks.

6.2 Ground types encountered during investigation of the site

The exploratory holes encountered the following ground types, listed in approximate stratigraphic order:

- Made Ground (concrete): found only in borehole BH06 in 100mm thickness.
- Topsoil: encountered in most exploratory holes, typically in 100-400mm thickness, up to 800mm in trial pit TP112.
- Made Ground (fill): reworked gravelly clay with fragments of brick, concrete, plastic, glass and/or timber. Found in at the surface or beneath topsoil in several trial pits and boreholes, to depths typically on the order of 0.5-1.2m, and to 2.2m in trial pit TP109.
- Glacial Till: brown to black sandy gravelly clay, frequently with low cobble content and rare boulders, typically firm or stiff. Present in all exploratory holes down to a maximum depth of 14.5m (borehole BH139).
- Bedrock: Rockhead was encountered at depths ranging from 0.95m in several trial pits, to 14.5m in borehole BH139. Bedrock typically consisted of weak to medium strong dark grey limestone (usually argillaceous, and often fossiliferous). Some boreholes also encountered very weak to weak black carbonaceous limestone and mudstone. Borehole BH139 went through a sequence of extremely weak mudstones, siltstones and sandstones between 39m and 47m, before returning to more competent grey limestone.

6.3 Groundwater

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.

It should be noted that any groundwater strikes within bedrock may have been masked by the fluid used as the drilling flush medium.

Standpipes were installed in every borehole, and continued monitoring of these will allow determination of the seasonal variation in groundwater level.

7 REFERENCES

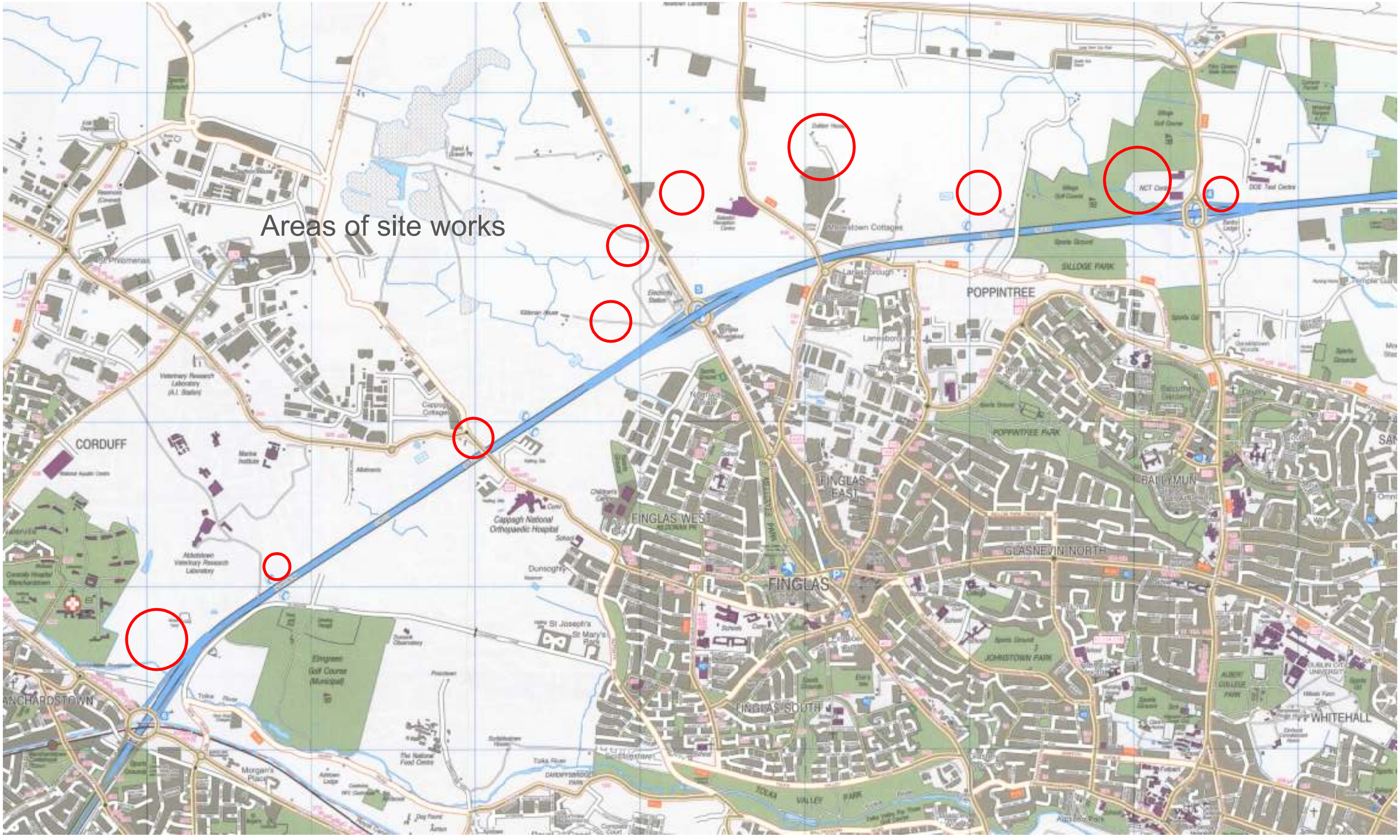
BS 1377: 1990: Methods of test for soils for civil engineering purposes. British Standards Institution.

BS 5930+A2: 2010: Code of practice for site investigations (Amendment 2). British Standards Institution.

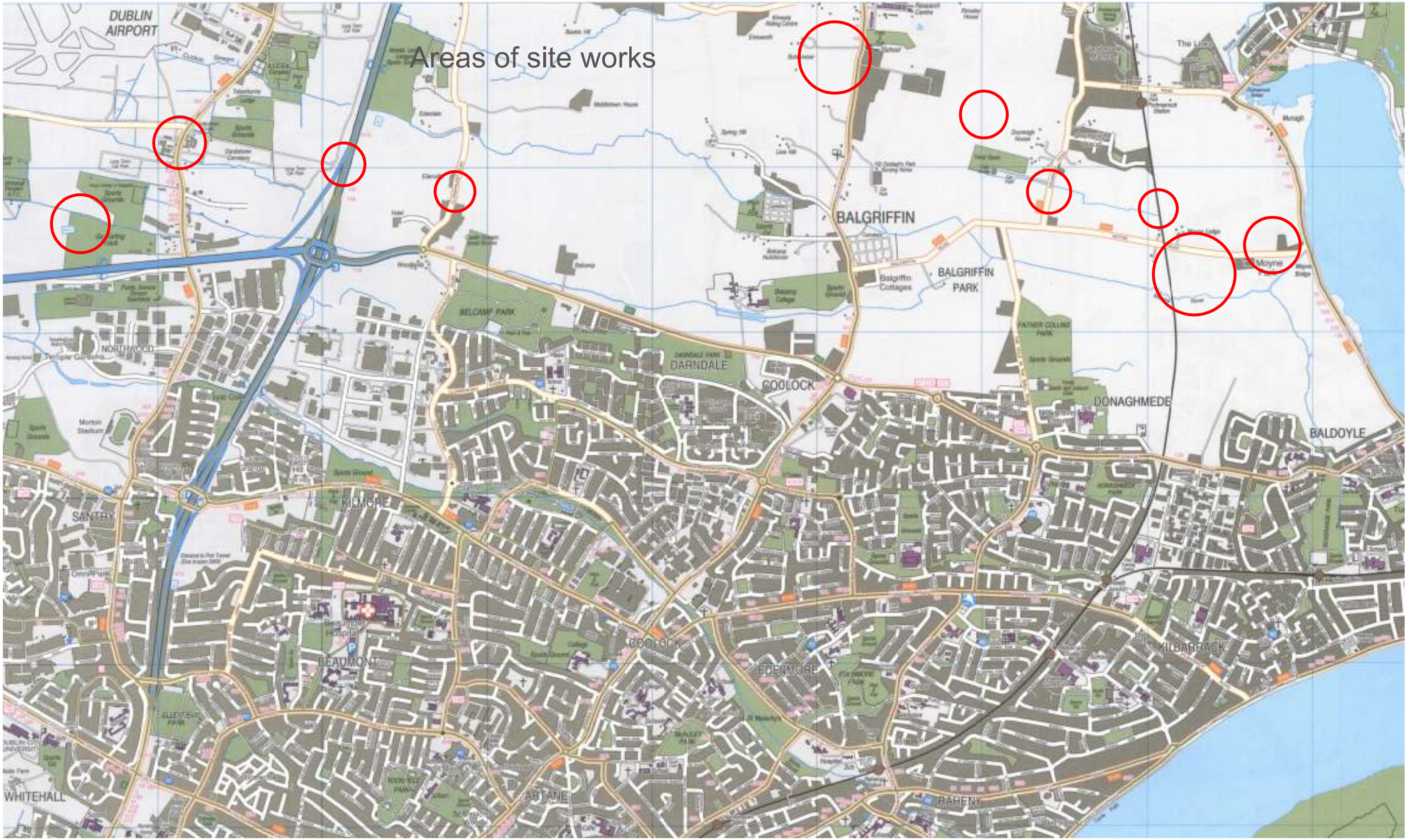
BS EN 1997-2: 2007: Eurocode 7 - Geotechnical design - Part 2 Ground investigation and testing. British Standards Institution.

BS EN ISO 14688-1: 2002: Geotechnical investigation and testing - Identification and classification of soil - Part 1 Identification and description. British Standards Institution.

Appendix A
Site and exploratory hole location plans



PROJECT: Greater Dublin Drainage Scheme Ground Investigation		TITLE: Site location plan			
CLIENT: Irish Water	KEY:	CAUSEWAY GEOTECH	SCALE: NTS@A3	DATE: 19/02/2015	
ENGINEER: Tobin Consulting Engineers			DRWN: BS CHCK: DO'M	SERIES: 1 of 2	DWG No: 14-645-SL-001



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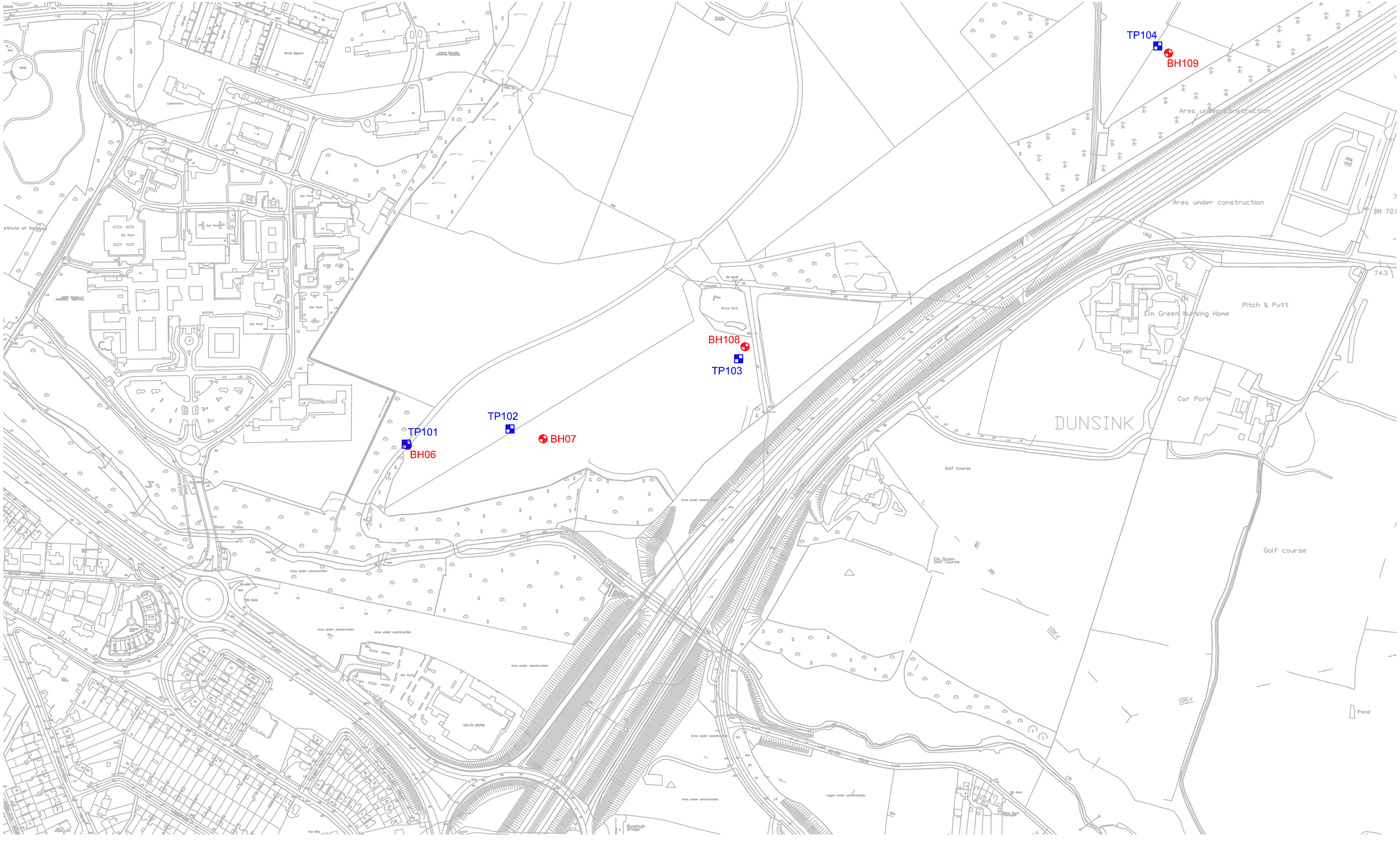
ENGINEER: Tobin Consulting Engineers			DRWN: BS CHCK: DO'M	SERIES: 2 of 2	DWG No: 14-645-SL-002



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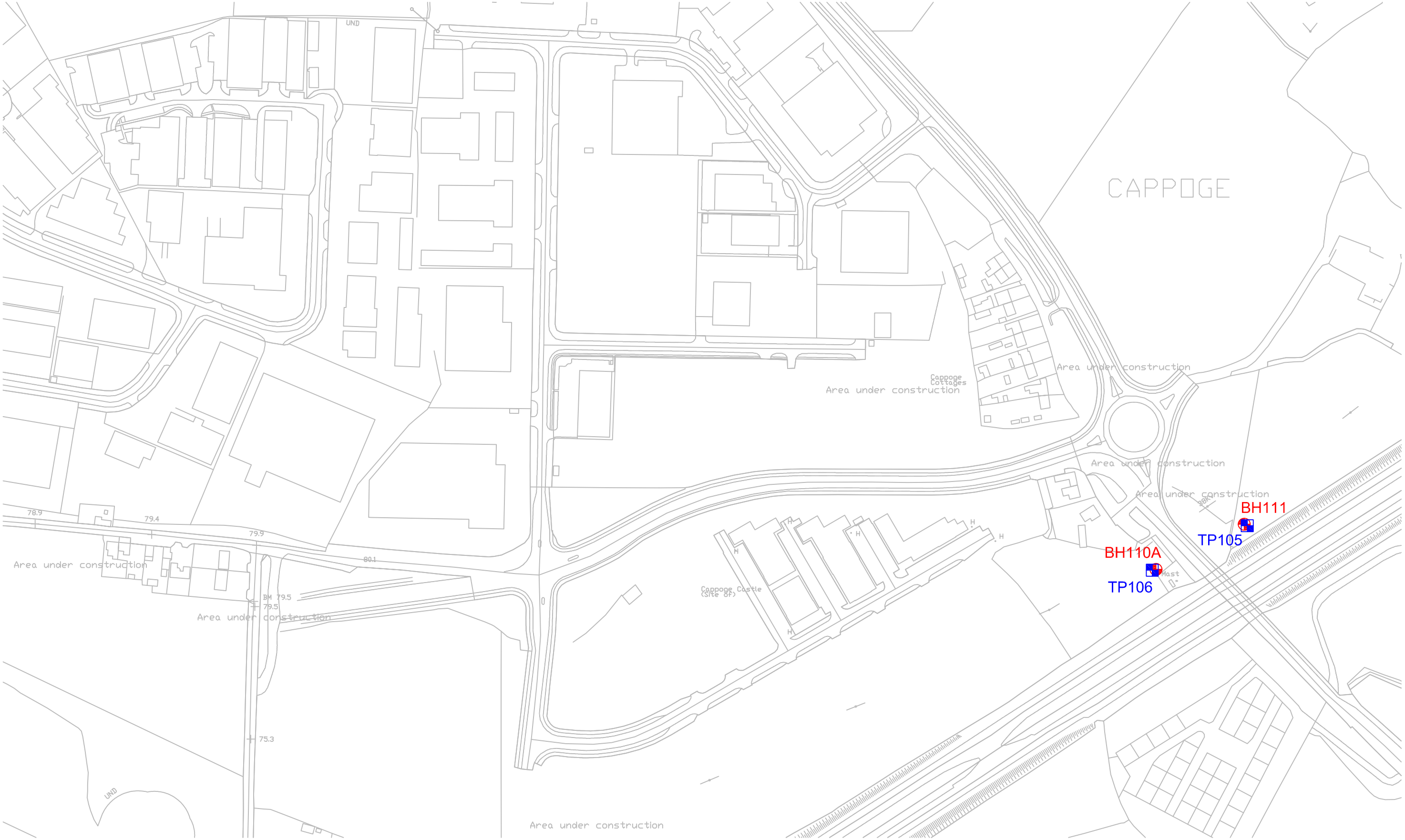
ENGINEER: Tobin Consulting Engineers			DRWN: BS CHCK: DO'M	SERIES: 1 of 10	DWG No: 14-645-EHL-001



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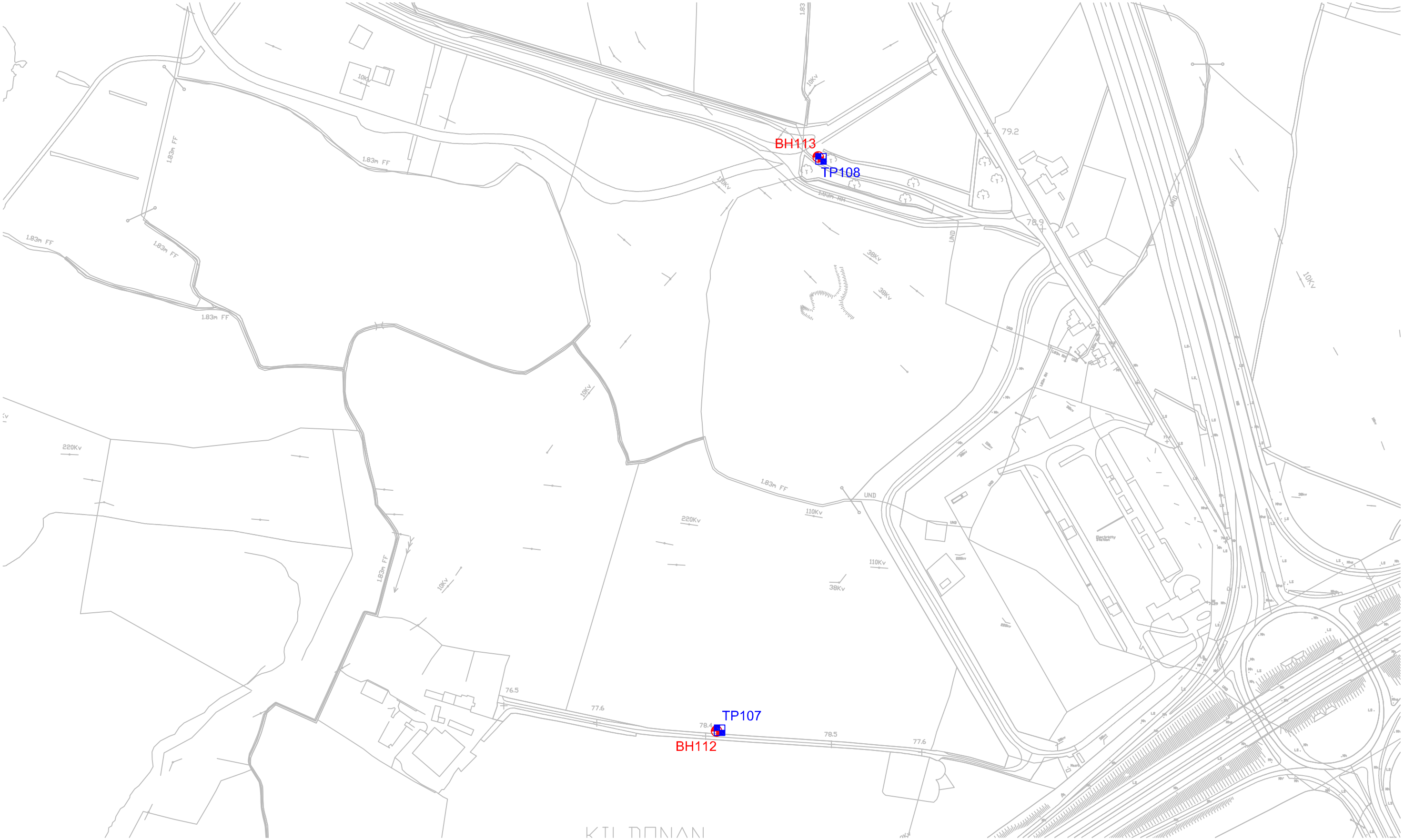
ENGINEER: Tobin Consulting Engineers			DRWN: BS CHCK: DO'M	SERIES: 2 of 10	DWG No: 14-645-EHL-002



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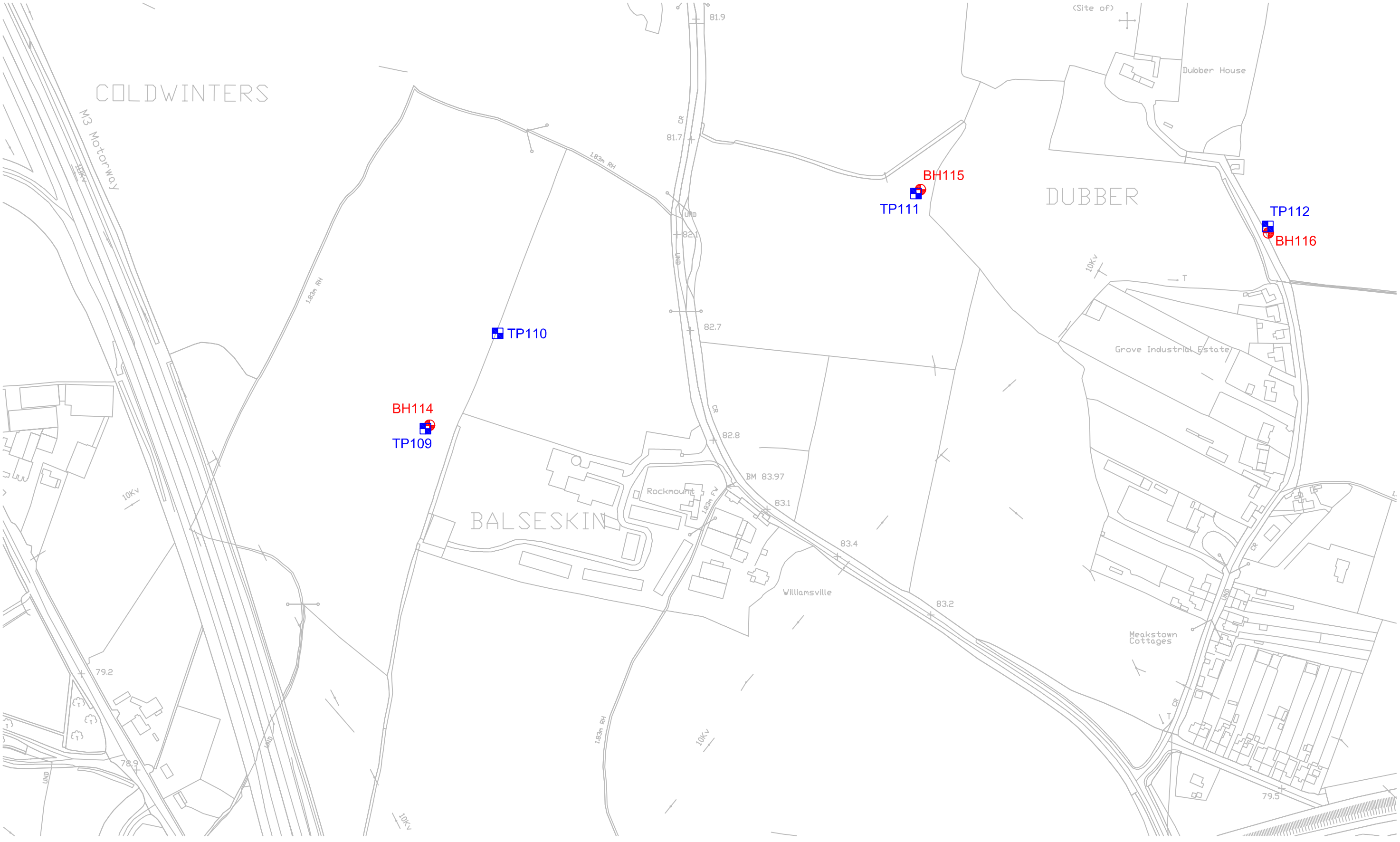
ENGINEER: Tobin Consulting Engineers			DRWN: BS CHCK: DO'M	SERIES: 3 of 10	DWG No: 14-645-EHL-003



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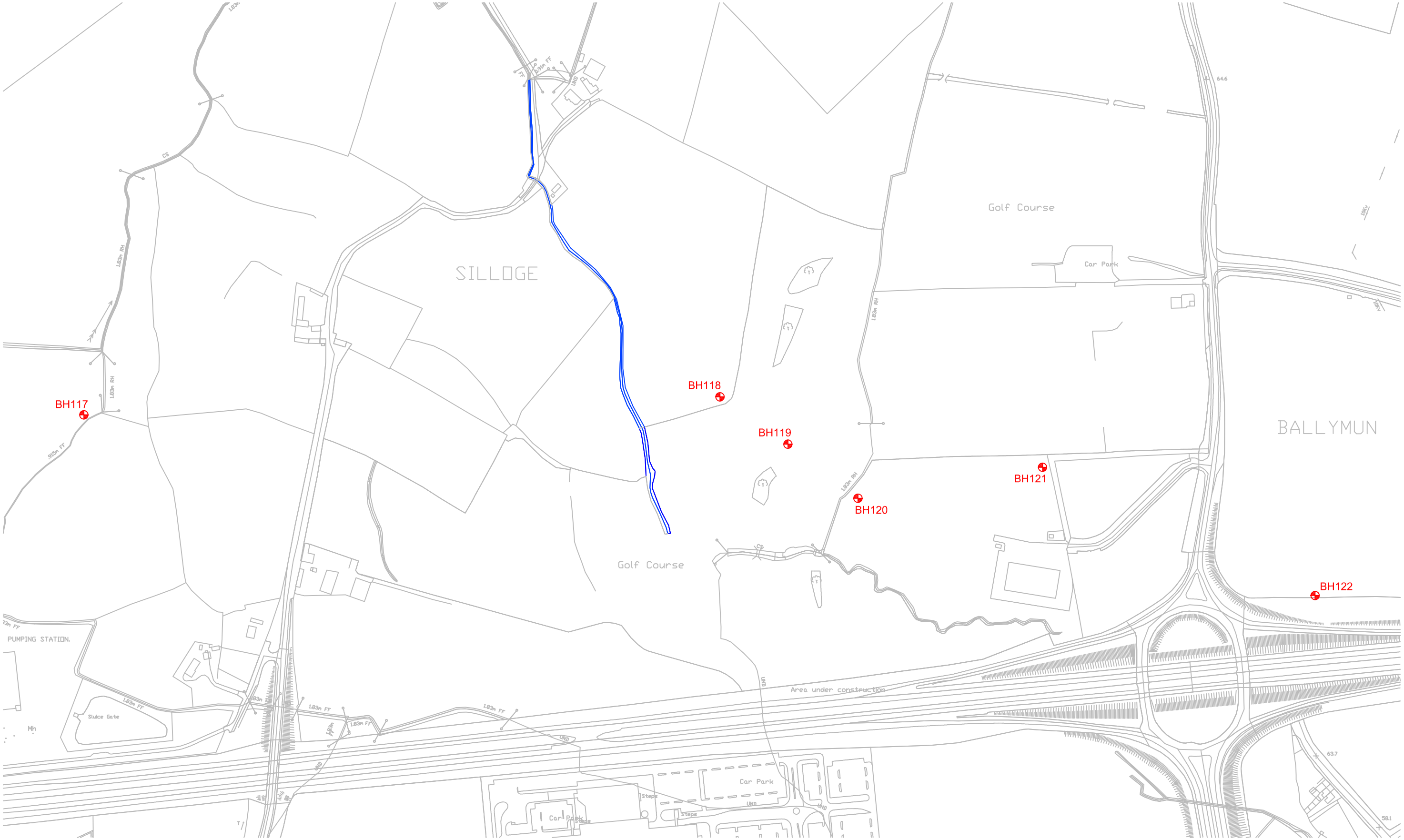
ENGINEER: Tobin Consulting Engineers			DRWN: BS CHCK: DO'M	SERIES: 4 of 10	DWG No: 14-645-EHL-004



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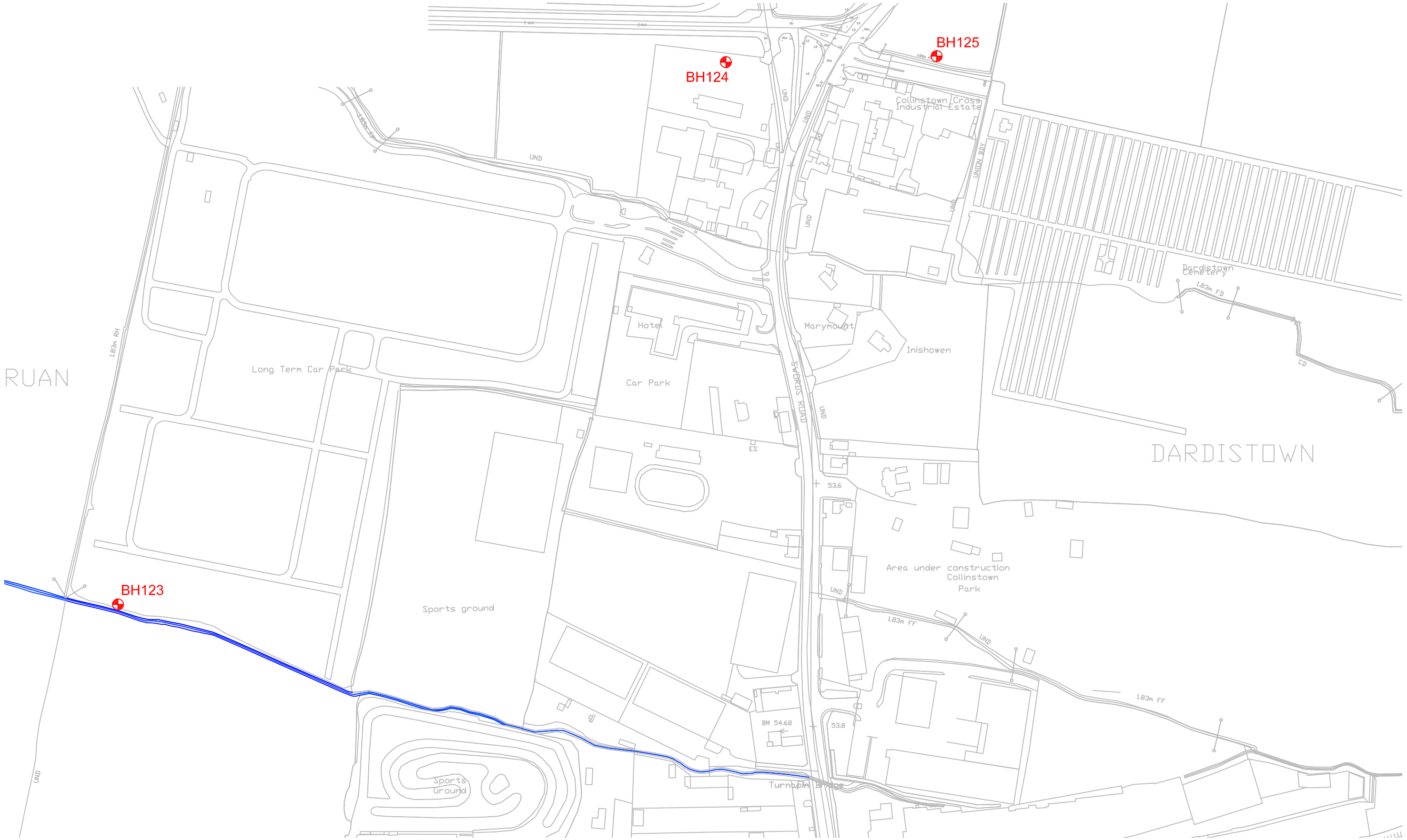
ENGINEER: Tobin Consulting Engineers			DRWN: BS CHCK: DO'M	SERIES: 5 of 10	DWG No: 14-645-EHL-005



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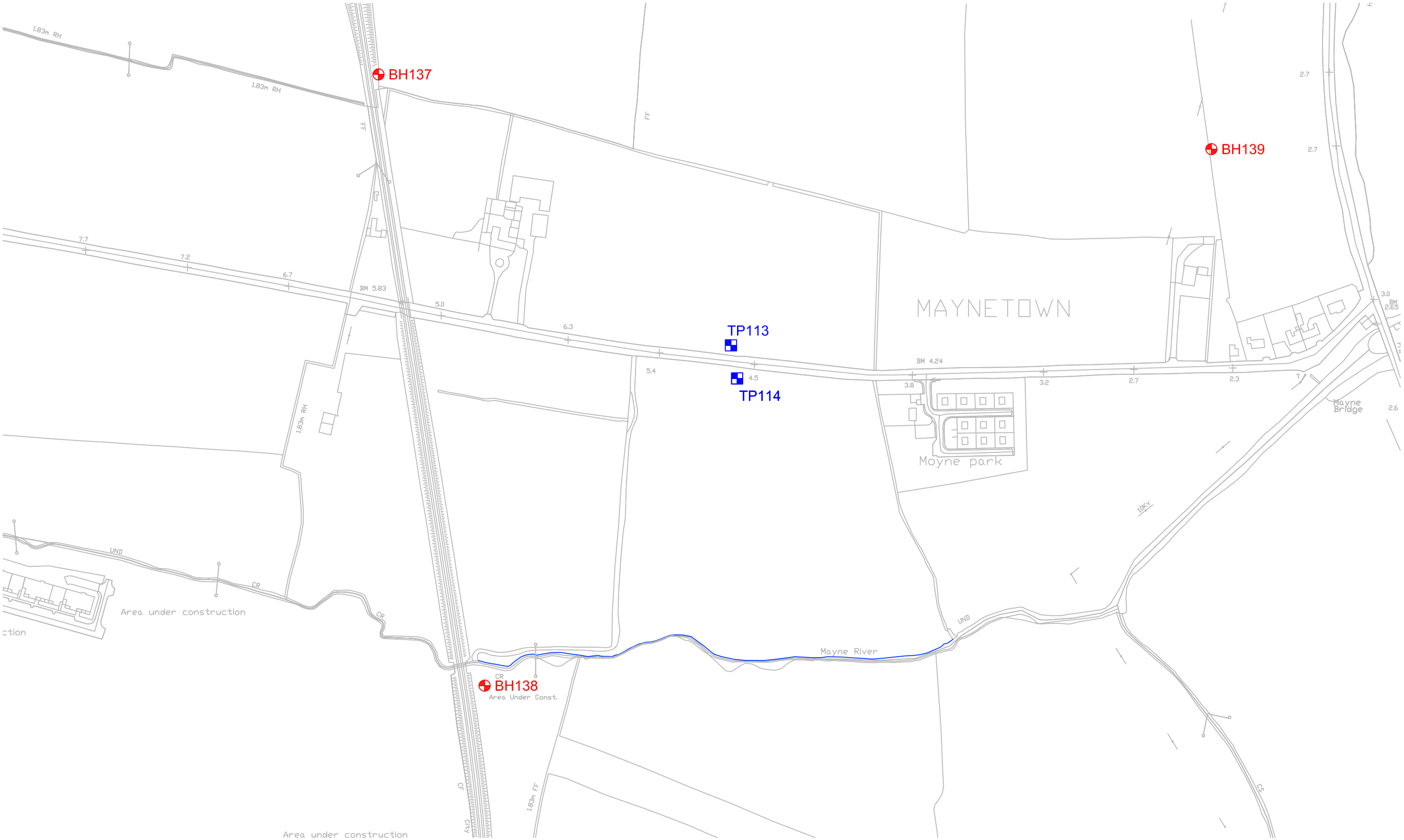
ENGINEER: Tobin Consulting Engineers			DRWN: BS CHCK: DO'M	SERIES: 6 of 10	DWG No: 14-645-EHL-006

PROJECT: Greater Dublin Drainage Scheme Ground Investigation		TITLE: Exploratory hole location plan			
CLIENT: Irish Water	KEY:	CAUSEWAY GEOTECH	SCALE: NTS@A3	DATE: 19/02/2015	
ENGINEER: Tobin Consulting Engineers			DRWN: BS CHCK: DO'M	SERIES: 7 of 10	DWG No: 14-645-EHL-007

PROJECT: Greater Dublin Drainage Scheme Ground Investigation		TITLE: Exploratory hole location plan			
CLIENT: Irish Water	KEY:	CAUSEWAY GEOTECH	SCALE: NTS@A3	DATE: 19/02/2015	
ENGINEER: Tobin Consulting Engineers			DRWN: BS CHCK: DO'M	SERIES: 8 of 10	DWG No: 14-645-EHL-001

PROJECT: Greater Dublin Drainage Scheme Ground Investigation		TITLE: Exploratory hole location plan			
CLIENT: Irish Water	KEY:	CAUSEWAY GEOTECH	SCALE: NTS@A3	DATE: 19/02/2015	
ENGINEER: Tobin Consulting Engineers			DRWN: BS CHCK: DO'M	SERIES: 9 of 10	DWG No: 14-645-EHL-009



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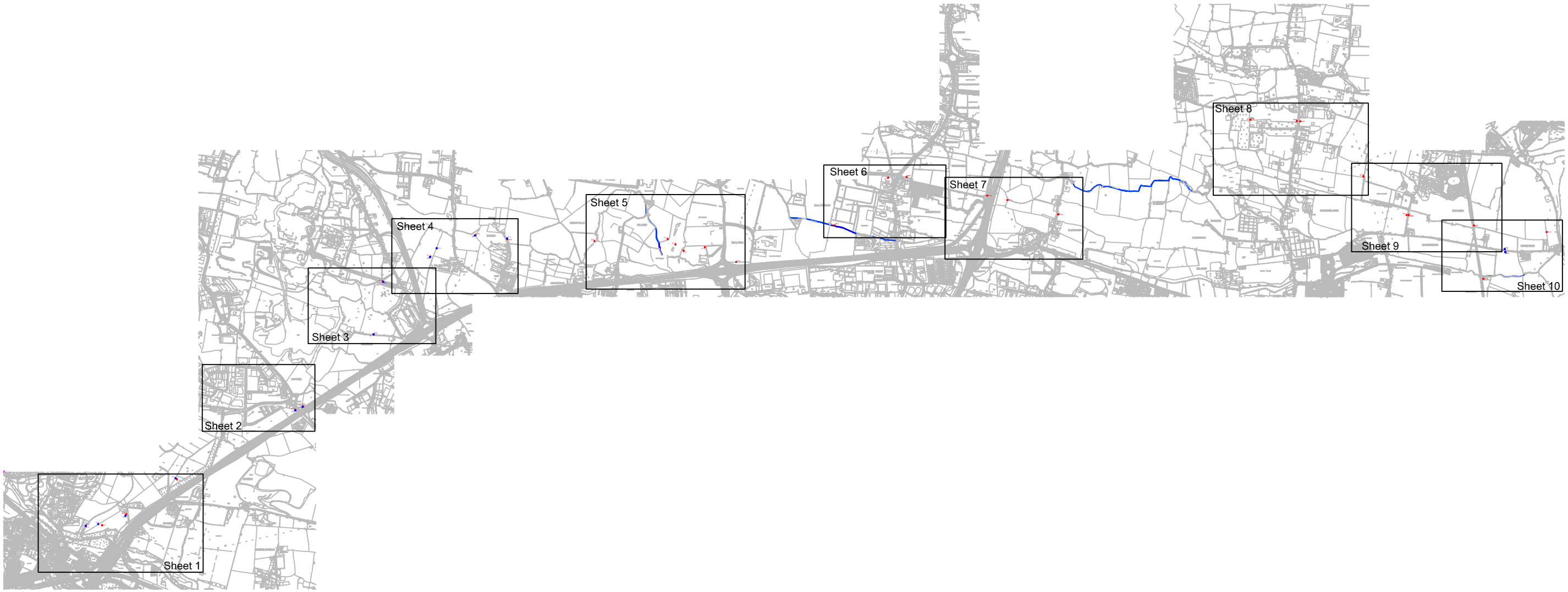
ENGINEER: Tobin Consulting Engineers			DRWN: BS CHCK: DO'M	SERIES: 10 of 10	DWG No: 14-645-EHL-010



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CLIENT: Irish Water	KEY:	CAUSEWAY GEOTECH	SCALE: NTS@A3	DATE: 19/02/2015	
ENGINEER: Tobin Consulting Engineers			DRWN: BS CHCK: DO'M	SERIES: 1 of 1	DWG No: 14-645-EHL-Overview

Appendix B
Borehole logs

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation		**Borehole No.** BH106
Method: 0.00–1.20 Inspection Pit; 1.20–2.30 Rotary Drilling; 2.30–7.00 Rotary Coring	**Co-ords:** 308842.77mE 238647.09mN	**Client:** Irish Water	Sheet 1 of 1
		Client's Representative: Tobin Consulting Engineers	**Scale:** 1:50
Plant: Hand Excavator+Comacchio 205	**Ground Level:** 49.61MOD	**Dates:** 24/11/2014	**Crew:** JC
			Logged By: DOM +MFG

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
						(0.10) 49.51 0.10	CONCRETE		
						(0.30) 49.21 0.40	MADE GROUND - Brown sandy angular to subangular fine to coarse GRAVEL		
						(0.60) 48.61 1.00	Firm brown slightly sandy gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded, fine to coarse.		
						(0.40) 48.21 1.40	Stiff greyish brown slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded, fine to coarse.		
						(0.90) 47.31 2.30	Weak dark grey LIMESTONE. Probably highly weathered (recovered as clayey sandy angular to subangular gravel and cobbles)		
2.30 - 3.10	100	73	21	12			Medium strong thinly to thickly laminated dark grey ARGILLACEOUS LIMESTONE interbedded with medium to widely spaced very thin beds of weak black CARBONACEOUS MUDSTONE with occasional pyrite veins.		
3.10 - 4.45	100	79	44	7			Partially weathered with some oxidation staining along joint surfaces.		
							Discontinuity Set 1: Bedding/lamination planes, 10 to 20°, very close to medium spaced, planar, smooth, typically closed to occasionally open, stained brown to 4.3m, clean below.		
							Discontinuity Set 2: white calcite veins, very close to closely spaced, randomly orientated, typically subparallel to bedding, stepped to curved, typically closed with calcite infill <1-20mm thick.		
							2.75-2.80m: Pyrite-rich.		
							2.80-3.10m: Extremely weak - possible fault gouge.		
4.45 - 5.50	100	53	0	20		(4.70)			
5.50 - 7.00	100	77	63	6		42.61 7.00	End of core at 7.00 m		

Remarks

Core Barrel: +6	**Water Strikes:** Struck (m) / Rose to (m) / Time (min)
Flush Type:	
Water Added: From (m) / To (m)	**Casing:** To (m) / Diameter (mm)

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation	**Borehole No.** BH107
Method: 0.00–1.20 Inspection Pit; 1.20–2.50 Rotary Drilling; 2.50–7.00 Rotary Coring	**Co-ords:** 309008.92mE 238655.10mN	**Client:** Irish Water	Sheet 1 of 1
Plant: Hand Excavator+Comacchio 205	**Ground Level:** 54.19MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 26/11/2014	**Crew:** JC
			Logged By: DOM +MFG

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
						(0.10) 54.09 0.10	TOPSOIL		
						(0.60)	Firm brown slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded, fine to coarse.		
						53.49 0.70			
						(0.50)	Firm light brown sandy gravelly CLAY with occasional cobbles. Gravel is subangular to subrounded, fine to coarse. Cobbles are subangular to subrounded.		
1.20	SPT (S)				N=33 (2,2/5,9,7,12)	52.99 1.20			
						(0.30)	Extremely weak dark grey LIMESTONE. (Probably highly weathered - recovered as angular to subangular fine to coarse gravel)		
						52.69 1.50	Weak to medium strong dark grey LIMESTONE.		
						(1.00)			
2.50 - 3.40	100	94	0	20		51.69 2.50	Medium strong thinly to thickly laminated dark grey ARGILLACEOUS LIMESTONE. Partially weathered to 3.9m with some increased facturing and oxidation staining along discontinuity surfaces. Discontinuity Set 1: Bedding, very close to medium spaced, 20 to 40°, planar, smooth, typically closed to open at close to medium spacing, clean to stained orangey brown above 3.9m.		
3.40 - 4.70	100	100	59			(3.70)			
4.70 - 6.20	70	70	70	7			*4.70-6.20m: Assumed zone of core loss.*		
6.20 - 7.00	0	0	0	NR		47.99 6.20	No recovery. Probably LIMESTONE.		
						(0.80)			
						47.19 7.00	End of core at 7.00 m		

Remarks

Core Barrel:	Water Strikes:		
+6	Struck (m)	Rose to (m)	Time (min)
Flush Type:			

Water Added:		Casing:	
From (m)	To (m)	To (m)	Diameter (mm)

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation	**Borehole No.** BH108
Method: 0.00–1.20 Inspection Pit; 1.20–2.60 Rotary Drilling; 2.60–6.80 Rotary Coring	**Co-ords:** 309256.52mE 238767.91mN	**Client:** Irish Water	Sheet 1 of 1
Plant: Hand Excavator+Comacchio 205	**Ground Level:** 59.37MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 02/12/2014	**Crew:** JG
			Logged By: DOM +MFG

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
						(0.20) 59.17 0.20	TOPSOIL		
							Stiff to very stiff dark grey slightly sandy slightly gravelly slightly silty CLAY with occasional cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded, fine to coarse.		
1.20	SPT (S)				86 (5,8/86 for 220mm)	(2.30)			
2.00	SPT (S)				50 (8,18/50 for 25mm)				
						56.87 2.50			
2.60 - 3.60	100	64	46	15			Medium strong thinly to thickly laminated dark grey speckled white fossiliferous ARGILLACEOUS LIMESTONE interbedded with medium to widely spaced very thin beds of weak black CARBONACEOUS LIMESTONE. Partially weathered with some slight brown staining along joint surfaces. Discontinuity Set 1: bedding planes, close to medium spaced, 15 to 30°, planar to curved, smooth, typically closed to occasionally open at close to medium spaced intervals, clean. Discontinuity Set 2: joints, widely spaced, subvertical to 70°, planar to stepped, rough, open, locally stained light brown.		
3.60 - 4.60	100	95	92	5					
4.60 - 5.60	100	91	66			(4.30)			
5.60 - 6.60	100	82	57	15 5					
6.60 - 6.80	100	80	40			52.57 6.80	End of core at 6.80 m		

Remarks

Core Barrel:	**Water Strikes:**		
7	**Struck (m)**	**Rose to (m)**	**Time (min)**
Flush Type:			

Water Added:		**Casing:**	
From (m)	**To (m)**	**To (m)**	**Diameter (mm)**

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation	**Borehole No.** BH109
Method: 2.50 6.20 Rotarty Coring; 1.20 2.50 Rotary Drilling; 0.00 1.20 Inspection Pit	**Co-ords:** 309775.62mE 239127.79mN	**Client:** Irish Water	Sheet 1 of 1
Plant: Comacchio 205+Hand Excavator	**Ground Level:** 71.94MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 03/12/2014	**Crew:** JG
			Logged By: MFG +DOM

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
						(0.30) 71.64 0.30	TOPSOIL		
							Stiff brownish grey slightly sandy slightly gravelly slightly silty CLAY with occasional cobbles and boulders. Sand is fine to coarse. Gravel is angular to subangular fine to coarse.		
1.20	SPT (S)				N=18 (3,4/5,4,4,5)	(2.00)			
2.00	SPT (S)				55 (4,4/55 for 125mm)				
						69.64 2.30			
2.50 - 3.50				NI		(0.35)	Destructured dark grey LIMESTONE - recovered as brownish grey angular to subangular fine to coarse clayey gravel		
	97	62	26	7		69.29 2.65	Medium strong thinly laminated dark grey speckled white fossiliferous ARGILLACEOUS LIMESTONE with medium to wiidely spaced very thin beds of weak black CARBONACEOUS LIMESTONE.		
				20			Partially weathered to 3.5m with orangey brown staining on joint surfaces, typically unweathered below.		
3.50 - 4.50	100	100	95	7					
4.50 - 5.50	100	97	31			(3.55)			
				20					
5.50 - 6.20	100	56	27	7					
						65.74 6.20	End of core at 6.20 m		

Remarks

Core Barrel:	**Water Strikes:**		
7	**Struck (m)**	**Rose to (m)**	**Time (min)**
Flush Type:			

Water Added:		**Casing:**	
From (m)	**To (m)**	**To (m)**	**Diameter (mm)**

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation	**Borehole No.** BH110
Method: 0.00–1.20 Inspection Pit; 1.20–2.80 Rotary Drilling; 2.80–7.50 Rotary Coring	**Co-ords:** 310992.31mE 239835.86mN	**Client:** Irish Water	Sheet 1 of 1
Plant: Hand Excavator+Comacchio 205	**Ground Level:** 76.98MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 04/12/2014	**Crew:** JG
			Logged By: DOM +MFG

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
						(0.30) 76.68 0.30	MADE GROUND		
0.50	ES						Stiff brownish grey slightly sandy slightly gravelly slightly silty CLAY with occasional cobbles. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
1.00	ES								
1.20	SPT (S)				N=17 (3,3/3,4,5,5)	*(2.50)*			
2.00	SPT (S)				N=25 (5,5/6,6,6,7)				
						74.18 2.80			
						(0.40)	Weak dark grey LIMESTONE. Probably destructured - recovered as clayey angular gravel.		
3.20 - 4.20	100	96	56	7		73.78 3.20	Medium strong thinly laminated grey to dark grey ARGILLACEOUS LIMESTONE. Partially weathered with some clay lining along joint surfaces. Discontinuity Set 1: Bedding planes, extremely closely spaced, subhorizontal to 20°, planar, smooth, typically closed to occasionally open at close to medium spacings, unstained to lined with grey clay <1mm thick.		
4.20 - 5.20	100	100	68						
5.20 - 6.20	100	98	54			*(4.30)*			
6.20 - 7.20	100	83	67						
7.20 - 7.50	100	100	100			69.48 7.50	End of core at 7.50 m		

Remarks

Core Barrel:

Flush Type:

Water Strikes: Struck (m)	Rose to (m)	Time (min)

Water Added: From (m)	To (m)	Casing: To (m)	Diameter (mm)

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation	**Borehole No.** BH111
Method: 1.00 5.40 Rotary coring; 0.00 1.00 Hand dug	**Co-ords:** 311065.92mE 239873.57mN	**Client:** Irish Water	Sheet 1 of 1
Plant: Comacchio 205+Hand tools	**Ground Level:** 76.63MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 12/12/2014	**Crew:** JC
			Logged By: MFG +DOM

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
						(0.10) 76.53 0.10	TOPSOIL Firm to stiff brown slightly sandy slightly gravelly slightly silty CLAY with occasional cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded, fine to coarse.		
						(0.70)			
						75.83 0.80 (0.20)	Dark grey LIMESTONE. Highly weathered (Driller's description)		
1.00 - 1.40	88	63	48	6		75.63 1.00	Medium strong thinly laminated dark grey ARGILLACEOUS LIMESTONE. Partially weathered to 2.4m with some increased fracturing and clay lining along joint surfaces. Discontinuity Set 1: Bedding planes, extremely closely spaced, subhorizontal to 20°, planar, smooth, typically closed to occasionally open at very close to close spacings, unstained to lined with clay film <1mm thick above 2.4m depth. Discontinuity Set 2: joint, subvertical, planar to curved, infilled with calcite, running from 4.7m to 5.4m		
1.40 - 1.90	70	0	0	NI					
1.90 - 2.70	91	90	70	8					
2.70 - 4.00	100	100	93	6		(4.40)	*2.25-2.40m: Weak, slightly fissile shaley LIMESTONE*		
4.00 - 5.40	97	97	56	4		71.23 5.40	End of core at 5.40 m		

Remarks

Core Barrel:	**Water Strikes:** Struck (m)	Rose to (m)	Time (min)
Flush Type:			
Water Added: From (m) / To (m)	**Casing:** To (m) / Diameter (mm)		

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation	**Borehole No.** BH112
Method: 0.00 7.00 Rotary Drilling	**Co-ords:** 311792.60mE 240612.28mN	**Client:** Irish Water	Sheet 1 of 1
Plant: Beretta T41	**Ground Level:** 78.80MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 03/02/2015	**Crew:** GT
			Logged By: DOM

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
						(0.30) 78.50 0.30	TOPSOIL		
							Firm brown slightly sandy gravelly slightly silty CLAY with occasional cobbles. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
						(2.00)			
1.50 1.50	SPT (S) D				N=14 (2,2/3,4,3,4)				
						76.50 2.30	Very stiff grey black slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse		
3.00 3.00	SPT (S) D				N=52 (12,10/14,12,12,14)				
4.50 4.50	SPT (S) D				50 (25 for 40mm/50 for 40mm)	*(4.70)*			
						71.80 7.00	End of core at 7.00 m		

Remarks

Core Barrel:	**Water Strikes:**		
	Struck (m)	**Rose to (m)**	**Time (min)**
Flush Type:			

Water Added:		**Casing:**	
From (m)	**To (m)**	**To (m)**	**Diameter (mm)**
		7.00	200

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation	**Borehole No.** BH113
Method: 0.00 8.00 Rotary Drilling	**Co-ords:** 311888.63mE 241154.58mN	**Client:** Irish Water	Sheet 1 of 1
Plant: Beretta T41	**Ground Level:** 78.77MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 03/02/2015	**Crew:** GT
			Logged By:

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
						(2.00)	MADE GROUND - brown slightly sandy gravelly slightly silty CLAY		
1.50 1.50	SPT (S) D				N=12 (2,2/3,2,3,4)				
						76.77 2.00	Stiff dark grey to black slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse		
3.00 3.00	SPT (S) D				N=18 (5,4/5,4,4,5)	*(2.50)*			
4.50 4.50	D SPT (S)				50 (25 for 50mm/50 for 60mm)	74.27 4.50	Very stiff dark grey to black slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
6.00 6.00	SPT (S) D				50 (25 for 35mm/50 for 50mm)	*(3.50)*			
						70.77 8.00	End of core at 8.00 m		

Remarks

Core Barrel:	**Water Strikes:** Struck (m)	Rose to (m)	Time (min)
Flush Type:			
Water Added: From (m)	To (m)	**Casing:** To (m)	Diameter (mm)
		2.00	200

AGS

Causeway Geotech Ltd	Project no. 14-645	Project Name: Greater Dublin Drainage Scheme Ground Investigation	Borehole No. BH114
Method: 8.50 14.50 Rotary Coring; 0.00 8.50 Rotary Drilling	**Co-ords:** 312375.60mE 241410.32mN	**Client:** Irish Water	Sheet 1 of 2
		Client's Representative: Tobin Consulting Engineers	**Scale:** 1:50
Plant: Beretta T41	**Ground Level:** 85.66MOD	**Dates:** 04/02/2015	**Crew:** GT
			Logged By: DOM

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
						(1.50)	MADE GROUND - Hardcore fill with pockets of brown CLAY.		
1.50 1.50	SPT (S) D				N=19 (2,2/3,4,5,7)	84.16 1.50	Stiff becoming very stiff grey slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse		
3.00 3.00	SPT (S) D				N=24 (3,4/5,6,7,6)				
4.50 4.50	SPT (S) D				50 (25 for 60mm/50 for 50mm)	*(7.00)*			
8.50 - 9.50	0	0	0			77.16 8.50	No recovery. Probably distinctly weathered to destructured LIMESTONE.		
9.50 - 10.50	0	0	0			*(3.00)*			

Continued on next sheet

Remarks

Core Barrel:	Water Strikes:		
T210	Struck (m)	Rose to (m)	Time (min)
Flush Type:	8.50	8.50	10

Water Added:		Casing:	
From (m)	To (m)	To (m)	Diameter (mm)

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation		**Borehole No.** BH114
Method: 8.50 14.50 Rotary Coring; 0.00 8.50 Rotary Drilling	**Co-ords:** 312375.60mE 241410.32mN	**Client:** Irish Water	Sheet 2 of 2
Plant: Beretta T41	**Ground Level:** 85.66MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 04/02/2015	**Crew:** GT
			Logged By: DOM

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
10.50 - 11.50	0	0	0						
11.50 - 12.50	100	95	88	20 1		74.16 11.50	Medium strong grey, white and yellow largely recrystallised LIMESTONE with very closely spaced coarse sand to medium gravel sized vugs. Distinctly weathered: vugs throughout, clay present on joints above 11.65m. DS1: Joints, close to medium spaced, subhorizontal to 30°, stepped and irregular, rough, open, clean. DS2: Joints, widely spaced, 60-70°, planar to slightly irregular, rough, open, patchy yellow staining, 1mm yellowish grey clay present on joint at 11.5-11.65m.		
12.50 - 13.50	65	60	60	4		(3.30)	*13.1-14.0m: Assumed zone of core loss.*		
13.50 - 14.50	54	37	14	NI 8					
14.50 - 14.80	100	100	100	3		70.86 14.80	End of core at 14.80 m		

Remarks

Core Barrel: T210

Flush Type:

Water Strikes:

Struck (m)	Rose to (m)	Time (min)
8.50	8.50	10

Water Added:

From (m)	To (m)

Casing:

To (m)	Diameter (mm)

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation		**Borehole No.** BH115
Method: 0.00 3.00 Rotary Drilling; 3.00 8.80 Rotary Coring	**Co-ords:** 312836.67mE 241631.51mN	**Client:** Irish Water	Sheet 1 of 1
			Scale: 1:50
Plant: Beretta T41		**Client's Representative:** Tobin Consulting Engineers	**Crew:** MFG
	Ground Level: 78.92MOD	**Dates:** 31/01/2015	**Logged By:** DOM

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
						(0.30) 78.62 0.30	TOPSOIL		
							Firm brown slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse, gravel is subangular to subrounded fine to coarse.		
1.50 1.50	SPT (S) D				N=13 (2,3/2,3,4,4)	*(2.70)*			
3.00 - 4.00	95	70	0			75.92 3.00	Medium strong thinly laminated dark grey to black slightly carbonaceous ARGILLACEOUS LIMESTONE.		
4.00 - 5.00	90	70	0	18			Partially weathered: oxidation staining on some joints, closer fracture spacing, especially above 6.3m.		
5.00 - 6.00	90	60	0				DS1: Bedding, subhorizontal to 10°, planar, smooth, typically closed to often open at very close spacing.		
6.00 - 7.00	100	90	22			*(5.80)*	DS2: Joints, medium spaced, 20-30°, stepped, rough, open, oxidised brown.		
7.00 - 8.00	100	100	63	10			DS3: Thin calcite veins, widely spaced, 70-80°, planar, smooth to rough, typically closed, occasionally open, 1mm calcite fill, stained brown.		
8.00 - 8.80	100	100	20			70.12 8.80	End of core at 8.80 m		

Remarks

Core Barrel: T2101

Flush Type:

Water Strikes:

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

Water Added:

From (m)	To (m)

Casing:

To (m)	Diameter (mm)
3.00	200

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation	**Borehole No.** BH116
Method: 0.00 2.00 Rotary Drilling; 2.00 9.70 Rotary Coring	**Co-ords:** 313163.53mE 241590.94mN	**Client:** Irish Water	Sheet 1 of 1
Plant: Beretta T41	**Ground Level:** 75.64MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 02/02/2015	**Crew:** GT
			Logged By: DOM +MFG

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
						(0.30) 75.34 0.30	TOPSOIL		
							Firm brown slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse		
						(1.70)			
1.50 1.50	SPT (S) D				N=14 (2,2/4,3,4,3)				
2.00 - 3.00	45	0	0			73.64 2.00	Weak thinly laminated black CARBONACEOUS LIMESTONE. Distinctly weathered: brown oxidised joints, weakened, much closer fracture spacing. DS1: Joints, very closely spaced, all angles but typically 60-80°, planar and stepped, rough, open, brown oxidation staining.		
3.00 - 4.00	40	0	0	NI			DS1: Bedding, 20-40°, planar, smooth, typically closed to occasionally open at very close to close spacing.		
4.00 - 5.00	45	5	0						
5.00 - 6.00	45	25	0	20		(6.80)			
6.00 - 7.00	40	5	0						
7.00 - 8.80	25	2	0	NI					
8.80 - 9.70	100	61	49	20		66.84 8.80	Medium strong thinly laminated dark grey ARGILLACEOUS LIMESTONE. DS1: Bedding thinly laminated 40 to 50°, planar, smooth, typically closed to often open between 8.8 and 9.25m at very close spacing no staining.		
				6		(0.90)			
						65.94 9.70	End of core at 9.70 m		

Remarks

Core Barrel:	**Water Strikes:**		
T2101	**Struck (m)**	**Rose to (m)**	**Time (min)**
Flush Type:			

Water Added:		**Casing:**	
From (m)	**To (m)**	**To (m)**	**Diameter (mm)**

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation	**Borehole No.** BH117	
Method: 0.00 6.00 Cable Percussion	**Co-ords:** 314059.18mE 241569.93mN	**Client:** Irish Water	Sheet 1 of 1
Plant: Dando 3000	**Ground Level:** 72.59MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 12/01/2015	**Crew:** CC
			Logged By: DOM

Depth (m)	Sample / Test	Casing Depth (m)	Water Depth (m)	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
					(0.35)	TOPSOIL		
0.35 - 1.20	B				72.24 0.35	Stiff brown slightly sandy slightly gravelly silty CLAY with rare cobbles. Sand is fine to coarse. Gravel is subangular to subrounded, fine to coarse.		
1.20	D				*(1.45)*			
1.20 - 1.65	U							
1.80 - 3.00	B				70.79 1.80	Firm to stiff dark grey to black slightly sandy slightly gravelly slightly silty CLAY with occasional cobbles and lenses of gravelly sand. Sand is fine to coarse. Gravel is subangular to subrounded, fine to coarse.		
2.00	SPT(S)			N=43 (4,6/10,10,11,12)				
2.00	D							
3.00 - 3.45	U							
3.50	D							
3.50 - 4.00	B							
4.00	SPT(S)			N=44 (5,7/9,11,12,12)	*(4.20)*			
4.00	D							
4.50 - 5.00	B							
5.00	SPT(S)			N=41 (6,6/8,10,10,13)				
5.00	D							
6.00	SPT(S)			N=38 (4,8/9,9,10,10)	66.59 6.00	End of borehole at 6.00 m		
6.00	D							

Remarks

SPTs carried out using SPT hammer CC04.
Borehole terminated at scheduled completion depth.

Chiselling:

From (m)	To (m)	Time (hh:mm)
0.00	1.20	01:00

Water Strikes:

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

Water Added:

From (m)	To (m)

Casing:

To (m)	Diameter (mm)
6.00	200

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation	**Borehole No.** BH118
Method: 0.00 8.50 Cable Percussion; 8.50 13.60 Rotary Drilling	**Co-ords:** 314809.73mE 241591.19mN	**Client:** Irish Water	Sheet 1 of 2
Plant: Dando 2000+Beretta T41	**Ground Level:** 70.22MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 22/01/2015	**Crew:** MMc+GT
			Logged By:

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
0.00 - 0.50	B					*(0.40)*	TOPSOIL - Brown slightly sandy clay with rootlets.		
0.50	D					69.82 0.40	Stiff brown slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subrounded to angular fine to coarse of sandstone		
1.20 1.20 - 1.65 1.20 - 1.65	SPT (S) D B				N=16 (2,3/4,3,4,5)	*(1.60)*			
2.00 2.00 - 2.45 2.00 - 2.45	SPT (S) D B				N=20 (4,5/6,4,5,5)	68.22 2.00	Stiff, becoming very stiff downhole, dark grey slightly sandy gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subrounded to angular fine to coarse of sandstone		
3.00 3.00 - 3.45 3.00 - 3.45	SPT (S) B D				N=20 (5,4/6,4,5,5)				
4.00 4.00 - 4.45 4.00 - 4.45	SPT (S) B D				N=22 (6,6/5,5,5,7)				
5.00 5.00 - 5.45 5.00 - 5.45	SPT (S) B D				N=23 (6,5/6,5,6,6)	*(6.50)*			
6.50 6.50 - 6.95 6.50 - 6.95	SPT (S) B D				N=31 (7,8/7,8,8,8)				
8.00 8.00 - 8.45 8.00 - 8.45	SPT (S) D B				N=32 (8,7/9,8,8,7)				
						61.72 8.50	Very stiff dark grey slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is angular to subangular, fine to coarse.		
10.00	SPT (S)				50 (25 for 20mm/50 for 30mm)				

Continued on next sheet

Remarks

Core Barrel:

Flush Type:

Water Strikes: Struck (m)	Rose to (m)	Time (min)
11.50	11.50	10

Water Added: From (m)	To (m)	Casing: To (m)	Diameter (mm)
		13.60	150

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation	**Borehole No.** BH118
Method: 0.00 8.50 Cable Percussion; 8.50 13.60 Rotary Drilling	**Co-ords:** 314809.73mE 241591.19mN	**Client:** Irish Water	Sheet 2 of 2
Plant: Dando 2000+Beretta T41	**Ground Level:** 70.22MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 22/01/2015	**Crew:** MMc+GT
			Logged By:

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
11.50	SPT (S)				50 (25 for 0mm/50 for 0mm)	*(5.10)*			
13.00	SPT (S)				50 (25 for 30mm/50 for 25mm)	56.62 13.60	End of core at 13.60 m		

Remarks

Core Barrel:

Flush Type:

Water Strikes:

Struck (m)	Rose to (m)	Time (min)
11.50	11.50	10

Water Added:

From (m)	To (m)

Casing:

To (m)	Diameter (mm)
13.60	150

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation	**Borehole No.** BH119
Method: 0.00 13.00 Rotary Drilling	**Co-ords:** 314889.92mE 241535.37mN	**Client:** Irish Water	Sheet 1 of 2
Plant: Beretta T41	**Ground Level:** 68.26MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 05/02/2015	**Crew:** GT
			Logged By: DOM

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
							TOPSOIL - Brown CLAY.		
						(2.00)			
1.50 1.50	SPT (S) D				N=18 (4,3/4,5,4,5)				
						66.26 2.00	Stiff becoming very stiff downhole slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse		
3.00 3.00	SPT (S) D				N=27 (5,6/5,7,8,7)				
4.50 4.50	D SPT (S)				N=34 (7,8/9,8,9,8)				
6.00	SPT (S)				50 (25 for 10mm/50 for 0mm)	*(11.00)*			
7.50 7.50	SPT (S) D				50 (25 for 50mm/50 for 60mm)				
9.00	SPT (S)				50 (25 for 70mm/50 for 80mm)				

Continued on next sheet

Remarks

Core Barrel:

Flush Type:

Water Strikes: Struck (m)	Rose to (m)	Time (min)

Water Added: From (m)	To (m)	Casing: To (m)	Diameter (mm)

AGS

Causeway Geotech Ltd	Project no. 14-645	Project Name: Greater Dublin Drainage Scheme Ground Investigation	Borehole No. BH119
Method: 0.00 13.00 Rotary Drilling	**Co-ords:** 314889.92mE 241535.37mN	**Client:** Irish Water	Sheet 2 of 2
		Client's Representative: Tobin Consulting Engineers	**Scale:** 1:50
Plant: Beretta T41	**Ground Level:** 68.26MOD	**Dates:** 05/02/2015	**Crew:** GT
			Logged By: DOM

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
						55.26 13.00	End of core at 13.00 m		

Remarks

Core Barrel:	Water Strikes: Struck (m)	Rose to (m)	Time (min)
Flush Type:			
Water Added: From (m)	To (m)	Casing: To (m)	Diameter (mm)

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation	**Borehole No.** BH120	
Method: 0.00 11.50 Cable Percussion	**Co-ords:** 314972.58mE 241471.58mN	**Client:** Irish Water	Sheet 1 of 2
Plant: Dando 2000	**Ground Level:** 65.99MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 13/01/2015	**Crew:** CC
			Logged By: DOM

Depth (m)	Sample / Test	Casing Depth (m)	Water Depth (m)	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
0.00 - 1.70	B					MADE GROUND - Firm brown grey CLAY with glass shards.		
0.50	ES							
					(1.70)			
1.00	ES							
1.20	D			N=10 (2,2/2,3,2,3)				
1.20	SPT(S)							
1.50	ES							
1.70 - 2.00	B				64.29 1.70	Stiff to very stiff brown slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse		
2.00	D			N=39 (4,6/9,9,10,11)				
2.00	ES							
2.00	SPT(S)							
					(1.40)			
3.00	D			N=45 (5,9/11,10,12,12)				
3.00	SPT(S)				62.89 3.10	Very stiff black slightly sandy gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
3.10 - 4.00	B							
4.00	D			50 (7,10/50 for 225mm)				
4.00	SPT(S)							
					(2.40)			
5.00	SPT(S)			N=35 (4,6/7,8,10,10)				
5.00	D							
5.50 - 6.50	B				60.49 5.50	Stiff black slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse		
6.50	D			N=23 (2,3/5,5,6,7)				
6.50	SPT(S)							
					(5.00)			
8.00	D			N=19 (3,3/4,5,5,5)				
8.00	SPT(S)							
8.00 - 9.00	B							
9.50	SPT(S)			N=29 (3,5/7,7,7,8)				
9.50	D							

Continued on next sheet

Remarks

SPTs carried out using SPT hammer CC04.
Refusal met on possible large boulder at 11.50m

Chiselling:

From (m)	To (m)	Time (hh:mm)
0.00	1.20	00:30
11.40	11.50	01:00

Water Strikes:

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

Water Added:

From (m)	To (m)

Casing:

To (m)	Diameter (mm)
11.40	200

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation		**Borehole No.** BH120
Method: 0.00 11.50 Cable Percussion	**Co-ords:** 314972.58mE 241471.58mN	**Client:** Irish Water	Sheet 2 of 2
Plant: Dando 2000	**Ground Level:** 65.99MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 13/01/2015	**Crew:** CC
			Logged By: DOM

Depth (m)	Sample / Test	Casing Depth (m)	Water Depth (m)	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
10.50 - 11.00	B				55.49 10.50	Stiff black slightly sandy gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse		
11.00	D				*(1.00)*			
					54.49 11.50	End of borehole at 11.50 m		

Remarks

SPTs carried out using SPT hammer CC04.
Refusal met on possible large boulder at 11.50m

Chiselling:

From (m)	To (m)	Time (hh:mm)
0.00	1.20	00:30
11.40	11.50	01:00

Water Strikes:

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

Water Added:

From (m)	To (m)

Casing:

To (m)	Diameter (mm)
11.40	200

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation	**Borehole No.** BH121
Method: 0.00 4.30 Cable Percussion; 4.30 11.90 Rotary Drilling	**Co-ords:** 315190.35mE 241508.11mN	**Client:** Irish Water	Sheet 1 of 2
Plant: Dando 2000+Comacchio 405	**Ground Level:** 66.66MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 13/01/2015	**Crew:** CC+GT
			Logged By: DOM

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
						(0.20)	MADE GROUND - Hardcore Fill		
0.20 - 1.20	B					66.46 0.20	MADE GROUND - Firm very sandy gravelly CLAY with occasional boulders.		
0.50	ES								
1.00	ES								
1.20	SPT		1.20		N=10 (2,3/3,3,2,2)				
1.20	(S)								
1.50	1.20 D ES					(2.50)			
2.00	SPT		2.00		N=17 (2,2/6,6,3,2)				
2.00	(S)								
2.00	2.00								
2.00 - 2.50	ES D B								
2.70	ES					63.96 2.70			
2.70 - 3.00	B						Very stiff black slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
3.00	3.00		3.00		50 (7,10/50 for 225mm)				
3.00	SPT								
	(S) D								
3.50 - 4.00	B					(1.80)			
4.00	D		4.00		50 (8,12/50 for 150mm)				
4.00	SPT								
	(S) 4.00								
						62.16 4.50	Very stiff to hard grey slightly sandy slightly gravelly slightly silty CLAY		
6.00	SPT				50 (25 for 0mm/50 for 0mm)				
	(S)								
						(7.40)			
7.50	SPT				50 (25 for 25mm/50 for 35mm)				
	(S)								
9.00	SPT				50 (25 for 45mm/50 for 35mm)				
	(S)								

Continued on next sheet

Remarks

SPTs carried out using SPT hammer CC04.

Core Barrel:

Flush Type:

Water Strikes:

Struck (m)	Rose to (m)	Time (min)
2.70	0.70	20
10.50	0.70	20

Water Added:

From (m)	To (m)

Casing:

To (m)	Diameter (mm)
4.30	200

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation		**Borehole No.** BH121
Method: 0.00 4.30 Cable Percussion; 4.30 11.90 Rotary Drilling	**Co-ords:** 315190.35mE 241508.11mN	**Client:** Irish Water	Sheet 2 of 2
Plant: Dando 2000+Comacchio 405	**Ground Level:** 66.66MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 13/01/2015	**Crew:** CC+GT
			Logged By: DOM

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
10.50	SPT (S)				50 (25 for 0mm/50 for 0mm)				
						54.76 11.90	End of core at 11.90 m		

Remarks

SPTs carried out using SPT hammer CC04.

Core Barrel:

Flush Type:

Water Strikes:

Struck (m)	Rose to (m)	Time (min)
2.70	0.70	20
10.50	0.70	20

Water Added:

From (m)	To (m)

Casing:

To (m)	Diameter (mm)
4.30	200

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation	**Borehole No.** BH122
Method: 0.00 10.50 Cable Percussion	**Co-ords:** 315511.95mE 241356.89mN	**Client:** Irish Water	Sheet 1 of 2
Plant: Dando 3000	**Ground Level:** 64.22MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 07/01/2015	**Crew:** CC
			Logged By: DOM

Depth (m)	Sample / Test	Casing Depth (m)	Water Depth (m)	Field Records	Level & Depth	Stratum Description
					(0.20)	TOPSOIL
0.20 - 1.20	B				64.02 0.20	Firm to stiff brown slightly sandy gravelly slightly silty CLAY with occasional cobbles and boulders. Gravel is subangular to subrounded fine to coarse. Sand is fine to medium.
					(1.50)	
1.20	SPT(S)			N=16 (3,3/4,3,4,5)		
1.20	D					
1.70 - 2.00	B				62.52 1.70	Very stiff black slightly sandy slightly gravelly slightly silty CLAY with occasional cobbles and boulders. Gravel is subangular to subrounded fine to coarse. Cobbles and boulders are subangular to subrounded.
2.50 - 3.00	B					
3.00	D			50 (6,7/50 for 225mm)		
3.00	SPT(S)					
4.00	D			50 (4,7/50 for 215mm)		
4.00	SPT(S)					
4.50 - 5.00	B					
5.00	SPT(S)			50 (7,13/50 for 200mm)		
5.00	D					
6.00 - 6.50	B				*(8.80)*	
6.50	SPT(S)			50 (25 for 125mm/50 for 150mm)		
6.50	D					
7.00 - 7.50	B					
7.50	SPT(S)			50 (9,12/50 for 225mm)		
7.50	D					
9.00	D			50 (11,14/50 for 150mm)		
9.00	SPT(S)					
9.50 - 10.00	B					

Continued on next sheet

Remarks

SPT's carried out using SPT Hammer CC04

Chiselling:

From (m)	To (m)	Time (hh:mm)
0.00	1.20	01:00

Water Strikes:

Struck (m)	Rose to (m)	Time (min)
3.90	2.6	20

Water Added:

From (m)	To (m)

Casing:

To (m)	Diameter (mm)
10.50	200

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation	**Borehole No.** BH122	
Method: 0.00 10.50 Cable Percussion	**Co-ords:** 315511.95mE 241356.89mN	**Client:** Irish Water	Sheet 2 of 2
Plant: Dando 3000	**Ground Level:** 64.22MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 07/01/2015	**Crew:** CC
			Logged By: DOM

Depth (m)	Sample / Test	Casing Depth (m)	Water Depth (m)	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
10.40 10.50	SPT(S) D			50 (10,13/50 for 200mm)	53.72 10.50	End of borehole at 10.50 m		

Remarks

SPT's carried out using SPT Hammer CC04

Chiselling:

From (m)	To (m)	Time (hh:mm)
0.00	1.20	01:00

Water Strikes:

Struck (m)	Rose to (m)	Time (min)
3.90	2.6	20

Water Added:

From (m)	To (m)

Casing:

To (m)	Diameter (mm)
10.50	200

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation	**Borehole No.** BH123
Method: 0.00 4.00 Cable Percussion; 4.00 8.00 Rotary Drilling	**Co-ords:** 316520.88mE 241732.26mN	**Client:** Irish Water	Sheet 1 of 1
Plant: Dando 3000+Beretta T41	**Ground Level:** 56.88MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 08/12/2014	**Crew:** CC+SJ
			Logged By: DOM

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
						(0.25)	MADE GROUND: Grey GRAVEL (hardcore fill).		
0.25 - 1.00	B					56.63 0.25	Firm to stiff dark brown slightly sandy gravelly silty CLAY with occasional cobbles and rare boulders. Sand is fine to coarse. Gravel is subangular to subrounded, fine to coarse.		
						(1.05)			
1.00 1.00	1.00 SPT (S)		1.00		N=15 (3,3/3,4,4,4)				
1.30 - 2.00	D B					55.58 1.30	Stiff dark brown slightly slightly sandy slightly gravelly slightly silty CLAY with occasional cobbles and rare boulders. Sand is fine to coarse. Gravel is subangular to subrounded, fine to coarse.		
						(1.20)			
2.00 2.00	2.00 SPT (S) D		2.00		N=19 (3,4/4,4,5,6)				
2.50 - 3.00	B					54.38 2.50	Very stiff dark grey to black slightly sandy slightly gravelly slightly silty CLAY with occasional cobbles and rare boulders. Sand is fine to coarse. Gravel is subangular to subrounded, fine to coarse.		
3.00 3.00	3.00 D SPT (S)		3.00		50 (25 for 50mm/50 for 75mm)				
						(1.50)			
4.00 4.00	4.00 D SPT (S)		4.00		50 (25 for 65mm/50 for 50mm)	52.88 4.00	Dark grey slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
5.50	SPT (S)				50 (8,30/50 for 75mm)				
						(4.00)			
7.00	SPT (S)				50 (25 for 50mm/50 for 75mm)				
8.00	SPT (S)				50 (7,28/50 for 75mm)	48.88 8.00	End of core at 8.00 m		

Remarks

Core Barrel:

Flush Type:

Water Strikes:

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

Water Added:

From (m)	To (m)

Casing:

To (m)	Diameter (mm)
4.00	200

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation		**Borehole No.** BH124
Method: 0.00 4.60 Cable Percussion; 4.60 10.00 Rotary Drilling	**Co-ords:** 317070.14mE 242222.29mN	**Client:** Irish Water	Sheet 1 of 1
Plant: Dando 2000+Beretta T41	**Ground Level:** 57.53MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 14/01/2015	**Crew:** CC+GT
			Logged By: DOM

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
0.00 - 1.20	B						Firm brown slightly sandy slightly gravelly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded, fine to coarse.		
						(2.10)			
1.20	D		1.20		N=11 (2,2/3,2,3,3)				
1.20	SPT (S)								
1.50					N=14 (2,2/3,3,4,4)				
1.50 - 2.00	1.20 SPT (S)								
	B								
2.00			2.00		N=31 (2,4/7,7,8,9)				
2.00	SPT (S)					55.43 2.10			
2.10 - 3.00	D 2.00 B						Very stiff grey slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse		
3.00	3.00		3.00	2.9	N=45 (6,9/10,11,11,13)				
3.00	SPT (S)								
	D								
3.50 - 4.00	B								
4.00	D		4.00	3.8	50 (9,12/50 for 150mm)				
4.00	4.00 SPT (S)								
6.00	SPT (S)				50 (25 for 10mm/50 for 10mm)	*(7.90)*			
7.50	SPT (S)				50 (25 for 80mm/50 for 100mm)				
7.50	D								
9.00	SPT (S)				50 (25 for 15mm/50 for 25mm)				
9.00	D								
						47.53 10.00	End of core at 10.00 m		

Remarks

SPTs carried out using SPT hammer CC04.

Core Barrel:

Flush Type:

Water Strikes:

Struck (m)	Rose to (m)	Time (min)
2.90	2.60	20

Water Added:

From (m)	To (m)

Casing:

To (m)	Diameter (mm)
4.60	200

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation	**Borehole No.** BH125
Method: 0.00 4.00 Cable Percussion; 4.00 11.20 Rotary Drilling	**Co-ords:** 317260.55mE 242227.75mN	**Client:** Irish Water	Sheet 1 of 2
Plant: Dando 2000+Beretta T41	**Ground Level:** 55.75MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 15/01/2015	**Crew:** CC+SJ
			Logged By: DOM

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
						(0.35)	TOPSOIL		
0.35	B					55.40 0.35	Stiff brown slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse		
1.20	D				N=19 (2,3/4,4,5,6)	*(1.45)*			
1.20	SPT (S)								
1.20	D								
1.80	B					53.95 1.80	Very stiff black slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse		
2.00	SPT (S)				N=50 (17 for 90mm/10,11,15,14)				
2.00	D								
3.00	SPT (S)				50 (6,9/50 for 200mm)	*(2.20)*			
3.00	D								
3.00	D								
3.50	B								
4.00	D				50 (10,15/50 for 150mm)	51.75 4.00	Very stiff dark gray slightly sandy slightly gravelly slightly silty CLAY with large boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Boulders are subangular to subrounded		
4.00	D								
4.00	SPT (S)								
6.20	SPT (S)				50 (10,29/50 for 75mm)	*(7.20)*			
7.70	SPT (S)				50 (12,13/50 for 10mm)				
9.20	SPT (S)				80 (8,32/80 for 150mm)				

Continued on next sheet

Remarks

SPTs carried out using SPT hammer CC04.

Core Barrel:

Flush Type:

Water Strikes: Struck (m)	Rose to (m)	Time (min)
2.80	2.6	20

Water Added: From (m)	To (m)	Casing: To (m)	Diameter (mm)
		4.00	200

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation		**Borehole No.** BH125
Method: 0.00 4.00 Cable Percussion; 4.00 11.20 Rotary Drilling	**Co-ords:** 317260.55mE 242227.75mN	**Client:** Irish Water	Sheet 2 of 2
			Scale: 1:50
Plant: Dando 2000+Beretta T41		**Client's Representative:** Tobin Consulting Engineers	**Crew:** CC+SJ
	Ground Level: 55.75MOD	**Dates:** 15/01/2015	**Logged By:** DOM

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
						44.55 11.20	End of core at 11.20 m		

Remarks

SPTs carried out using SPT hammer CC04.

Core Barrel:

Flush Type:

Water Strikes:

Struck (m)	Rose to (m)	Time (min)
2.80	2.6	20

Water Added:

From (m)	To (m)

Casing:

To (m)	Diameter (mm)
4.00	200

AGS

Causeway Geotech Ltd	Project no. 14-645	Project Name: Greater Dublin Drainage Scheme Ground Investigation	Borehole No. BH126
Method: 0.00 4.70 Cable Percussion; 4.70 11.70 Rotary Drilling	**Co-ords:** 318086.46mE 242037.20mN	**Client:** Irish Water	Sheet 1 of 2
			Scale: 1:50
Plant: Dando 2000+Beretta T41		**Client's Representative:** Tobin Consulting Engineers	**Crew:** CC+GT
	Ground Level: 51.32MOD	**Dates:** 16/01/2015	**Logged By:** DOM

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
						(0.20)	TOPSOIL		
0.20	B					51.12 0.20	Stiff brown slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse		
						(1.00)			
1.20	D				N=23 (3,3/4,5,7,7)	50.12 1.20	Very stiff black slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse		
1.20	SPT (S)								
1.20	D								
1.70	B								
2.00	D				N=49 (7,10/10,11,13,15)				
2.00	SPT (S)								
2.50	D								
2.50	B								
3.00	SPT (S)				50 (6,9/50 for 150mm)	(3.50)			
3.00	D								
3.50	B								
3.50	D								
4.00	D				50 (25 for 130mm/50 for 130mm)				
4.00	SPT (S)								
4.50	D								
						46.62 4.70	Very stiff to hard black slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse		
5.50	SPT (S)				50 (25 for 20mm/50 for 0mm)				
7.00	SPT (S)				50 (25 for 3mm/50 for 0mm)				
						(7.00)			
8.50	SPT (S)				50 (25 for 20mm/50 for 0mm)				
10.00	SPT (S)				50 (25 for 0mm/50 for 0mm)				

Continued on next sheet

Remarks

Core Barrel:

Flush Type:

Water Strikes: Struck (m)	Rose to (m)	Time (min)
7.00	7.0	10

Water Added: From (m)	To (m)	Casing: To (m)	Diameter (mm)
		4.70	200

Causeway Geotech Ltd	Project no. 14-645	Project Name: Greater Dublin Drainage Scheme Ground Investigation	Borehole No. BH126
Method: 0.00 4.70 Cable Percussion; 4.70 11.70 Rotary Drilling	**Co-ords:** 318086.46mE 242037.20mN	**Client:** Irish Water	Sheet 2 of 2
		Client's Representative: Tobin Consulting Engineers	**Scale:** 1:50
Plant: Dando 2000+Beretta T41	**Ground Level:** 51.32MOD	**Dates:** 16/01/2015	**Crew:** CC+GT
			Logged By: DOM

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
11.50	SPT (S)				50 (25 for 20mm/50 for 225mm)	39.62 11.70	End of core at 11.70 m		

Remarks

Core Barrel:

Flush Type:

Water Strikes:

Struck (m)	Rose to (m)	Time (min)
7.00	7.0	10

Water Added:

From (m)	To (m)

Casing:

To (m)	Diameter (mm)
4.70	200

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation	**Borehole No.** BH127
Method: 0.00 4.50 Cable Percussion; 4.50 9.50 Rotary Drilling	**Co-ords:** 318292.95mE 241991.77mN	**Client:** Irish Water	Sheet 1 of 1
Plant: Dando 2000+Beretta T41	**Ground Level:** 49.17MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 14/01/2015	**Crew:** CC+SJ
			Logged By: DOM+

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
						(0.30)	TOPSOIL		
0.30 - 1.20	B					48.87 0.30	Stiff to very stiff brown grey slightly sandy slightly gravelly slightly clayey SILT. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
						(1.50)			
1.20 1.20	1.20 SPT (S) D		1.20		N=31 (4,6/6,7,9,9)				
1.80 - 2.00	B					47.37 1.80	Very stiff black slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
2.00 2.00	2.45 SPT (S) D		2.45		N=49 (6,8/10,11,13,15)				
2.50 - 3.00	B								
3.00 3.00	D SPT (S)				50 (9,15/50 for 150mm)	*(2.70)*			
4.00 4.00	4.00 D SPT (S)		4.00		50 (11,14/50 for 150mm)				
						44.67 4.50	Dark grey slightly sandy slightly gravelly slightly silty CLAY with large boulder. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
6.00	SPT (S)				86 (11,34/86 for 150mm)				
						(5.00)			
7.50	SPT (S)				50 (25 for 60mm/50 for 10mm)				
9.50	SPT (S)				50 (7,35/50 for 75mm)	39.67 9.50	End of core at 9.50 m		

Remarks

SPTs carried out using SPT hammer CC04.

Core Barrel:

Flush Type:

Water Strikes: Struck (m)	Rose to (m)	Time (min)

Water Added: From (m)	To (m)

Casing: To (m)	Diameter (mm)
4.50	200

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation	**Borehole No.** BH128
Method: 0.00 3.60 Cable Percussion; 3.60 8.00 Rotary Drilling	**Co-ords:** 318814.73mE 241844.11mN	**Client:** Irish Water	Sheet 1 of 1
Plant: Dando 2000+Beretta T41	**Ground Level:** 45.95MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 06/01/2015	**Crew:** CC+SJ
			Logged By: DOM

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
0.00 - 0.30	B					*(0.30)*	TOPSOIL		
0.30 - 1.10	B					45.65 0.30	Firm to stiff light brown slightly sandy slightly gravelly slightly clayey SILT with occasional cobbles and boulders. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse.		
						(0.80)			
1.10 - 2.00	B					44.85 1.10	Very stiff black slightly sandy gravelly slightly silty CLAY with occasional cobbles and boulders. Gravel is subrounded to subangular fine to coarse.		
1.20	D								
1.20	U								
2.00	SPT				N=41 (4,8/10,10,11,10)				
2.00	(S)								
	D					*(2.50)*			
2.50 - 3.00	B								
3.00	U								
3.50	D				50 (25 for 25mm/50 for 50mm)				
3.50	SPT					42.35 3.60	Very stiff to hard dark grey slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse		
	(S)								
5.00	SPT				50 (9,26/50 for 75mm)				
	(S)								
						(4.40)			
6.50	SPT				50 (7,32/50 for 75mm)				
	(S)								
8.00	SPT				50 (6,28/50 for 75mm)	37.95 8.00	End of core at 8.00 m		
	(S)								

Remarks

SPT's carried out using SPT Hammer CC04

Core Barrel:

Flush Type:

Water Strikes:

Struck (m)	Rose to (m)	Time (min)
3.60	3.10	20

Water Added:

From (m)	To (m)

Casing:

To (m)	Diameter (mm)
3.60	200

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation	**Borehole No.** BH130
Method: 0.00 4.00 Cable Percussion; 4.00 7.60 Rotary Drilling	**Co-ords:** 320784.92mE 242815.26mN	**Client:** Irish Water	Sheet 1 of 1
Plant: Dando 2000+Beretta T41	**Ground Level:** 28.54MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 22/01/2015	**Crew:** MMc+GT
			Logged By:

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
						(0.40)	TOPSOIL - Light brown slightly sandy clay with rootlets		
						28.14 0.40			
0.50 - 1.00 0.50 - 1.00	D B						Firm brown mottled grey slightly sandy slightly gravelly slightly silty CLAY. Gravel is subrounded to angular fine to coarse of sandstone		
						(1.10)			
1.20 1.20 - 1.65 1.20 - 1.65	SPT (S) B D				N=14 (3,3/4,3,3,4)				
						27.04 1.50			
							Stiff grey mottled brown slightly gravelly slightly silty CLAY. Gravel is subrounded to angular fine to coarse of sandstone		
2.00 2.00 - 2.45 2.00 - 2.45	SPT (S) B D				N=21 (5,4/5,6,5,5)	*(1.00)*			
						26.04 2.50			
							Stiff dark grey slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to rounded fine to coarse.		
3.00 3.00 - 3.45 3.00 - 3.45	SPT (S) D B				N=25 (6,5/6,6,7,6)	*(1.50)*			
4.00 4.00 - 4.45 4.00 - 4.50	SPT (S) B D				N=30 (7,6/7,8,8,7)	24.54 4.00	Very stiff dark grey slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to rounded fine to coarse.		
5.00 5.00 - 5.45 5.00 - 5.45	SPT (S) B D				N=30 (7,7/6,7,8,9)				
						(3.60)			
7.00	SPT (S)				50 (25 for 2mm/50 for 3mm)				
						20.94 7.60			
							End of core at 7.60 m		

Remarks

Core Barrel:

Flush Type:

Water Strikes:

Struck (m)	Rose to (m)	Time (min)
7.00	7.0	10

Water Added:

From (m)	To (m)

Casing:

To (m)	Diameter (mm)
7.60	150

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation	**Borehole No.** BH131
Method: 0.00–3.00 Cable Percussion; 3.00–5.60 Rotary Drilling; 5.60–7.60 Rotary Coring	**Co-ords:** 321261.16mE 242801.77mN	**Client:** Irish Water	Sheet 1 of 1
Plant: Dando 2000+Beretta T41	**Ground Level:** 22.70MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 21/01/2015	**Crew:** MMc+GT
			Logged By: +MFG

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
						(0.10) 22.60 0.10	TOPSOIL		
						(0.20) 22.40 0.30	White mottled grey slightly clayey slightly silty fine to coarse SAND		
0.50 - 1.00	D						Stiff brown mottled grey slightly sandy gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse		
0.50 - 1.00	B								
1.20	SPT				N=17 (4,4/3,4,5,5)	(1.90)			
1.20 - 1.65	(S)								
1.20 - 1.65	D								
	B								
2.00	SPT				N=19 (4,5/6,5,4,4)				
2.00 - 2.45	(S)					20.50 2.20			
2.00 - 2.45	B						Stiff to very stiff dark grey slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
	D								
2.50 - 3.00	B					(0.80)			
2.50 - 3.00	D								
3.00	SPT				50 (25 for 30mm/50 for 20mm)	19.70 3.00	Stiff dark grey CLAY with frequent boulders.		
	(S)								
						(2.60)			
5.00	SPT				50 (25 for 5mm/50 for 5mm)				
	(S)								
5.60 - 6.60						17.10 5.60	Medium strong, thinly laminated to very thinly bedded, dark grey ARGILLACEOUS LIMESTONE.		
	90	84	84				Partially weathered.		
							DS1: Joints, close to medium spaced, horizontal to 20° planar, smooth to rough, open, occasional oxidised brown, rare slickensides.		
6.60 - 7.60				4		(2.00)			
	90	85	76						
						15.10 7.60	End of core at 7.60 m		

Remarks

Core Barrel:	**Water Strikes:**		
+Impreg	**Struck (m)**	**Rose to (m)**	**Time (min)**
Flush Type:	5.00	5.0	10

Water Added:		**Casing:**	
From (m)	**To (m)**	**To (m)**	**Diameter (mm)**
		5.50	150

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation		**Borehole No.** BH132
Method: 0.00 4.50 Rotary Drilling; 4.50 7.60 Rotary Coring	**Co-ords:** 321296.46mE 242799.15mN	**Client:** Irish Water	Sheet 1 of 1
Plant: Beretta T41	**Ground Level:** 22.49MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 11/02/2015	**Crew:** GT
			Logged By: MFG

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
						(0.20) 22.29 0.20	TOPSOIL Brown marly CLAY		
						(1.80)			
						20.49 2.00	Grey slightly slightly sandy slightly gravelly slightly silty CLAY with occasional cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded, fine to coarse.		
						(2.50)			
4.50 - 5.50	95	91	49	NI 5 20 5		17.99 4.50	Medium strong thinly laminated dark grey to black CARBONACEOUS LIMESTONE with fine to coarse sand sized pyrite crystals scattered throughout. Partially weathered: Slightly closer fracture spacing and patchy brownish grey staining on some joints. DS1: Bedding, thinly laminated 40 to 50°, smooth, typically closed to often open at very close or close spacing, unstained. DS2: Joints, medium spaced, 70 to 90°, planar, smooth, open, patchy light brownish grey staining. DS3: Calcite vein at 4.95m, 45°, planar, rough, open, up to 5mm calcite, unstained.		
5.50 - 6.50	75	48	15	15 20 12		(3.10)			
6.50 - 7.60	77	27	0	20		14.89 7.60	End of core at 7.60 m		

Remarks

Core Barrel:	**Water Strikes:**		
T2101	**Struck (m)**	**Rose to (m)**	**Time (min)**
Flush Type:			

Water Added:		**Casing:**	
From (m)	**To (m)**	**To (m)**	**Diameter (mm)**
		4.50	151

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation	**Borehole No.** BH133
Method: 0.00 5.50 Cable Percussion; 5.50 7.60 Rotary Drilling	**Co-ords:** 321944.99mE 242233.04mN	**Client:** Irish Water	Sheet 1 of 1
Plant: Dando 2000+Beretta T41	**Ground Level:** 18.76MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 23/01/2015	**Crew:** MMc+GT
			Logged By: DOM

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
						(0.40)	TOPSOIL - Brown slightly sandy firm clay with rootlets		
						18.36 0.40			
0.50 - 1.00	D					*(0.20)*	Brown clayey silty fine to medium SAND		
0.50 - 1.00	B					18.16 0.60	Stiff to very stiff brown slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subrounded to angular fine to coarse		
1.20	SPT				N=19 (4,5/5,4,5,5)				
1.20 - 1.65	(S)								
1.20 - 1.65	B								
	D								
2.00	2.00		2.00		N=19 (5,5/4,5,5,5)	*(2.70)*			
2.00 - 2.35	SPT								
2.00 - 2.45	(S)								
	B								
	D								
3.00	SPT		3.00		N=31 (9,8/7,8,9,7)				
3.00 - 3.45	(S)								
3.00 - 3.45	3.00								
	B					15.46 3.30			
	D						Very stiff black slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subrounded to angular fine to coarse		
4.00	SPT		4.00		N=31 (7,8/7,9,7,8)				
4.00 - 4.45	(S)								
4.00 - 4.45	4.00								
	B								
	D								
5.00	SPT		5.00		N=37 (9,10/8,10,9,10)				
5.00 - 5.45	(S)					*(3.70)*			
5.00 - 5.45	5.00								
	B								
5.50	D		5.50		50 (25 for 81mm/50 for 125mm)				
	5.50								
	SPT								
	(S)								
6.50	SPT				50 (25 for 50mm/50 for 40mm)				
	(S)								
						11.76 7.00			
						(0.60)	Coarse GRAVEL (possible boulder)		
						11.16 7.60	End of core at 7.60 m		

Remarks

Core Barrel:

Flush Type:

Water Strikes:

Struck (m)	Rose to (m)	Time (min)
7.00	7.0	10

Water Added:

From (m)	To (m)
0.00	5.50

Casing:

To (m)	Diameter (mm)
5.50	200

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation	**Borehole No.** BH134
Method: 0.00 7.50 Cable Percussion	**Co-ords:** 322387.05mE 241837.46mN	**Client:** Irish Water	Sheet 1 of 1
Plant: Dando 3000	**Ground Level:** 11.63MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 08/01/2015 - 09/01/2015	**Crew:** CC
			Logged By: DOM

Depth (m)	Sample / Test	Casing Depth (m)	Water Depth (m)	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
					(0.30)	TOPSOIL		
0.30 - 1.20	B				11.33 0.30	Firm to stiff brown slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded, fine to coarse.		
					(1.50)			
1.20	D							
1.20	U							
1.80 - 2.50	B				9.83 1.80	Very stiff dark grey to black slightly sandy slightly gravelly slightly silty CLAY with occasional cobbles. Sand is fine to coarse. Gravel is subangular to subrounded, fine to coarse.		
2.00	SPT(S)			N=50 (6,9/50 for 240mm)				
2.00	D							
3.00	SPT(S)			50 (8,13/50 for 200mm)				
3.00	D				*(2.70)*			
3.50 - 4.00	B							
4.00	SPT(S)			50 (25 for 140mm/50 for 130mm)				
4.00	D							
4.50 - 6.00	B				7.13 4.50	Very stiff dark greyish brown slightly sandy slightly gravelly slightly silty CLAY with occasional cobbles and rare boulders. Sand is fine to coarse. Gravel is angular to subangular, fine to coarse.		
5.00	SPT(S)			N=50 (7,9/50 for 235mm)				
5.00	D							
					(3.00)			
6.50	SPT(S)			N=50 (9,11/12,12,13,13)				
6.50	D							
					4.13 7.50	End of borehole at 7.50 m		

Remarks

SPT's carried out using SPT Hammer CC04
Refusal met on possible large boulder

Chiselling:

From (m)	To (m)	Time (hh:mm)
0.00	1.30	01:00
7.20	7.80	01:30

Water Strikes:

Struck (m)	Rose to (m)	Time (min)
7.00	6.50	20

Water Added:

From (m)	To (m)

Casing:

To (m)	Diameter (mm)
7.50	200

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation		**Borehole No.** BH135
Method: 0.00 8.40 Cable Percussion	**Co-ords:** 322408.09mE 241838.13mN	**Client:** Irish Water	Sheet 1 of 1
		Client's Representative: Tobin Consulting Engineers	**Scale:** 1:50
Plant: Dando 2000	**Ground Level:** 11.18MOD	**Dates:** 27/01/2015	**Crew:** MMc
			Logged By: MMc

Depth (m)	Sample / Test	Casing Depth (m)	Water Depth (m)	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
					(0.30)	TOPSOIL		
					10.88 0.30			
0.50 - 1.00	D					Stiff to very stiff brown mottled grey slightly sandy slightly gravelly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse, of various lithologies.		
0.50 - 1.00	B							
1.20	SPT(S)			N=20 (3,3/4,5,6,5)				
1.20 - 1.65	D							
1.20 - 1.65	B				*(2.40)*			
2.00	SPT(S)			N=36 (3,5/7,10,10,9)				
2.00 - 2.45	D							
2.00 - 2.45	B							
					8.48 2.70			
3.00	SPT(S)			N=33 (4,5/6,8,10,9)		Very stiff dark grey slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of various lithologies.		
3.00 - 3.45	D							
3.00 - 3.45	B							
4.00	SPT(S)			N=36 (6,8/7,9,10,10)				
4.00 - 4.45	B							
4.00 - 4.45	D							
					(3.80)			
5.00	SPT(S)			N=43 (8,9/10,11,10,12)				
5.00 - 5.45	B							
5.00 - 5.45	D							
6.50	SPT(S)			N=50 (7,9/50 for 275mm)	4.68 6.50	Very stiff brown slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of various lithologies, gravelly below 7m.		
6.50 - 6.95	D							
6.50 - 6.95	B				*(0.90)*			
					3.78 7.40	Very stiff brown slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of various lithologies.		
8.00	SPT(C)			50 (9,10/50 for 160mm)	*(1.00)*			
8.00 - 8.40	B							
8.00 - 8.40	D							
					2.78 8.40	End of borehole at 8.40 m		

Remarks

Chiselling:

From (m)	To (m)	Time (hh:mm)
7.40	8.40	02:00

Water Strikes:

Struck (m)	Rose to (m)	Time (min)
7.40	6.5	20

Water Added:

From (m)	To (m)
0.00	7.40

Casing:

To (m)	Diameter (mm)
8.40	200

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation	**Borehole No.** BH137
Method: 0.00 7.60 Cable Percussion; 7.60 10.90 Symmetrix	**Co-ords:** 323078.15mE 241730.65mN	**Client:** Irish Water	Sheet 1 of 2
Plant: Dando 2000+Beretta T41	**Ground Level:** 8.68MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 27/01/2015	**Crew:** MMc
			Logged By: DOM

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
						(0.50)	TOPSOIL - soft to firm brown sandy clay with rootlets.		
0.50 - 1.00 0.50 - 1.00	D B					8.18 0.50	Stiff brown slightly sandy slightly gravelly silty CLAY. Sand is fine to coarse. Gravel is subangular to rounded fine to coarse.		
1.20 1.20 - 1.65 1.20 - 1.65	SPT (S) B D				N=23 (5,6/5,7,6,5)				
2.00 2.00 - 2.45 2.00 - 2.45	SPT (S) D B				N=24 (5,7/6,5,6,7)	*(3.20)*			
3.00 3.00 - 3.45 3.00 - 3.45	SPT (S) B D				N=29 (6,7/8,7,7,7)				
						4.98 3.70	Very stiff dark grey slightly sandy slightly gravelly slightly silty CLAY with occasional cobbles. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of various lithologies.		
4.00 4.00 - 4.45 4.00 - 4.45	SPT (S) B D				N=40 (7,8/8,9,10,13)	*(1.30)*			
5.00 5.00 - 5.45 5.00 - 5.45	SPT (S) D B				N=48 (7,8/10,14,12,12)	3.68 5.00	Very stiff dark grey slightly sandy gravelly slightly silty CLAY with occasional cobbles. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of various lithologies.		
6.50 6.50 6.50	D B SPT (S)				N=46 (9,10/11,12,12,11)				
7.40 7.40 - 7.80 7.40 - 7.80	SPT (C) B D				50 (10,11/50 for 125mm)	*(5.90)*			
9.00	SPT (S)				50 (25 for 0mm/50 for 0mm)		*Coarse GRAVEL (possibly a broken up boulder)*		

Continued on next sheet

Remarks

Refusal met on possible large boulder at 7.6m

Core Barrel:

Flush Type:

Water Strikes:

Struck (m)	Rose to (m)	Time (min)
9.50	9.50	10

Water Added:

From (m)	To (m)

Casing:

To (m)	Diameter (mm)
7.60	200

Causeway Geotech Ltd	Project no. 14-645	Project Name: Greater Dublin Drainage Scheme Ground Investigation	Borehole No. BH137
Method: 0.00 7.60 Cable Percussion; 7.60 10.90 Symmetrix	**Co-ords:** 323078.15mE 241730.65mN	**Client:** Irish Water	Sheet 2 of 2
		Client's Representative: Tobin Consulting Engineers	**Scale:** 1:50
Plant: Dando 2000+Beretta T41	**Ground Level:** 8.68MOD	**Dates:** 27/01/2015	**Crew:** MMc
			Logged By: DOM

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
						-2.22 10.90	End of core at 10.90 m		

Remarks

Refusal met on possible large boulder at 7.6m

Core Barrel:

Flush Type:

Water Strikes:

Struck (m)	Rose to (m)	Time (min)
9.50	9.50	10

Water Added:

From (m)	To (m)

Casing:

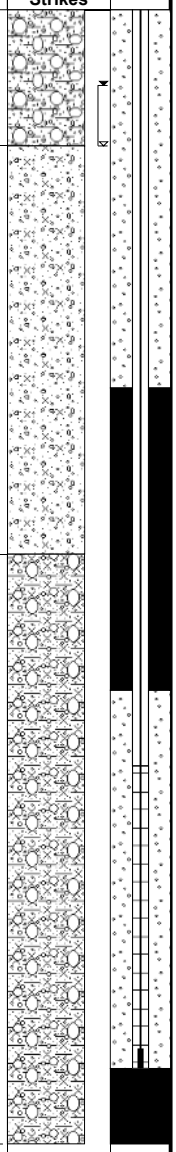
To (m)	Diameter (mm)
7.60	200

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation	**Borehole No.** BH138	
Method: 0.00 7.50 Cable Percussion	**Co-ords:** 323173.16mE 241183.17mN	**Client:** Irish Water	Sheet 1 of 1
Plant: Dando3000	**Ground Level:** 4.22MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 10/12/2014	**Crew:** CC
			Logged By: DOM

Depth (m)	Sample / Test	Casing Depth (m)	Water Depth (m)	Field Records	Level & Depth		Stratum Description
0.00 - 0.90	B						Firm to stiff brown sandy gravelly CLAY with occasional cobbles and boulders. Sand is fine to coarse. Gravel is angular to subrounded, fine to coarse.
					(0.90)		
0.90 - 1.50	B				3.32	0.90	Medium dense grey slightly silty slightly sandy subangular to rounded fine to coarse GRAVEL with occasional cobbles. Sand is fine to coarse.
1.00	D	1.00	0.7	N=16 (3,3/4,3,4,5)			
1.00	SPT(C)						
2.00	SPT(C)	2.00	1.2	N=12 (2,3/3,3,3,3)			
2.00	D				*(2.70)*		
2.50 - 3.00	B						
3.00	SPT(C)	3.00	2.6	N=17 (1,1/2,3,5,7)			
3.00	D						
3.60 - 4.00	B				0.62	3.60	Very stiff dark grey to black slightly sandy slightly gravelly slightly silty CLAY with occasional cobbles and boulders. Sand is fine to coarse. Gravel is angular to subrounded, fine to coarse.
4.00	U						
4.50	D						
5.00	D	5.00	4.8	50 (8,12/50 for 200mm)			
5.00	SPT(S)						
5.50 - 6.00	B				*(3.90)*		
6.00	SPT(S)	6.00		50 (3,11/50 for 150mm)			
6.00	D						
6.50 - 7.00	B						
7.00	SPT(S)	7.00		50 (25 for 75mm/50 for 125mm)			
7.00	D						
					-3.28	7.50	End of borehole at 7.50 m



Remarks

Chiselling:

From (m)	To (m)	Time (hh:mm)
0.00	1.00	00:30

Water Strikes:

Struck (m)	Rose to (m)	Time (min)
0.90	0.50	20

Water Added:

From (m)	To (m)
0.90	3.60

Casing:

To (m)	Diameter (mm)
7.50	200

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation	**Borehole No.** BH139
Method: 0.00 14.50 Cable Percussion; 14.50 78.40 Rotary Coring	**Co-ords:** 323824.04mE 241663.70mN	**Client:** Irish Water	Sheet 1 of 8
Plant: Dando 2000+Beretta T41	**Ground Level:** 9.07MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 04/02/2015 - 12/02/2015	**Crew:** MMcC
			Logged By: DOM +MFG

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
						(0.40)	TOPSOIL		
						8.67 0.40			
0.50 - 1.00 0.50 - 1.00	D B						Stiff brown slightly sandy slightly gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse, various lithologies.		
1.20 1.20 - 1.65 1.20 - 1.65	SPT (S) B D				N=19 (5,6/5,5,4,5)	*(2.30)*			
2.00 2.00 - 2.45 2.00 - 2.45	SPT (S) D B				N=26 (7,6/7,7,6,6)				
						6.37 2.70			
3.00 3.00 - 3.45 3.00 - 3.45	SPT (S) D B				N=42 (7,9/10,11,10,11)		Very stiff black slightly sandy slightly gravelly slightly silty CLAY with occasional cobbles. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
4.00 4.00 - 4.45 4.00 - 4.45	SPT (S) D B				N=36 (7,8/8,10,9,9)				
5.00 5.00 - 5.45 5.00 - 5.45	SPT (S) B D				N=41 (8,9/9,10,12,10)	*(4.80)*			
6.00 - 6.45	B								
6.50 6.50	D SPT (S)				N=37 (7,9/10,8,9,10)				
						1.57 7.50			
8.00 8.00 - 8.45 8.00 - 8.45	SPT (S) D B				N=25 (6,7/6,7,6,6)		Stiff dark grey slightly sandy slightly gravelly slightly silty CLAY with occasional cobbles. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		

Continued on next sheet

Remarks

Core Barrel:

Flush Type:

Water Strikes: Struck (m)	Rose to (m)	Time (min)

Water Added: From (m)	To (m)

Casing: To (m)	Diameter (mm)
74.50	200

AGS

Causeway Geotech Ltd	Project no. 14-645	Project Name: Greater Dublin Drainage Scheme Ground Investigation	Borehole No. BH139
Method: 0.00 14.50 Cable Percussion; 14.50 78.40 Rotary Coring	**Co-ords:** 323824.04mE 241663.70mN	**Client:** Irish Water	Sheet 2 of 8
Plant: Dando 2000+Beretta T41	**Ground Level:** 9.07MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 04/02/2015 - 12/02/2015	**Crew:** MMcC
			Logged By: DOM +MFG

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
						(7.00)			
14.50 - 15.60	100	0	0	NA		-5.43 14.50 (1.50)	Dark brown clayey very gravelly SAND with occasional cobbles and boulders. Sand is fine to coarse. Gravel is angular to subangular fine to coarse. Cobbles are subangular to subrounded. *14.6m to 14.90m: Limestone boulder*		
15.60 - 16.90	100	0	0	NI		-6.93 16.00	Extremely weak to weak grey and light brown LIMESTONE. Distinctly weathered to destructured: greatly weakened, much closer fracture spacing and frequently recovered as ordered to disordered lithorelics in light brown sandy clay matrix.		
16.90 - 18.40	100	22	0	20		(4.10)			
18.40 - 19.90	100	4	0	NI					
19.90 - 21.40						-11.03 20.10	Weak to medium strong, locally very weak, grey with light brown patches		

Continued on next sheet

Remarks

Core Barrel:

Flush Type:

Water Strikes: Struck (m)	Rose to (m)	Time (min)

Water Added: From (m)	To (m)	Casing: To (m)	Diameter (mm)
		74.50	200

AGS

Causeway Geotech Ltd	Project no. 14-645	Project Name: Greater Dublin Drainage Scheme Ground Investigation	Borehole No. BH139
Method: 0.00 14.50 Cable Percussion; 14.50 78.40 Rotary Coring	**Co-ords:** 323824.04mE 241663.70mN	**Client:** Irish Water	Sheet 3 of 8
Plant: Dando 2000+Beretta T41	**Ground Level:** 9.07MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 04/02/2015 - 12/02/2015	**Crew:** MMcC
			Logged By: DOM +MFG

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
							LIMESTONE. Distinctly weathered, occasionally partially destructured: weakened, closer fracture spacing. Yellowish light brown oxidation staining penetrating in. DS1: Joints, close to medium spaced, subhorizontal to 50°, planar to irregular, smooth to rough, open, typically filled with 1 to 10mm soft light brown sandy clay, oxidation staining often penetrating in. DS2: Joints, medium spaced, 70° to vertical, undulating, smooth to rough, open, typically filled with 1 to 10mm soft light brown sandy clay.		
21.40 - 22.90	100	76	40	5					
	100	37	9	15		(4.50)			
22.90 - 24.40	100	60	9	10					
24.40 - 25.80				NI			*24.0m to 24.6m: Very weak, partially destructured.*		
	100	67	33			-15.53 24.60	Medium strong, grey LIMESTONE. Partially weathered. DS1: Joints, medium spaced, horizontal to 40°, planar, smooth to rough, open, occasionally clean, typically filled with 10 to 20mm light brown soft sandy clay. DS2: Joints, medium to widely spaced, 70° to subvertical, planar to undulating, smooth to rough, open, thin light brown clay film.		
25.80 - 27.40	100	90	30	8					
27.40 - 28.90	100	80	26			(6.05)			
28.90 - 30.40	100	90	73	5					
30.40 - 31.90									

Continued on next sheet

Remarks

Core Barrel:	Water Strikes: Struck (m)	Rose to (m)	Time (min)
Flush Type:			

Water Added: From (m)	To (m)	Casing: To (m)	Diameter (mm)
		74.50	200

Causeway Geotech Ltd	Project no. 14-645	Project Name: Greater Dublin Drainage Scheme Ground Investigation	Borehole No. BH139
Method: 0.00 14.50 Cable Percussion; 14.50 78.40 Rotary Coring	**Co-ords:** 323824.04mE 241663.70mN	**Client:** Irish Water	Sheet 4 of 8
Plant: Dando 2000+Beretta T41	**Ground Level:** 9.07MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 04/02/2015 - 12/02/2015	**Crew:** MMcC
			Logged By: DOM +MFG

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
						-21.58 30.65	Medium strong, grey to dark grey LIMESTONE with soft clay joint horizons. Partially weathered: oxidation staining penetrating in from some joints. DS1: Clay filled joints, close to medium spaced, subhorizontal to 50°, planar to slightly undulating, smooth, open, filled with 10 to 50mm soft orangey or yellowish light brown clay. DS2: Joints, widely spaced, 70° to subvertical, planar to undulating, smooth to rough, open, occasionally incipient, typically stained brown.		
	100	87	57	NI					
31.90 - 33.40									
	100	75	43	8					
33.40 - 34.90									
	100	65	17	15		*(7.55)*			
34.90 - 36.40									
	100	91	86						
36.40 - 37.90									
	96	80	72	4					
37.90 - 39.40									
	100	20	12	NI		-29.13 38.20 *(1.20)*	Extremely weak to weak, grey LIMESTONE. Distinctly weathered to destructured: greatly weakened, much closer fracture spacing and largely recovered as ordered lithorelics in yellowish grey clay matrix.		
39.40 - 40.90						-30.33 39.40	Extremely weak light grey fine grained SANDSTONE interbedded with extremely weak yellowish light grey SILTSTONE. Destructured: greatly weakened, mottled oxidation staining throughout. Largely recovered as firm to stiff sandy clay.		
	80	0	0						

Continued on next sheet

Remarks

Core Barrel:	Water Strikes: Struck (m)	Rose to (m)	Time (min)
Flush Type:			
Water Added: From (m) / To (m)	**Casing:** To (m)	Diameter (mm)	
	74.50	200	

Causeway Geotech Ltd	Project no. 14-645	Project Name: Greater Dublin Drainage Scheme Ground Investigation	Borehole No. BH139
Method: 0.00 14.50 Cable Percussion; 14.50 78.40 Rotary Coring	**Co-ords:** 323824.04mE 241663.70mN	**Client:** Irish Water	Sheet 5 of 8
Plant: Dando 2000+Beretta T41	**Ground Level:** 9.07MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 04/02/2015 - 12/02/2015	**Crew:** MMcC
			Logged By: DOM +MFG

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
40.90 - 42.40	94	0	0	NI		(3.75)			
42.40 - 43.90	100	0	0	NI		-34.08 43.15 (0.70)	Extremely weak light grey mottled yellow MUDSTONE. Destructured: greatly weakened, mottled yellow oxidation staining throughout. Recovered as stiff clay.		
43.90 - 45.40	100	13	0	NI		-34.78 43.85 (1.75)	Extremely weak to very weak, light grey fine grained SANDSTONE, with coarse sand-sized clear to brown calcite crystals occurring with increasing frequency from 44.9m to 45.6m. Distinctly weathered to destructured: greatly weakened, mottled oxidation staining, largely recovered as clayey sand.		
45.40 - 46.90	88	67	67	2		-36.53 45.60 (1.00)	Weak to medium strong grey and yellow LIMESTONE. Distinctly weathered slightly weakened, mottled oxidation staining, gravel-sized vugs created by dissolution.		
46.90 - 48.40	94	38	13	NI 10		-37.53 46.60 (0.50) -38.03 47.10	Extremely weak, light grey to yellow fine grained SANDSTONE, with frequent coarse sand-sized clear to brown calcite crystals. Destructured: greatly weakened, mottled oxidation staining, recovered as clayey sand. Very weak to weak grey LIMESTONE with extremely weak SANDSTONE horizons. Distinctly weathered to destructured: greatly weakened, much closer fracture spacing, locally recovered as ordered lithorelics in light brown, sandy clay matrix. Occasional red staining on some joints.		
48.40 - 49.90	93	31	0			(4.95)			
49.90 - 51.40	63	10	0	NI			*49.70m to 49.90m: Extremely weak destructured sandstone: possibly indicative of the type of material lost in subsequent two core runs.* *49.90m to 51.40m: AZCL*		

Continued on next sheet

Remarks

Core Barrel:

Flush Type:

Water Strikes: Struck (m)	Rose to (m)	Time (min)

Water Added: From (m)	To (m)

Casing: To (m)	Diameter (mm)
74.50	200

Causeway Geotech Ltd	Project no. 14-645	Project Name: Greater Dublin Drainage Scheme Ground Investigation	Borehole No. BH139
Method: 0.00 14.50 Cable Percussion; 14.50 78.40 Rotary Coring	**Co-ords:** 323824.04mE 241663.70mN	**Client:** Irish Water	Sheet 6 of 8
Plant: Dando 2000+Beretta T41	**Ground Level:** 9.07MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 04/02/2015 - 12/02/2015	**Crew:** MMcC
			Logged By: DOM +MFG

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
51.40 - 52.90	37	2	0	NR		-42.98 52.05 *(0.85)*	NO RECOVERY		
52.90 - 54.40	100	77	57	11		-43.83 52.90	Weak to medium strong, locally very weak close to some joints grey occasionally mottled yellow LIMESTONE. Partially to distinctly weathered: Closer fracture spacing, greatly weakened at some joints with yellow oxidation staining penetrating in. DS1: Joints, close to medium spaced, 30°to 50°, planar to stepped or undulating, smooth to rough, open, filled with <1 to 30mm light brown or yellow soft to stiff sandy clay. Red staining on some joints. Yellow staining often penetrating in up to 50mm, with corresponding very weak zone and occasionally very closely spaced anastomosing incipient joints. DS2: Joints, widely spaced, subvertical, undulating and very irregular, smooth to rough, open, to incipient, filled with 1 to 20mm light brown or yellow firm sandy clay.		
54.40 - 55.90	100	40	26						
55.90 - 57.40	100	100	95	3		*(8.80)*			
57.40 - 58.90	100	73	15	14					
58.90 - 60.40	100	53	23						
60.40 - 61.90	100	100	76	5					

Continued on next sheet

Remarks

Core Barrel:	Water Strikes: Struck (m)	Rose to (m)	Time (min)
Flush Type:			
Water Added: From (m) / To (m)	**Casing:** To (m)	Diameter (mm)	
	74.50	200	

Causeway Geotech Ltd	Project no. 14-645	Project Name: Greater Dublin Drainage Scheme Ground Investigation	Borehole No. BH139
Method: 0.00 14.50 Cable Percussion; 14.50 78.40 Rotary Coring	**Co-ords:** 323824.04mE 241663.70mN	**Client:** Irish Water	Sheet 7 of 8
Plant: Dando 2000+Beretta T41	**Ground Level:** 9.07MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:50
		Dates: 04/02/2015 - 12/02/2015	**Crew:** MMcC
			Logged By: DOM +MFG

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
						-52.63 61.70	Medium strong to strong thinly to thickly laminated dark grey ARGILLACEOUS LIMESTONE. Mostly unweathered. DS1: Bedding, thinly to thickly laminated, 30 to 50°, planar, smooth to rough, typically closed to occasionally open at medium to wide spacing, typically unstained. One at 63.75m stained blood red. DS2: Calcite veins at 72.4-73.3m, closely spaced, 50 to 80°, planar and stepped, closed with up to 30mm calcite. Open at 72.4m to72.5m with brown sandy clay film and brown staining.		
61.90 - 63.40	100	100	100	3					
63.40 - 64.90	100	100	100						
64.90 - 66.40	100	100	100						
66.40 - 67.90	100	100	100	2		*(16.70)*			
67.90 - 69.40	100	100	100						
69.40 - 70.90	100	100	100	1					
70.90 - 72.40									

Continued on next sheet

Remarks

Core Barrel:	Water Strikes: Struck (m)	Rose to (m)	Time (min)
Flush Type:			

Water Added: From (m)	To (m)	Casing: To (m)	Diameter (mm)
		74.50	200

AGS

Causeway Geotech Ltd	Project no. 14-645	Project Name: Greater Dublin Drainage Scheme Ground Investigation	Borehole No. BH139
Method: 0.00 14.50 Cable Percussion; 14.50 78.40 Rotary Coring	**Co-ords:** 323824.04mE 241663.70mN	**Client:** Irish Water	Sheet 8 of 8
			Scale: 1:50
Plant: Dando 2000+Beretta T41		**Client's Representative:** Tobin Consulting Engineers	**Crew:** MMcC
	Ground Level: 9.07MOD	**Dates:** 04/02/2015 - 12/02/2015	**Logged By:** DOM +MFG

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
	100	100	100						
72.40 - 73.90	100	83	70				*72.4m to 73.3m: Calcite veins*		
73.90 - 75.40	100	100	100						
75.40 - 76.90	100	100	92	3					
76.90 - 78.40	100	95	60				*76.8m to 78.0m: 50 to 70mm thick vein, subvertical, planar, slightly undulating, closed to incipient, filled with calcite and quartz mineralisation, and stiff yellowish brown clay.*		
						-69.33 78.40	End of core at 78.40 m		

Remarks

Core Barrel:

Flush Type:

Water Strikes:

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

Water Added:

From (m)	To (m)

Casing:

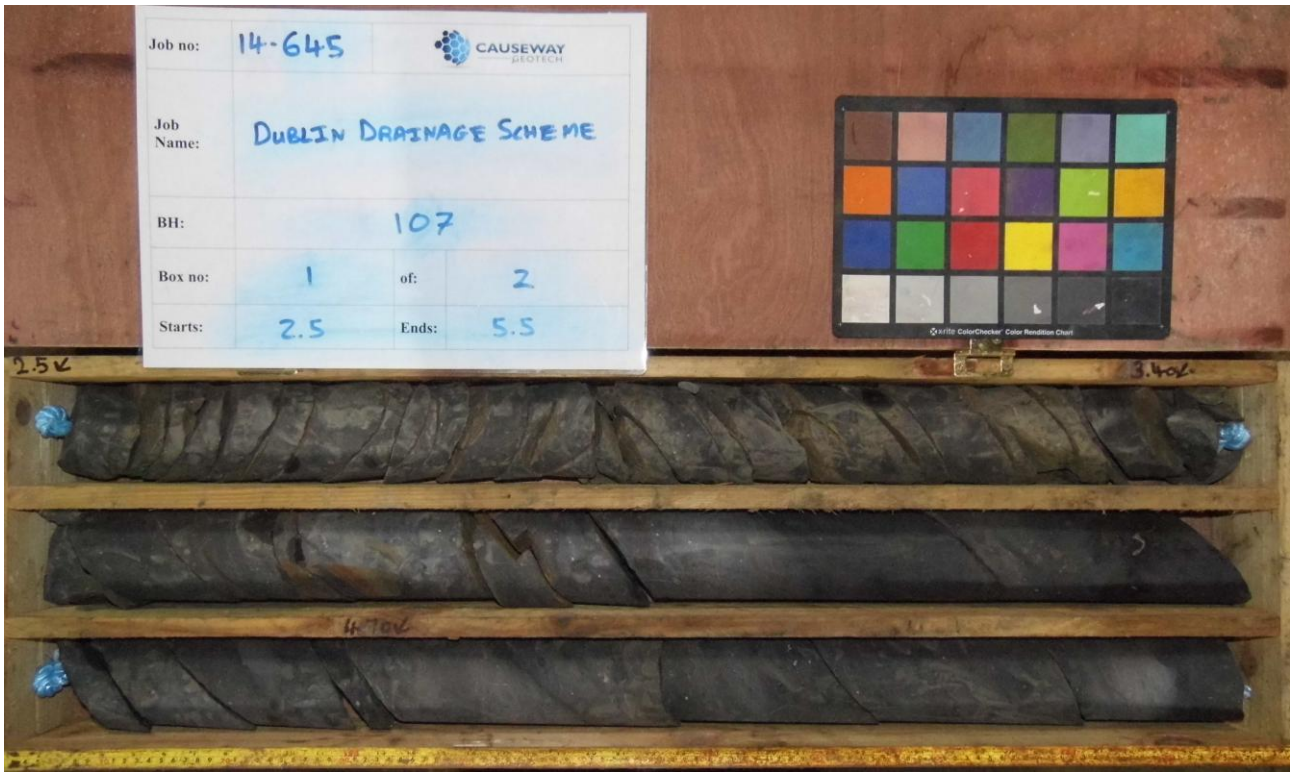
To (m)	Diameter (mm)
74.50	200

AGS

Appendix C
Core photographs

BH106 2.30-5.15m

BH106 5.15-7.00m



BH107 2.5-5.5m

BH107 5.5-6.2m

BH108 2.6-5.6m

BH108 5.6-6.8m

BH109 2.5-5.5m

BH109 5.5-6.2m

BH110 3.2-6.2m

BH110 6.2-7.5m

BH111 1.0-4.0m

BH111 4.0-5.4m

BH114 11.5-14.8m

BH115 3.0-6.0m

BH115 6.0-8.8m


Job no: 14-645
CAUSEWAY GEOTECH
Job Name: GREATER DUBLIN DRAINAGE SCHEME
BH: 116
Box no: 1
of: 3
Starts: 2.0
Ends: 5.0

BH116 2.0-5.0m

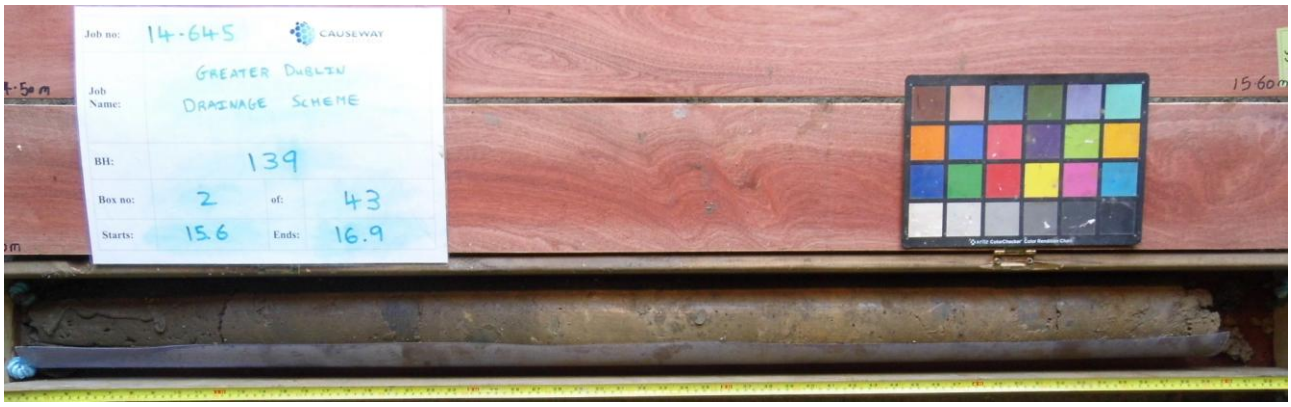
BH116 5.0-8.8m

BH116 8.8-9.7m

BH131 5.6-7.6m

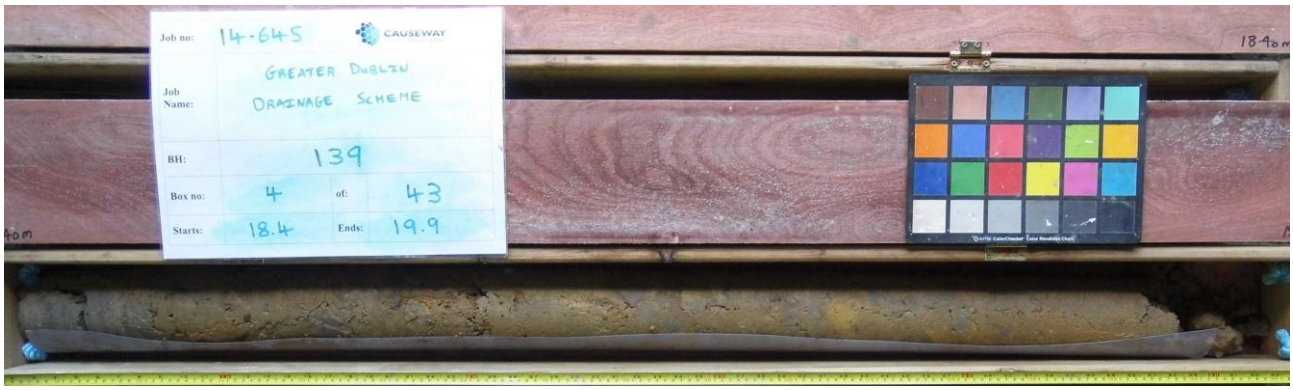
BH132 4.5-7.6m

BH139 14.5-15.6m



BH139 15.6-16.9m

BH139 16.9-18.4m



BH139 18.4-19.9m

BH139 19.9-21.4m

BH139 21.4-22.9m

BH139 22.9-24.4m

BH139 24.4-25.9m

BH139 25.9-27.4m

BH139 27.4-28.9m

BH139 28.9-30.4m

BH139 30.4-31.9m

BH139 31.9-33.4m

BH139 33.4-34.9m

BH139 34.9-36.4m

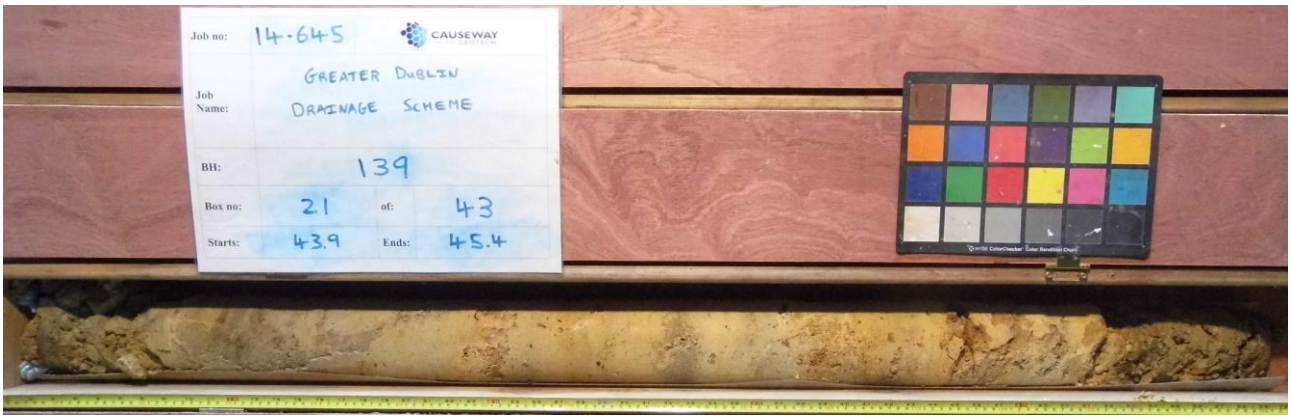
BH139 36.4-37.9m

BH139 37.9-39.4m

BH139 39.4-40.9m

BH139 40.9-42.4m

BH139 42.4-43.9m



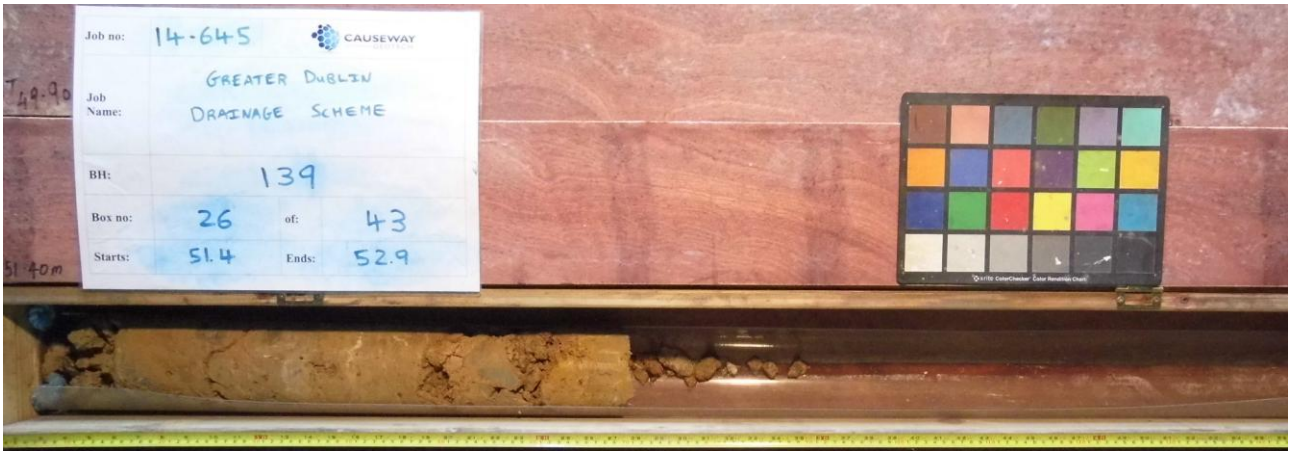
BH139 43.9-45.4m

BH139 45.4-46.9m

BH139 46.9-48.4m

BH139 48.4-49.9m

BH139 49.9-51.4m



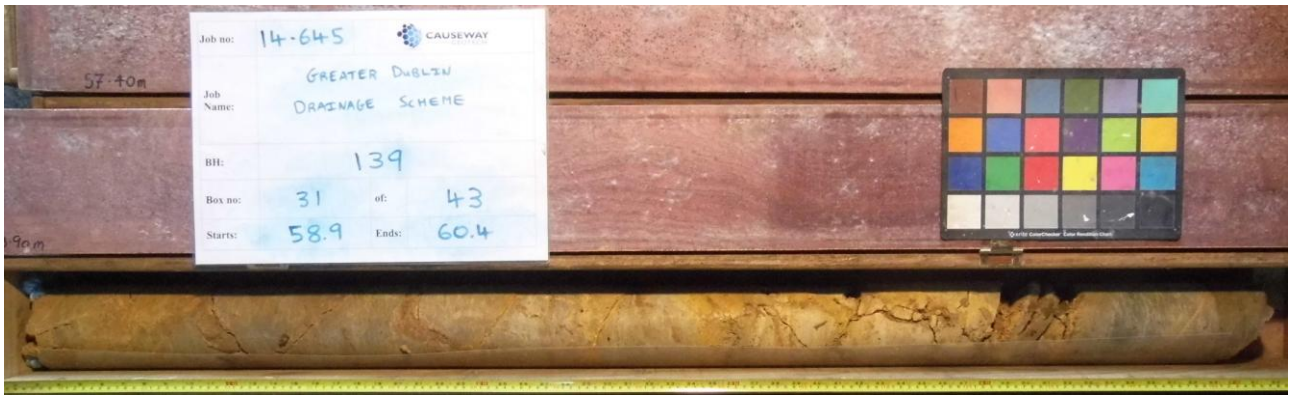
BH139 51.4-52.9m

BH139 52.9-54.4m

BH139 54.4-55.9m

BH139 55.9-57.4m

BH139 57.4-58.9m



BH139 58.9-60.4m

BH139 60.4-61.9m

BH139 61.9-63.4m

BH139 63.4-64.9m

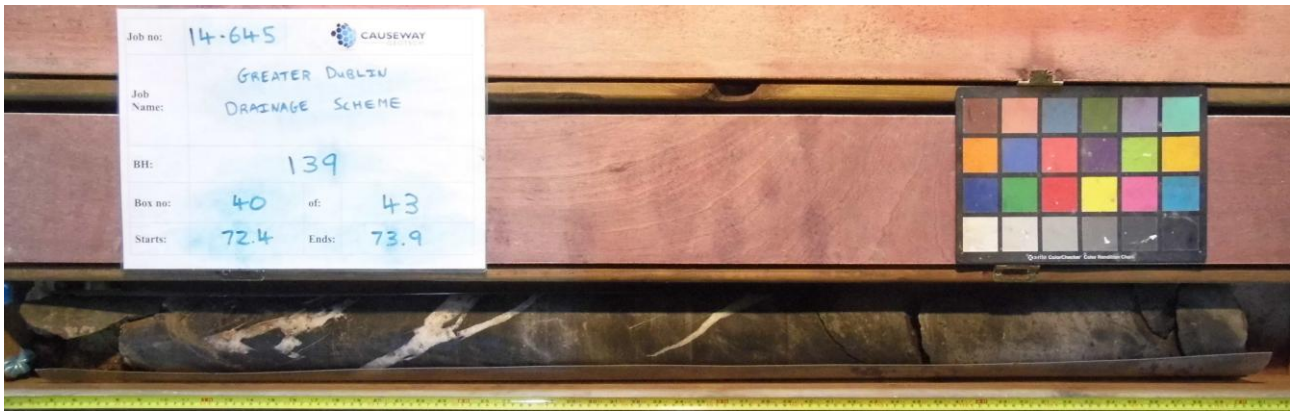
BH139 64.9-66.4m

BH139 66.4-67.9m

BH139 67.9-69.4m

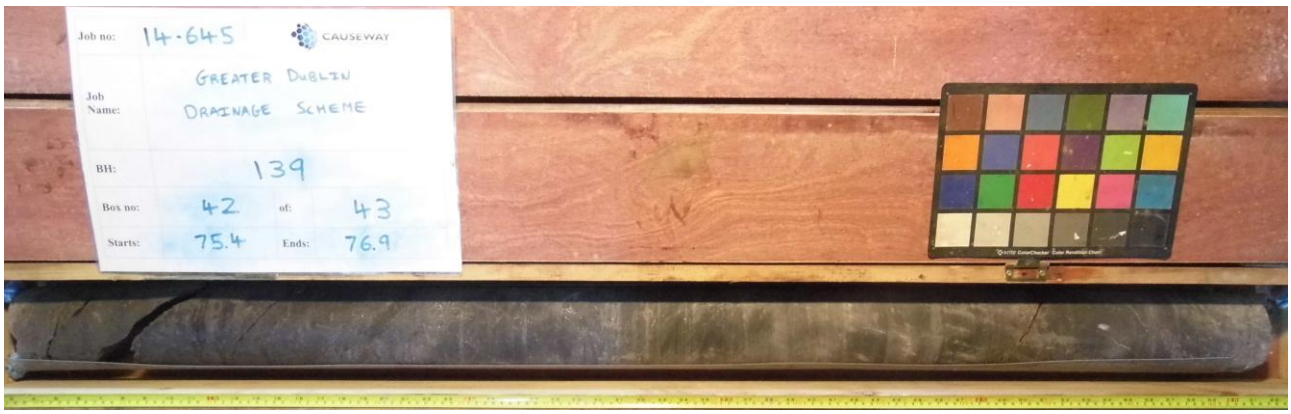
BH139 69.4-70.9m

BH139 70.9-72.4m



BH139 72.4-73.9m

BH139 73.9-75.4m



BH139 75.4-76.9m

BH139 76.9-78.4m

Appendix D
Trial pit logs

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation			**Trialpit No.** TP101
Method: Trial Pitting	**Plant:** 7t tracked excavator	**Co-ords:** 308841.24mE 238648.55mN	**Client:** Irish Water	Sheet 1 of 1
Width: 0.50m **Length:** 2.00m	**Bearing:** (deg. N) D C A B	**Ground Level:** 49.58MOD	**Client's Representative:** Tobin Consulting Engineers **Dates:** 11/12/2014	**Scale:** 1:25 **Crew:** **Logged By:** DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
			(0.10) 49.48 0.10	TOPSOIL		
0.20	ES			MADE GROUND - Soft to firm light brown slightly sandy slightly gravelly slightly clayey SILT with fragments of plastic and glass. Gravel is subrounded to subangular fine to medium.		
0.50	B		(1.05)			
0.80	ES					
			48.43 1.15	End of trial pit at 1.15 m		

Remarks

Refusal met on possible limestone bedrock

Water Strikes:

Struck (m)	Flow Details
1.40	

Stability: Stable

Difficulty:

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation			**Trialpit No.** TP102
Method: Trial Pitting	**Plant:** 7t tracked excavator	**Co-ords:** 308968.37mE 238667.25mN	**Client:** Irish Water	Sheet 1 of 1
Width: 0.50m	**Bearing:** D / C / A / B		**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:25
Length: 2.20m	(deg. N)	**Ground Level:** 54.59MOD	**Dates:** 11/12/2014	**Crew:** / **Logged By:** DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
			(0.20)	TOPSOIL		
			54.39 0.20	Firm brown slightly sandy gravelly slightly silty CLAY. Sand is fine to coarse. Gravel is subrounded to subangular fine to medium.		
0.50	B		(0.50)			
			53.89 0.70	Firm grey slightly sandy gravelly slightly silty CLAY with fragments of weathered roots. Sand is fine to coarse. Gravel is subrounded to subangular fine to medium.		
			(0.90)			
1.50	B		52.99 1.60	Possible limestone BEDROCK		
			(0.05) 52.94 1.65	End of trial pit at 1.60 m		

Remarks

Refusal met on possible limestone bedrock

Water Strikes:

Struck (m)	Flow Details

Stability: Stable

Difficulty:

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation			**Trialpit No.** TP103
Method: Trial Pitting	**Plant:** 7t tracked excavator	**Co-ords:** 309248.62mE 238753.21mN	**Client:** Irish Water	Sheet 1 of 1
Width: 0.50m	**Bearing:** D C A B		**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:25
Length: 1.80m	(deg. N)	**Ground Level:** 59.12MOD	**Dates:** 11/12/2014	**Crew:** **Logged By:** DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
				TOPSOIL		
			(0.40)			
			58.72 0.40	Firm brown slightly sandy slightly gravelly slightly clayey SILT. Gravel is subrounded to subangular fine to medium.		
0.50	B		*(0.40)*			
			58.32 0.80			
0.90	B		*(0.15)*	Firm brown slightly sandy slightly gravelly slightly clayey SILT with fragments of weathered roots and occasional cobbles. Sand is fine to coarse. Gravel is subrounded to subangular fine to medium		
			58.17 0.95	End of trial pit at 0.95 m		

Remarks

Refusal met on possible limestone bedrock

Water Strikes:

Struck (m)	Flow Details

Stability: Stable

Difficulty:

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation			**Trialpit No.** TP104
Method: Trial Pitting	**Plant:** 7t tracked excavator	**Co-ords:** 309762.45mE 239136.59mN	**Client:** Irish Water	Sheet 1 of 1
Width: 0.50m	**Bearing:** D C A B		**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:25
Length: 3.00m	(deg. N)	**Ground Level:** 71.56MOD	**Dates:** 11/12/2014	**Crew:** **Logged By:** DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
			(0.30) 71.26 0.30	TOPSOIL		
0.50	B		*(0.40)* 70.86 0.70	Firm brown slightly sandy slightly gravelly slightly clayey SILT with occasional cobbles. Sand is fine to coarse. Gravel is subrounded to subangular fine to medium.		
1.00	B		*(0.50)* 70.36 1.20	Firm grey brown slightly sandy slightly gravelly slightly clayey SILT with occasional cobbles. Sand is fine to coarse. Gravel is subrounded to subangular fine to medium.		
			(0.15) 70.21 1.35	Firm grey brown slightly sandy gravelly slightly silty CLAY with fragments of weathered roots. Gravel is subrounded to subangular fine to medium. End of trial pit at 1.35 m		

Remarks

Refusal met on possible limestone bedrock

Water Strikes:

Struck (m)	Flow Details

Stability:

Stable

Difficulty:

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation			**Trialpit No.** TP105
Method: Trial Pitting	**Plant:** 7t tracked excavator	**Co-ords:** 311068.44mE 239872.32mN	**Client:** Irish Water	Sheet 1 of 1
Width: 0.50m	**Bearing:** D / C / A / B		**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:25
Length: 1.80m	(deg. N)	**Ground Level:** 76.51MOD	**Dates:** 11/12/2014	**Crew:**
				Logged By: DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
			(0.10) 76.41 0.10	TOPSOIL		
0.30	ES			MADE GROUND - Firm brown grey slightly sandy slightly gravelly slightly silty CLAY with fragments of plastic and timber. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse.		
0.50	B		*(1.00)*			
1.00	ES					
			75.41 1.10	Firm brown slightly sandy slightly gravelly slightly silty CLAY with occasional cobbles. Gravel is subrounded to subangular fine to medium.		
			(0.50)			
1.50	ES					
1.50	B		74.91 1.60	End of trial pit at 1.60 m		

Remarks

Refusal met on possible large boulder or bedrock

Water Strikes:

Struck (m)	Flow Details

Stability: Stable

Difficulty:

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation			**Trialpit No.** TP106
Method: Trial Pitting	**Plant:** 7t tracked excavator	**Co-ords:** 310989.18mE 239835.24mN	**Client:** Irish Water	Sheet 1 of 1
Width: 0.50m	**Bearing:** D C A B (deg. N)	**Ground Level:** 77.01MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:25
Length: 2.10m			**Dates:** 11/12/2014	**Crew:**
				Logged By: DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
			77.01 0.00	TOPSOIL		
			(0.10)			
			76.91 0.10	MADE GROUND - Firm brown sandy slightly gravelly silty CLAY with fragments of brick, glass and timber. Sand is fine to coarse. Gravel is subrounded to subangular fine to coarse.		
0.20	ES					
0.30	B		*(0.35)*			
			76.56 0.45	Firm brown slightly sandy gravelly slightly silty CLAY. Gravel is subrounded to subangular fine to medium.		
0.60	ES					
0.80	B					
				End of trial pit at 0.95 m		

Remarks

Refusal met on possible limestone bedrock

Water Strikes:

Struck (m)	Flow Details

Stability: Stable

Difficulty:

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation			**Trialpit No.** TP107
Method: Trial Pitting	**Plant:** 7t tracked excavator	**Co-ords:** 311795.47mE 240613.08mN	**Client:** Irish Water	Sheet 1 of 1
Width: 0.50m	**Bearing:** D C A B (deg. N)	**Client's Representative:** Tobin Consulting Engineers		**Scale:** 1:25
Length: 2.00m		**Ground Level:** 78.89MOD	**Dates:** 11/12/2015	**Crew:** **Logged By:** MG

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
			(0.15) 78.74 0.15	TOPSOIL		
0.50	B		*(1.20)*	Firm brown gravelly CLAY. Gravel is fine to medium, subrounded to subangular.		
			77.54 1.35 *(0.15)*			
1.50	B		77.39 1.50	Firm brown gravelly CLAY with occasional cobbles of weathered limestone bedrock. Gravel is fine to medium, subrounded to subangular. End of trial pit at 1.50 m		

Remarks

Refusal met on possible limestone bedrock.

Water Strikes:

Struck (m)	Flow Details

Stability: Stable

Difficulty:

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation			**Trialpit No.** TP108
Method: Trial Pitting	**Plant:** CX130	**Co-ords:** 311891.22mE 241152.78mN	**Client:** Irish Water	Sheet 1 of 1
Width: 0.60m	**Bearing:** D C A B (deg. N)	**Ground Level:** 78.81MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:25
Length: 2.50m			**Dates:** 03/02/2015	**Crew:** **Logged By:** DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
				Firm brown slightly sandy gravelly slightly silty CLAY. Gravel is subangular to subrounded fine to coarse.		
1.00	B		*(2.00)*			
2.00	B		76.81 2.00	Firm to stiff dark grey slightly sandy gravelly slightly silty CLAY with occasional cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
3.00	B		*(2.50)*			
4.00	B					
			74.31 4.50	End of trial pit at 4.50 m		

Remarks

Water Strikes:

Struck (m)	Flow Details

Stability: Stable

Difficulty:

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation		**Trialpit No.** TP109
Method: Trial Pitting	**Plant:** CX130	**Co-ords:** 312371.79mE 241407.09mN	**Client:** Irish Water	Sheet 1 of 1
Width: 0.60m	**Bearing:** D C A B	**Ground Level:** 85.83MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:25
Length: 5.00m	(deg. N)		**Dates:** 03/02/2015	**Crew:**
				Logged By: DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
				MADE GROUND - Soft grey gravelly CLAY. Gravel is subangular to subrounded fine to medium. High content of fill material.		
0.50	ES					
1.00	B					
1.00	ES		*(2.20)*			
2.00	B					
2.00	ES					
			83.63 2.20	Soft grey slightly sandy slightly gravelly slightly silty CLAY. Gravel is subangular to subrounded fine to medium		
			(1.20)			
3.00	B					
3.00	ES					
			82.43 3.40	End of trial pit at 3.40 m		

Remarks

Trial pit terminated at site of trench wall falling in.

Water Strikes:

Struck (m)	Flow Details
0.50	

Stability:

Unstable - sides falling in.

Difficulty:

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation			**Trialpit No.** TP110
Method: Trial Pitting	**Plant:** CX130	**Co-ords:** 312439.57mE 241496.47mN	**Client:** Irish Water	Sheet 1 of 1
Width: 0.60m	**Bearing:** D C A B		**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:25
Length: 3.50m	(deg. N)	**Ground Level:** 83.87MOD	**Dates:** 03/02/2015	**Crew:** **Logged By:** DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
			(0.30)	TOPSOIL		
			83.57 0.30	Firm brown slightly sandy slightly gravelly CLAY with occasional cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium.		
0.50	B					
0.50	ES					
1.00	ES					
			(1.60)			
1.50	B					
			81.97 1.90	Firm to stiff dark grey slightly sandy gravelly slightly silty CLAY with occasional cobbles and boulders with fragments of weathered rock. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium.		
2.00	B					
2.00	ES		*(0.30)*			
			81.67 2.20	Weathered bedrock (dark grey LIMESTONE).		
			(0.20)			
			81.47 2.40	End of trial pit at 2.40 m		

Remarks

Refusal met on possible limestone bedrock

Water Strikes:

Struck (m)	Flow Details
2.40	

Stability: Stable

Difficulty:

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation			**Trialpit No.** TP112
Method: Trial Pitting	**Plant:** CX130	**Co-ords:** 313162.95mE 241596.95mN	**Client:** Irish Water	Sheet 1 of 1
Width: 0.60m	**Bearing:** D C A B	**Ground Level:** 75.80MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:25
Length: 3.00m	(deg. N)		**Dates:** 03/02/2015	**Crew:** **Logged By:** DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
				TOPSOIL		
			(0.80)			
0.50	B					
			75.00 0.80	Firm to stiff dark grey slightly sandy gravelly slightly silty CLAY with cobbles and boulders. Gravel is subangular to subrounded fine to medium. Cobbles and boulders subangular to subrounded.		
			(0.90)			
1.50	B					
			74.10 1.70	Weathered bedrock (dark grey LIMESTONE).		
			(0.20)			
			73.90 1.90	End of trial pit at 1.90 m		

Remarks

Refusal met on possible limestone bedrock

Water Strikes:

Struck (m)	Flow Details
1.70	

Stability: Stable

Difficulty:

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation			**Trialpit No.** TP113
Method: Trial Pitting	**Plant:** CX130	**Co-ords:** 323393.78mE 241487.97mN	**Client:** Irish Water	Sheet 1 of 1
Width: 0.60m	**Bearing:** D C A B	**Ground Level:** 4.84MOD	**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:25
Length: 3.00m	(deg. N)		**Dates:** 03/02/2015	**Crew:** **Logged By:** DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
				TOPSOIL		
			(0.30)			
			4.54 0.30	Firm brown slightly sandy gravelly slightly silty CLAY with occasional cobbles and boulders. Gravel is subangular to subrounded fine to medium. Cobbles and boulders are subangular to subrounded		
1.00	B					
2.00	B					
			(3.70)			
3.00	B					
4.00	B		0.84 4.00	Firm to stiff dark grey slightly sandy slightly gravelly slightly silty CLAY with occasional cobbles and rare boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium.		
			(0.50)			
			0.34 4.50	End of trial pit at 4.50 m		

Remarks

Water Strikes:

Struck (m)	Flow Details

Stability: Stable

Difficulty:

AGS

Causeway Geotech Ltd

Project no. 14-645	**Project Name:** Greater Dublin Drainage Scheme Ground Investigation			**Trialpit No.** TP114
Method: Trial Pitting	**Plant:** CX130	**Co-ords:** 323399.33mE 241458.33mN	**Client:** Irish Water	Sheet 1 of 1
Width: 0.60m	**Bearing:** D C A B		**Client's Representative:** Tobin Consulting Engineers	**Scale:** 1:25
Length: 3.50m	(deg. N)	**Ground Level:** 3.98MOD	**Dates:** 03/02/2015	**Crew:** **Logged By:** DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
			(0.25)	TOPSOIL		
			3.73 0.25	Firm brown slightly sandy gravelly slightly silty CLAY with occasional cobbles and boulders. Gravel is subangular to subrounded fine to medium. Cobbles and boulders are subangular to subrounded.		
1.00	B		*(1.85)*			
2.00	B		1.88 2.10	Firm to stiff dark grey slightly sandy slightly gravelly slightly silty CLAY with occasional cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium.		
3.00	B		*(2.40)*			
4.00	B		-0.52 4.50	End of trial pit at 4.50 m		

Remarks

Water Strikes:

Struck (m)	Flow Details

Stability: Stable

Difficulty:

AGS

Appendix E
Trial pit photographs

Trial pit TP101

Trial pit TP101

Trail pit TP101

Trial pit TP102

Trial pit TP102

Trial pit TP102

Trial pit TP103

Trial pit TP103

Trial pit TP103

Trial pit TP104

Trial pit TP104

Trial pit TP104

Trial pit TP105

Trial pit TP105

Trial pit TP105

Trial pit TP106

Trial pit TP106

Trial pit TP106

Trial pit TP107

Trial pit TP107

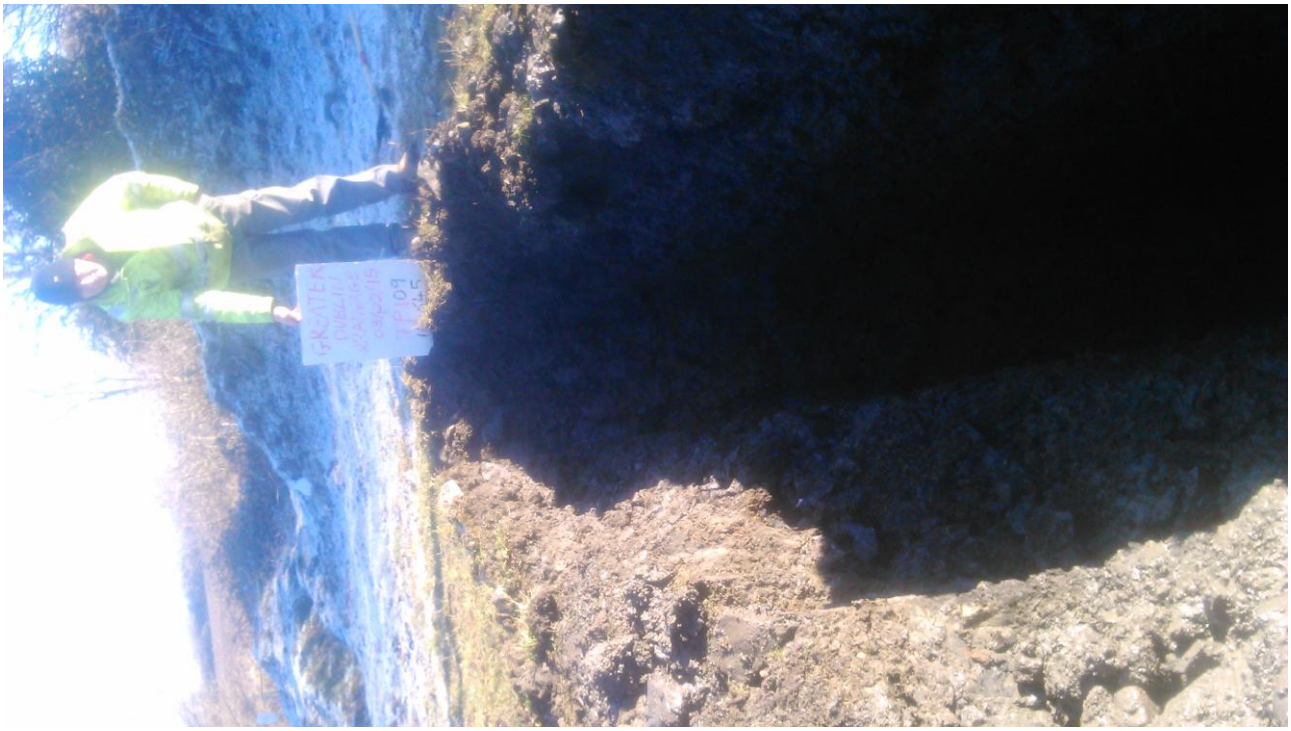
Trial pit TP107

Trial pit TP108

Trail pit TP108

Trial pit TP108

Trial pit TP109



Trial pit TP109

Trial pit TP109

Trial pit TP110

Trial pit TP110

Trial pit TP110

Trial pit TP112

Trial pit TP112

Trial pit TP112

Trial pit TP113

Trial pit TP113

Trial pit TP113

Trial pit TP114

Trial pit TP114

Trial pit TP114

Appendix F
Laboratory test results

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SOIL AND ROCK SAMPLE ANALYSIS
LABORATORY TEST REPORT

To:	**Bord Gais**
Copy:	**Orla Smyth (kkidd@bge.ie)**
From:	**Stephen Watson** **Laboratory Manager** **Causeway Geotech Ltd**
Tel:	**+44(0)2827666640**
E-mail:	**stephen.watson@causewaygeotech.com**
Date:	**25/02/15**
Ref:	**14-645**

Greater Dublin Drainage Scheme Ground Investigation

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 samples were delivered to our laboratory in Ballymoney, Co. Antrim on 18/01/2015 and tested in accordance with the electronic schedule received on 20/01/2015. Further testing instructions were received on 16/02/2015 All testing was performed 26/01/2015 to 25/02/2015.

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 one month 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

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Project Name **Greater Dublin Drainage Scheme Ground Investigation**

Report Reference. **14-645**

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	Comments
SOIL	Moisture content - oven drying method	BS 1377-2:1990	64	Currently working towards UKAS accreditation
SOIL	Liquid limit - cone penetrometer	BS 1377-2:1990	44	Currently working towards UKAS accreditation
SOIL	Liquid limit - cone penetrometer - one point	BS 1377-2:1990	44	Currently working towards UKAS accreditation
SOIL	Plastic limit	BS 1377-2:1990	44	Currently working towards UKAS accreditation
SOIL	Plasticity index and liquidity index	BS 1377-2:1990	44	Currently working towards UKAS accreditation
SOIL	Particle size distribution - wet sieving	BS 1377-2:1990	42	Currently working towards UKAS accreditation
SOIL	Particle size distribution - dry sieving	BS 1377-2:1990	0	Currently working towards UKAS accreditation
SOIL	Particle size distribution -sedimentation hydrometer method	BS 1377-2:1990	40	Currently working towards UKAS accreditation
SOIL	Density - linear	BS 1377-2:1990	0	Currently working towards UKAS accreditation
SOIL	Particle density – gas jar	BS 1377-2:1990	0	Currently working towards UKAS accreditation
SOIL	Dry density/moisture content relationship (2.5 kg rammer)	BS 1377-4:1990	0	Currently working towards UKAS accreditation
	Dry density/moisture content relationship (4.5 kg rammer)	BS 1377-4:1990	0	Currently working towards UKAS accreditation
SOIL	MCV	BS 1377-4:1990	0	Currently working towards UKAS accreditation

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SOIL	MCV relationship	BS 1377-4:1990	0	Currently working towards UKAS accreditation
SOIL	California Bearing Ratio (CBR)	BS 1377-4:1990	0	Currently working towards UKAS accreditation
SOIL	One-dimensional consolidation properties	BS 1377- 5:1990	0	Currently working towards UKAS accreditation
SOIL	Laboratory vane	BS 1377- 7:1990	0	Currently working towards UKAS accreditation
SOIL	Undrained shear strength – triaxial compression without measurement of pore pressure (loads from 0.12 to 24 kN)	BS 1377- 7:1990	0	Currently working towards UKAS accreditation
SOIL	Undrained shear strength – triaxial compression with multistage loading and without measurement of pore pressure (loads from 0.12 to 24 kN)	BS 1377- 7:1990	0	Currently working towards UKAS accreditation
ROCK	Point load index	ISRM Commission on Testing Methods. Suggested Method for Determining Point Load Strength 1985	10	Currently working towards UKAS accreditation
ROCK	UCS	ISRM Suggested Methods - Rock Characterization Testing and Monitoring, Ed. E T Brown - 1981	6	Currently working towards UKAS accreditation

CAUSEWAY GEOTECH

Summary of Classification Test Results

Project No.: 14-645

Project Name: Greater Dublin Drainage Scheme Ground Investigation

Hole No.	Sample Ref	Top	Base	Type	Soil Description	Density bulk Mg/m3	Density dry Mg/m3	w %	Passing 425µm %	LL %	PL %	PI %	Particle density Mg/m3	Remarks
BH117	B03	3.50	4.00	B	Very stiff dark grey to black sandy gravelly CLAY with occasional cobbles.			14.0	62	28 -1pt	NP			
BH117	B04	4.50	5.00	B	Very stiff dark grey to black sandy gravelly CLAY with occasional cobbles.			13.0						
BH117	D05	5.00		D	Very stiff dark grey to black sandy gravelly CLAY with occasional cobbles.			15.0						
BH117	B02	1.80	3.00	B	Very stiff dark grey to black sandy gravelly CLAY with occasional cobbles.			11.0	44	27 -1pt	15	12		
BH117	B01	0.35	1.20	B	Stiff brown sandy gravelly CLAY with rare cobbles.			12.0	57	29 -1pt	17	12		
BH118	8	8.00	8.45	B	Stiff dark grey slightly sandy slightly gravelly CLAY.			20.0	50	31 -1pt	18	13		
BH120	14	9.50		D	Firm to stiff black sandy gravelly CLAY.			22.0						
BH120	11	5.00		D	Stiff black sandy gravelly CLAY.			18.0						
BH120	4	5.50	6.50	B	Firm to stiff black sandy gravelly CLAY.			19.0	68	31 -1pt	16	15		
BH120	12	6.50		D	Firm to stiff black sandy gravelly CLAY.			12.0						
BH120	13	8.00		D	Firm to stiff black sandy gravelly CLAY.			17.0	50	28 -1pt	16	12		
BH120	2	1.70	2.00	B	Stiff brown sandy gravelly CLAY.			13.0	60	30 -1pt	17	13		
BH120	3	3.10	4.00	B	Stiff black sandy gravelly CLAY.			16.0	52	29 -1pt	15	14		
BH121	4	3.50	4.00	B	Stiff black sandy gravelly CLAY.			8.9	53	28 -1pt	16	12		
BH121	6	2.00		D	MADE GROUND - Firm very sandy gravelly CLAY with occasional boulders.			13.0	45	25 -1pt	16	9		
BH122	B07	9.50	10.00	B	Black very stiff gravelly CLAY with occasional cobbles and boulders.			27.0	56	31 -1pt	17	14		
BH122	B04	4.50	5.00	B	Black very stiff gravelly CLAY with occasional cobbles and boulders.			13.0						
BH122	B05	6.00	6.50	B	Black very stiff gravelly CLAY with occasional cobbles and boulders.			13.0	39	28 -1pt	15	13		
BH122	B06	7.00	7.50	B	Black very stiff gravelly CLAY with occasional cobbles and boulders.			16.0						
BH122	B03	2.50	3.00	B	Black very stiff gravelly CLAY with occasional cobbles and boulders.			12.0	54	29 -1pt	15	14		

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

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Table 1

sheet 1

CAUSEWAY GEOTECH

Summary of Classification Test Results

Project No.: 14-645

Project Name: Greater Dublin Drainage Scheme Ground Investigation

Hole No.	Sample				Soil Description	Density bulk / dry Mg/m3		w %	Passing 425µm %	LL %	PL %	PI %	Particle density Mg/m3	Remarks
	Ref	Top	Base	Type										
BH122	B01	0.20	1.20	B	Brown firm to stiff gravelly CLAY with occasional cobbles and boulders.			12.0	48	29 -1pt	16	13		
BH123	D04	4.00		D	Very stiff dark grey to black sandy gravelly CLAY with occasional cobbles and rare boulders.			9.1						
BH123	B02	1.30	2.00	B	Stiff dark brown sandy gravelly CLAY with occasional cobbles and boulders.			13.0	49	28 -1pt	15	13		
BH123	B03	2.50	3.00	B	Very stiff dark grey to black sandy gravelly CLAY with occasional cobbles and boulders.			11.0	48	31 -1pt	18	13		
BH123	B01	0.25	1.00	B	Firm to stiff dark brown sandy gravelly CLAY with occasional cobbles and boulders.			13.0	52	31 -1pt	17	14		
BH124	2	1.50	2.00	B	Firm brown gravelly CLAY			14.0	46	30 -1pt	17	13		
BH124	3	2.10	3.00	B	Very stiff black sandy gravelly CLAY.			16.0	51	30 -1pt	16	14		
BH124	1	0.00	1.20	B	Firm brown gravelly CLAY			16.0	64	35 -1pt	17	18		
BH125	3	3.50		B	Very stiff black sandy gravelly CLAY.			16.0	45	29 -1pt	15	14		
BH127	7	4.00		D	Very stiff black sandy gravelly CLAY.			12.0	57	29 -1pt	15	14		
BH127	2	1.80	2.00	B	Very stiff black sandy gravelly CLAY.			14.0						
BH127	3	2.50	3.00	B	Very stiff black sandy gravelly CLAY.			12.0	49	29 -1pt	16	13		
BH127	1	0.30	1.20	B	Stiff brown grey sandy gravelly CLAY			34.0	67	44 -1pt	32	12		
BH128	D03	3.50		D	Very stiff black gravelly CLAY with occasional cobbles and boulders.			9.7	35	29 -1pt	16	13		
BH128	B04	2.50	3.00	B	Very stiff black gravelly CLAY with occasional cobbles and boulders.			8.2	41	29 -1pt	16	13		
BH128	B02	0.30	1.10	B	Firm to stiff light brown gravelly CLAY with occasional cobbles and boulders.			30.0	78	45 -1pt	28	17		
BH128	B03	1.10	2.00	B	Very stiff black gravelly CLAY with occasional cobbles and boulders.			15.0	42	25 -1pt	14	11		
BH130	6	5.00	5.45	B	Very stiff dark grey slightly sandy slightly gravelly CLAY.			20.0	62	32 -1pt	18	14		
BH130	2	1.20	1.65	B	Firm brown mottled grey slightly gravelly CLAY.			16.0	53	32 -1pt	17	15		
BH135	6	5.00	5.45	B	Stiff dark grey sandy gravelly CLAY.			16.0	71	29 -1pt	16	13		

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

Key

Density test: Liquid Limit: Particle density

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

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

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

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Table 2

sheet 2

CAUSEWAY GEOTECH

Summary of Classification Test Results

Project No.: 14-645

Project Name: Greater Dublin Drainage Scheme Ground Investigation

Hole No.	Sample				Soil Description	Density bulk / dry Mg/m3		w %	Passing 425µm %	LL %	PL %	PI %	Particle density Mg/m3	Remarks
	Ref	Top	Base	Type										
BH135	2	1.20	1.65	B	Brown mottled grey sandy gravelly CLAY			20.0	60	35 -1pt	20	15		
BH137	2	1.20	1.65	B	Firm to soft brown sandy gravelly CLAY.			19.0	63	35 -1pt	17	18		
BH138	B03	2.50	3.00	B	Medium dense grey slightly sandy subangular to rounded fine to medium GRAVEL.			6.0						
BH138	B02	0.90	1.50	B	Medium dense grey slightly sandy subangular to rounded fine to medium GRAVEL.			5.4	10	27 -1pt	19	8		
BH139	8	8.00	8.45	B	Firm to stiff dark grey slightly sandy gravelly CLAY with occasional cobbles.			14.0	54	28 -1pt	15	13		
BH139	7	6.00	6.45	B	Stiff black slightly sandy slightly gravelly CLAY with occasional cobbles.			13.0	58	28 -1pt	15	13		
BH139	3	2.00	2.45	B	Firm to stiff brown slightly sandy slightly gravelly CLAY			16.0	67	30 -1pt	17	13		
TP100	B02	1.50		B	Firm brown gravelly CLAY.			8.3	33	29 -1pt	18	11		
TP100	B01	0.50		B	MADE GROUND - Firm brown grey gravelly CLAY with fragments of plastic timber and gravel.			14.0	55	29 -1pt	18	11		
TP101	B01	0.50		B	MADE GROUND - Soft to firm light brown gravelly CLAY with fragments of plastic and glass.			20.0	59	41 -1pt	27	14		
TP102	2	1.50		B	Firm grey gravelly CLAY with fragments of weathered roots.			13.0	37	30 -1pt	22	8		
TP102	B01	0.50		B	Firm brown gravelly CLAY.			14.0	35	37 -1pt	25	12		
TP103	B01	0.50		B	Firm brown gravelly CLAY			15.0	33	34 -1pt	24	10		
TP103	B02	0.90		B	Firm brown gravelly CLAY with fragments of weathered roots.			8.5	25	33 -1pt	24	9		
TP104	B01	0.50		B	Firm brown gravelly CLAY with occasional cobbles.			32.0	92	51 -1pt	29	22		
TP104	B02	1.00		B	Firm grey brown gravelly CLAY with occasional cobbles.			15.0	58	46 -1pt	28	18		
TP105	B02	0.80		B	Firm brown gravelly CLAY.			18.0	55	41 -1pt	25	16		
TP106	B01	0.30		B	MADE GROUND - Firm brown gravelly CLAY with fragments of brick,glass and timbers.			24.0	55	42 -1pt	25	17		
TP108	2	2.00		B	Firm to stiff dark grey gravelly CLAY with occasional cobbles			9.5	40	29 -1pt	17	12		
TP109	7	3.00		B	Soft grey gravelly CLAY.			22.0	59	39 -1pt	21	18		

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

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Table 3

sheet 3

Summary of Classification Test Results

Project No.	Project Name
14-645	Greater Dublin Drainage Scheme Ground Investigation

Hole No.	Sample				Soil Description	Density bulk Mg/m3	Density dry Mg/m3	*w* %	Passing 425µm %	LL %	PL %	PI %	Particle density Mg/m3	Remarks
	Ref	Top	Base	Type										
TP110	5	1.50		B	Firm brown gravelly CLAY with occasional cobbles and boulders.			13.0	49	32 -1pt	18	14		
TP112	2	1.50		B	Firm to stiff dark grey gravelly CLAY with cobbles and boulders.			10.0	26	33 -1pt	18	15		
TP113	4	4.00		B	Firm to stiff dark grey gravelly CLAY with cobbles and boulders.			10.0	62	25 -1pt	15	10		
TP114	4	4.00		B	Firm to stiff dark grey gravelly CLAY with occasional cobbles			9.1	65	26 -1pt	15	11		

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

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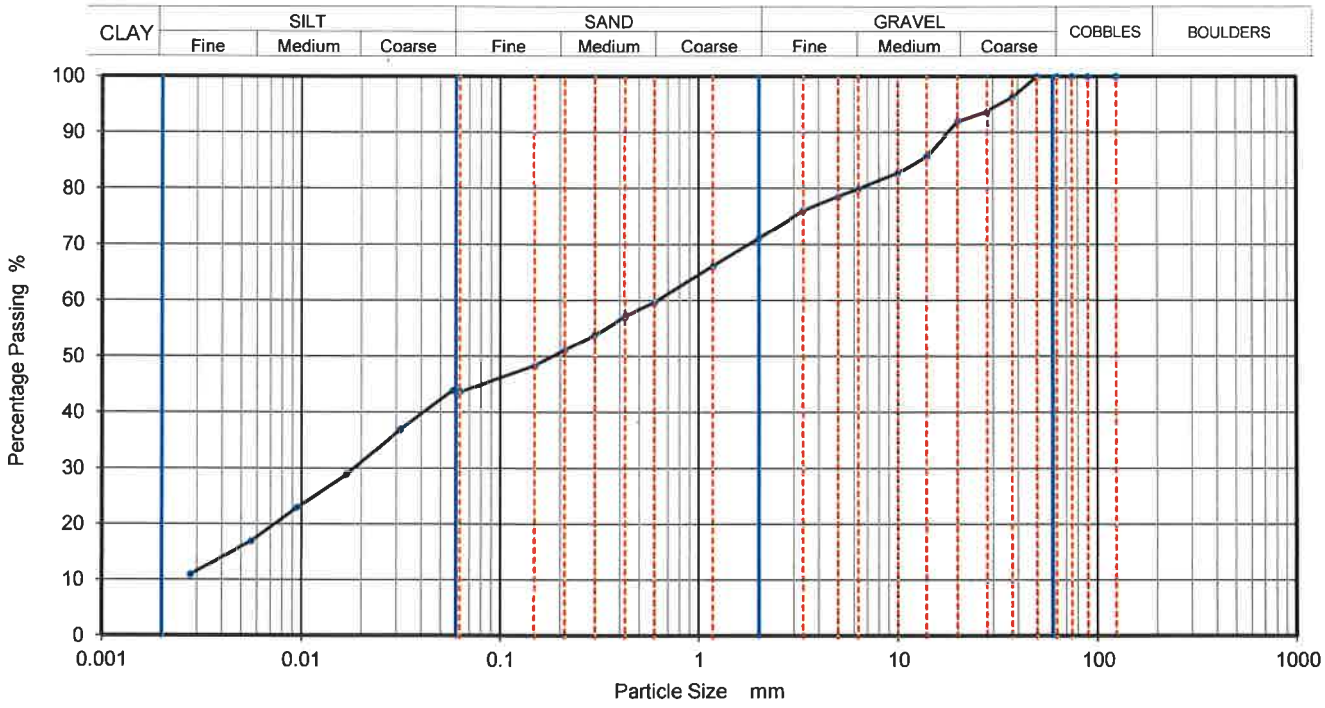
Table: 4

sheet: 4

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	BH117
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	B01
Soil Description	Stiff brown sandy gravelly CLAY with rare cobbles.			Depth, m	0.35
Specimen Reference	12	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645BH117B01



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0580	44
90	100	0.0315	37
75	100	0.0169	29
63	100	0.0095	23
50	100	0.0056	17
37.5	96	0.0028	11
28	94		
20	92		
14	86		
10	83		
6.3	80		
5	79		
3.35	76		
2	71		
1.18	66		
0.6	60	Particle density	(assumed)
0.425	57	1.50	Mg/m3
0.3	54		
0.212	51		
0.15	48		
0.063	44		

Dry Mass of sample, g	3361

Sample Proportions	% dry mass
Very coarse	0
Gravel	29
Sand	28
Fines <0.063mm	44

Grading Analysis		
D100	mm	
D60	mm	0.619
D30	mm	0.0181
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377 unless noted below

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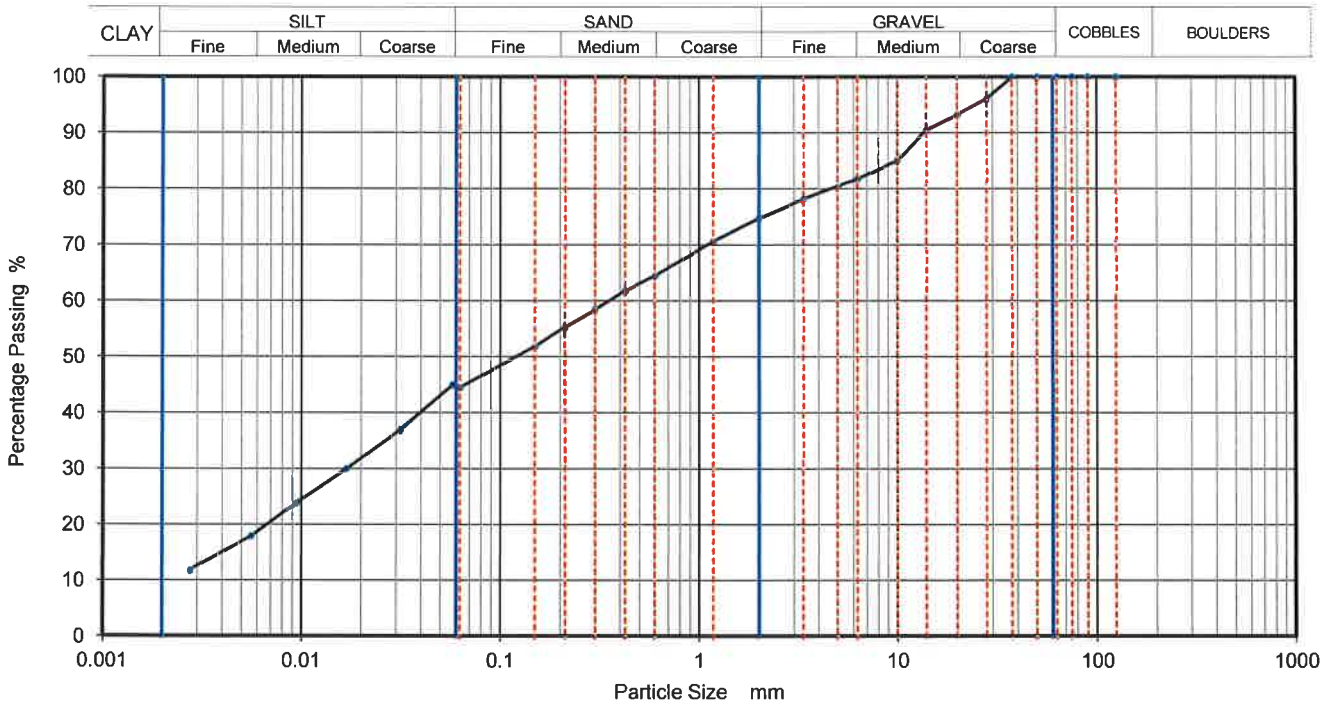
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	BH117
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	B03
Soil Description	Very stiff dark grey to black sandy gravelly CLAY with occasional cobbles.			Depth, m	3.50
Specimen Reference	12	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645BH117B03



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0575	45
90	100	0.0315	37
75	100	0.0168	30
63	100	0.0095	24
50	100	0.0056	18
37.5	100	0.0028	12
28	96		
20	93		
14	91		
10	85		
6.3	82		
5	81		
3.35	78		
2	75		
1.18	71		
0.6	65	Particle density	(assumed)
0.425	62	1.50	Mg/m3
0.3	59		
0.212	55		
0.15	52		
0.063	45		

Dry Mass of sample, g	3458

Sample Proportions	% dry mass
Very coarse	0
Gravel	25
Sand	30
Fines <0.063mm	45

Grading Analysis		
D100	mm	
D60	mm	0.35
D30	mm	0.0166
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377 unless noted below

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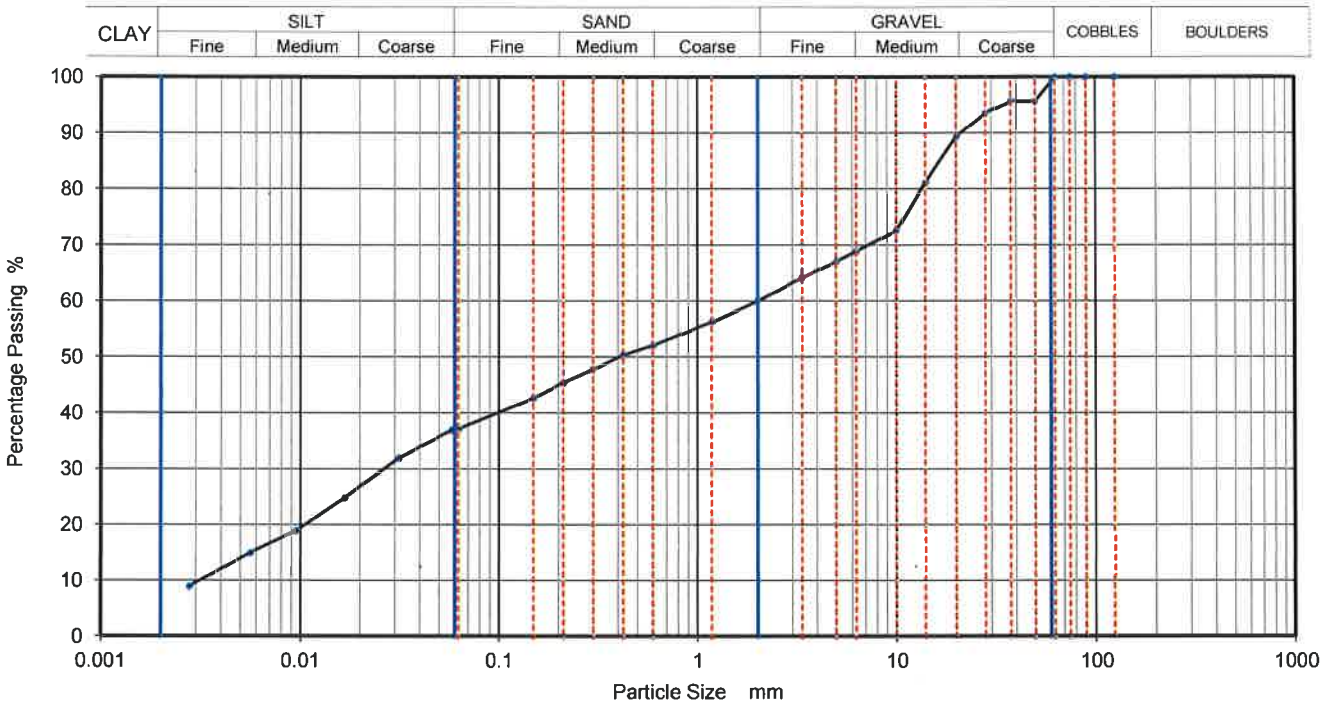
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	BH118
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	8
Soil Description	Stiff dark grey slightly sandy slightly gravelly CLAY.			Depth, m	8.00
Specimen Reference	6	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645BH118B8



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0580	37
90	100	0.0315	32
75	100	0.0169	25
63	100	0.0095	19
50	96	0.0056	15
37.5	96	0.0028	9
28	94		
20	89		
14	81		
10	73		
6.3	69		
5	67		
3.35	64		
2	60		
1.18	56		
0.6	52	Particle density	(assumed)
0.425	50	1.50	Mg/m3
0.3	48		
0.212	46		
0.15	43		
0.063	37		

Dry Mass of sample, g	5307

Sample Proportions	% dry mass
Very coarse	0
Gravel	40
Sand	23
Fines <0.063mm	37

Grading Analysis		
D100	mm	
D60	mm	1.99
D30	mm	0.0273
D10	mm	0.00315
Uniformity Coefficient		630
Curvature Coefficient		0.12

Remarks

Preparation and testing in accordance with BS1377 unless noted below

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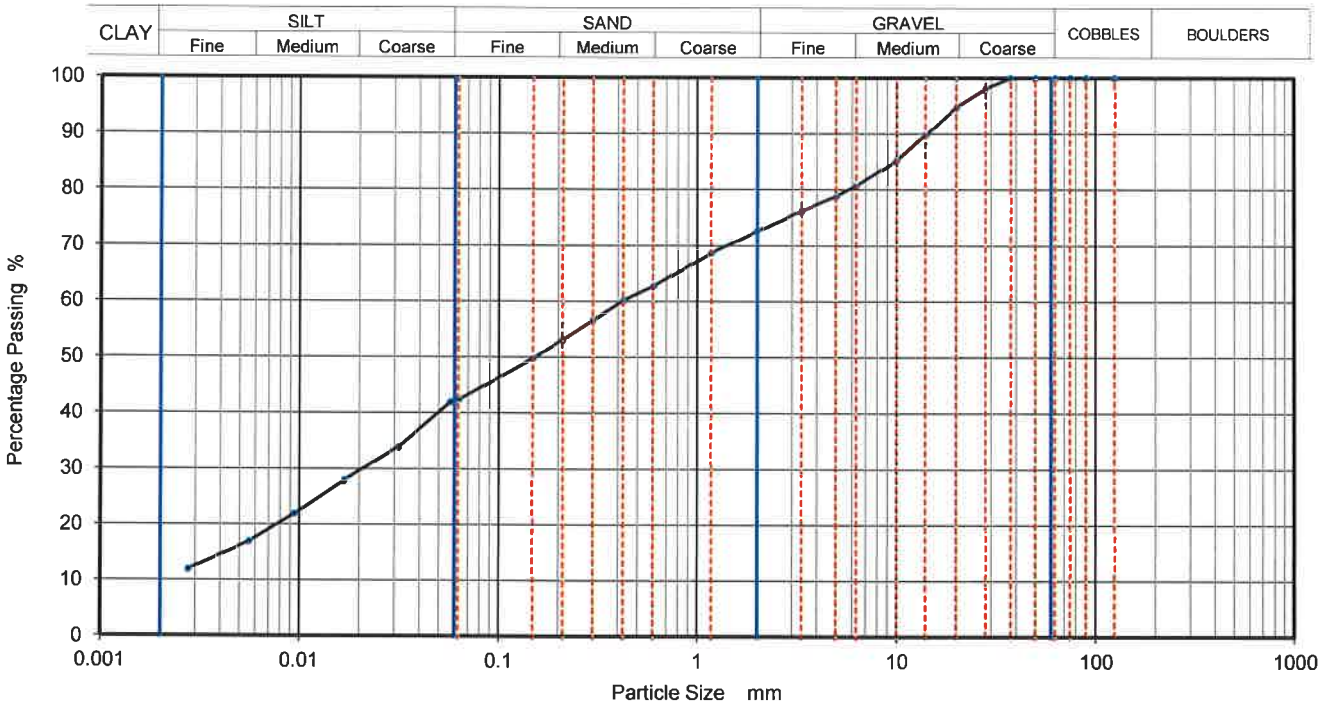
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	BH120
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	2
Soil Description	Stiff brown sandy gravelly CLAY.			Depth, m	1.70
Specimen Reference	12	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645BH120B2



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0571	42
90	100	0.0315	34
75	100	0.0168	28
63	100	0.0095	22
50	100	0.0056	17
37.5	100	0.0028	12
28	98		
20	95		
14	90		
10	85		
6.3	81		
5	79		
3.35	76		
2	73		
1.18	69		
0.6	63	Particle density (assumed)	
0.425	60	1.50	Mg/m3
0.3	57		
0.212	53		
0.15	50		
0.063	42		

Dry Mass of sample, g	2869

Sample Proportions	% dry mass
Very coarse	0
Gravel	27
Sand	30
Fines <0.063mm	42

Grading Analysis		
D100	mm	
D60	mm	0.416
D30	mm	0.021
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377 unless noted below

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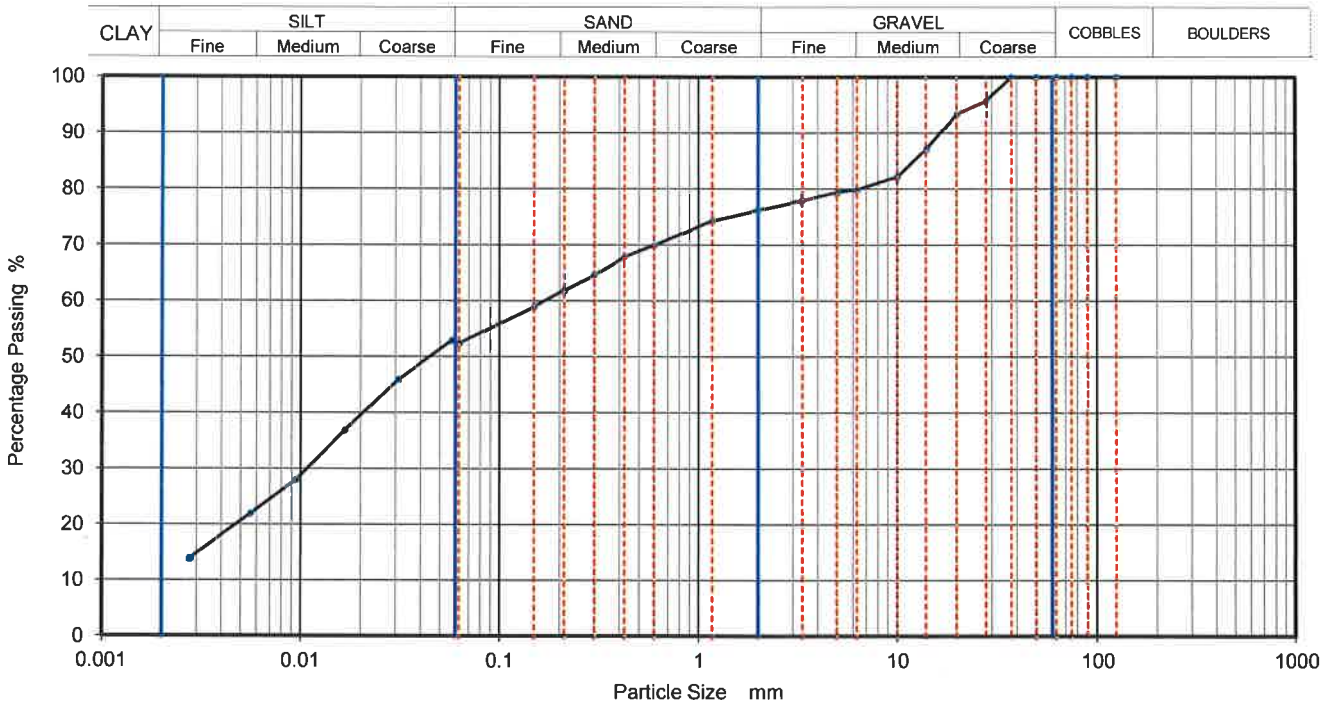
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	BH120
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	4
Soil Description	Firm to stiff black sandy gravelly CLAY.			Depth, m	5.50
Specimen Reference	12	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645BH120B4



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0575	53
90	100	0.0311	46
75	100	0.0167	37
63	100	0.0095	28
50	100	0.0056	22
37.5	100	0.0028	14
28	96		
20	93		
14	87		
10	82		
6.3	80		
5	79		
3.35	78		
2	76		
1.18	74		
0.6	70	Particle density	(assumed)
0.425	68	1.50	Mg/m3
0.3	65		
0.212	62		
0.15	59		
0.063	53		

Dry Mass of sample, g	2868

Sample Proportions	% dry mass
Very coarse	0
Gravel	24
Sand	24
Fines <0.063mm	52

Grading Analysis		
D100	mm	
D60	mm	0.168
D30	mm	0.0109
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	Fig 39
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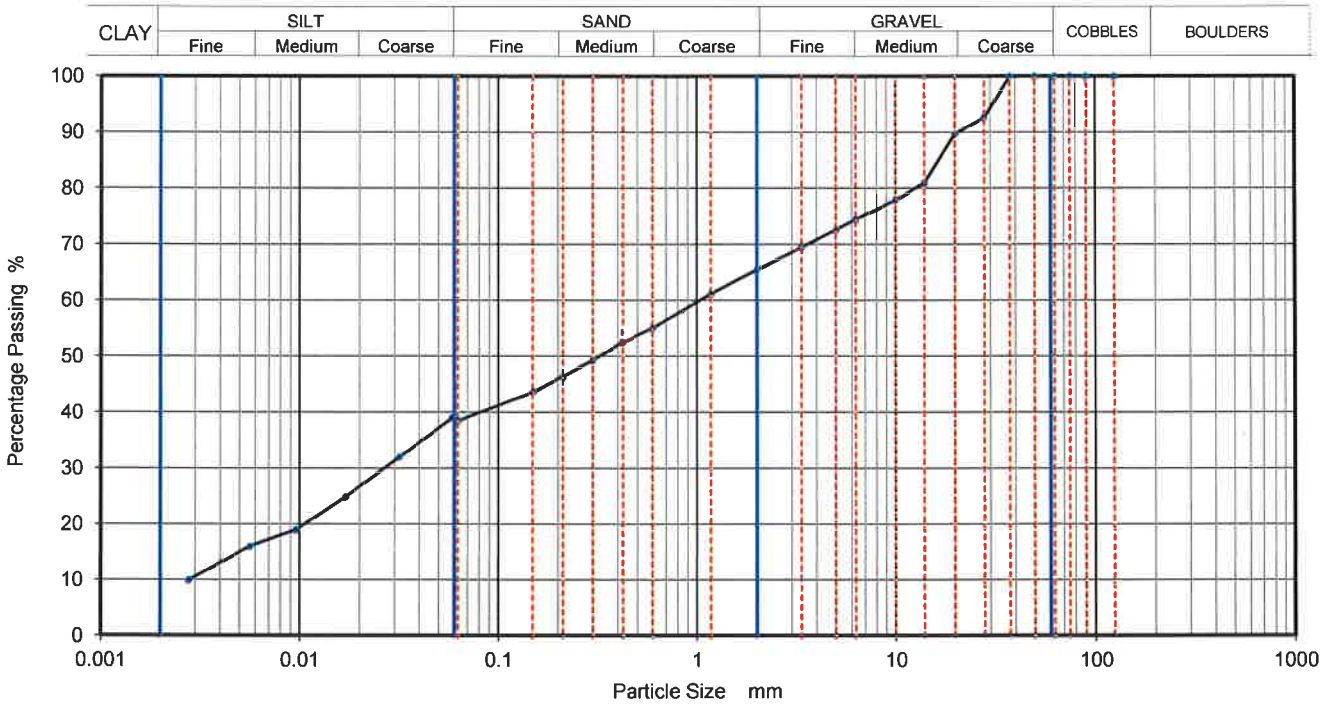
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	BH121
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	4
Soil Description	Stiff black sandy gravelly CLAY.			Depth, m	3.50
Specimen Reference	11	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645BH121B4



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0584	39
90	100	0.0317	32
75	100	0.0170	25
63	100	0.0096	19
50	100	0.0056	16
37.5	100	0.0028	10
28	93		
20	90		
14	81		
10	78		
6.3	75		
5	73		
3.35	70		
2	66		
1.18	61		
0.6	55	Particle density	(assumed)
0.425	53	1.50	Mg/m3
0.3	49		
0.212	47		
0.15	44		
0.063	39		

Dry Mass of sample, g	3718

Sample Proportions	% dry mass
Very coarse	0
Gravel	35
Sand	27
Fines <0.063mm	39

Grading Analysis		
D100	mm	
D60	mm	1.03
D30	mm	0.0256
D10	mm	0.00291
Uniformity Coefficient		360
Curvature Coefficient		0.22

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	Fig 33
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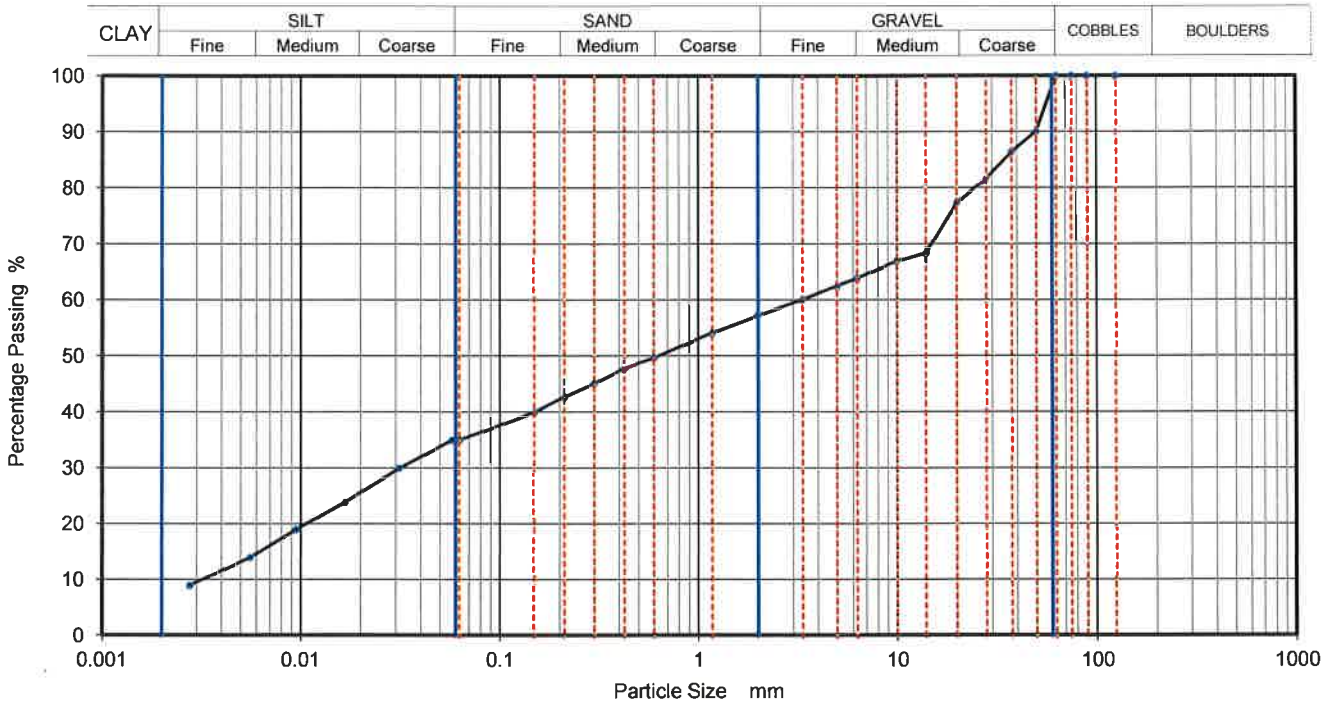
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	BH122
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	B01
Soil Description	Brown firm to stiff gravelly CLAY with occasional cobbles and boulders.			Depth, m	0.20
Specimen Reference	12	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14945BH122B01



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0575	35
90	100	0.0313	30
75	100	0.0168	24
63	100	0.0095	19
50	90	0.0056	14
37.5	86	0.0028	9
28	82		
20	77		
14	69		
10	67		
6.3	64		
5	63		
3.35	60		
2	57		
1.18	54		
0.6	50	Particle density	(assumed)
0.425	48	1.50	Mg/m3
0.3	45		
0.212	43		
0.15	40		
0.063	35		

Dry Mass of sample, g	6324

Sample Proportions	% dry mass
Very coarse	0
Gravel	43
Sand	22
Fines <0.063mm	35

Grading Analysis		
D100	mm	
D60	mm	3.26
D30	mm	0.0319
D10	mm	0.00306
Uniformity Coefficient		1100
Curvature Coefficient		0.1

Remarks

Preparation and testing in accordance with BS1377 unless noted below

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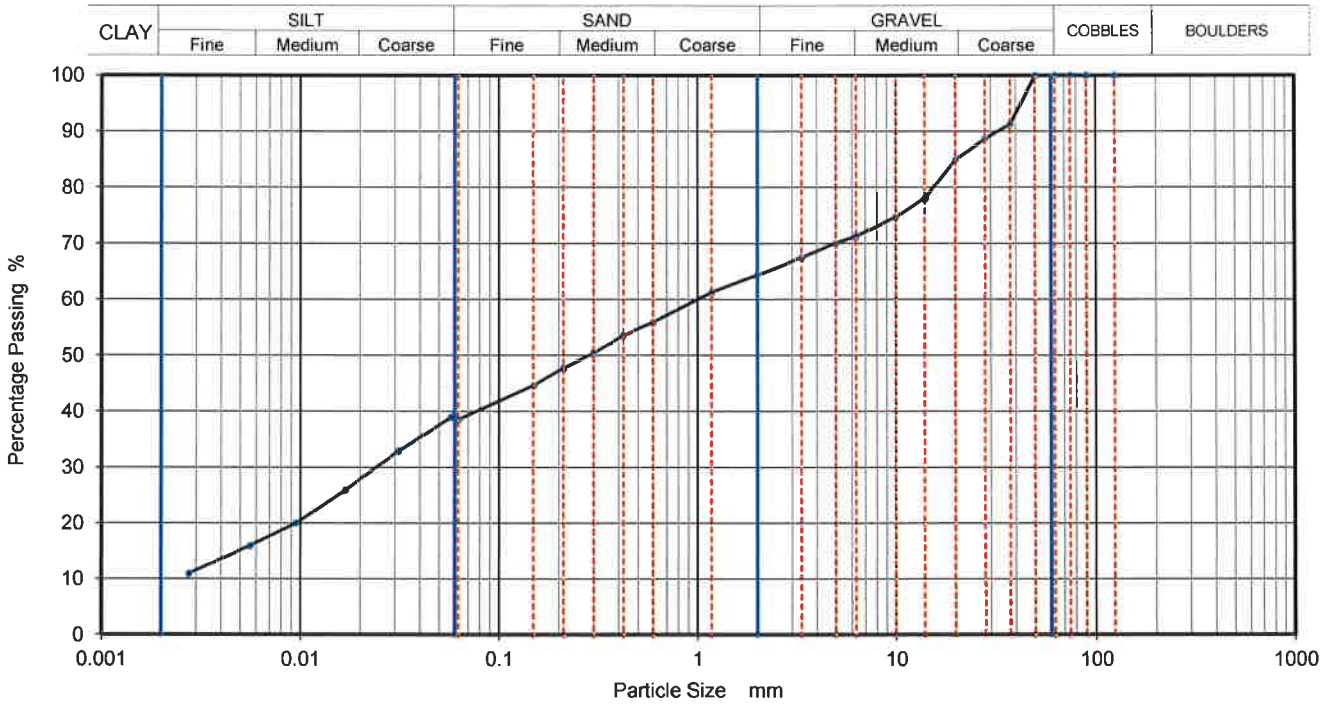
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	BH122
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	B03
Soil Description	Black very stiff gravelly CLAY with occasional cobbles and boulders.			Depth, m	2.50
Specimen Reference	12	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14945BH122B03



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0575	39
90	100	0.0313	33
75	100	0.0168	26
63	100	0.0095	20
50	100	0.0056	16
37.5	91	0.0028	11
28	89		
20	85		
14	78		
10	75		
6.3	71		
5	70		
3.35	68		
2	64		
1.18	61		
0.6	56	Particle density	(assumed)
0.425	54	1.50	Mg/m3
0.3	51		
0.212	48		
0.15	45		
0.063	39		

Dry Mass of sample, g	3892

Sample Proportions	% dry mass
Very coarse	0
Gravel	36
Sand	26
Fines <0.063mm	39

Grading Analysis		
D100	mm	
D60	mm	1
D30	mm	0.024
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377 unless noted below

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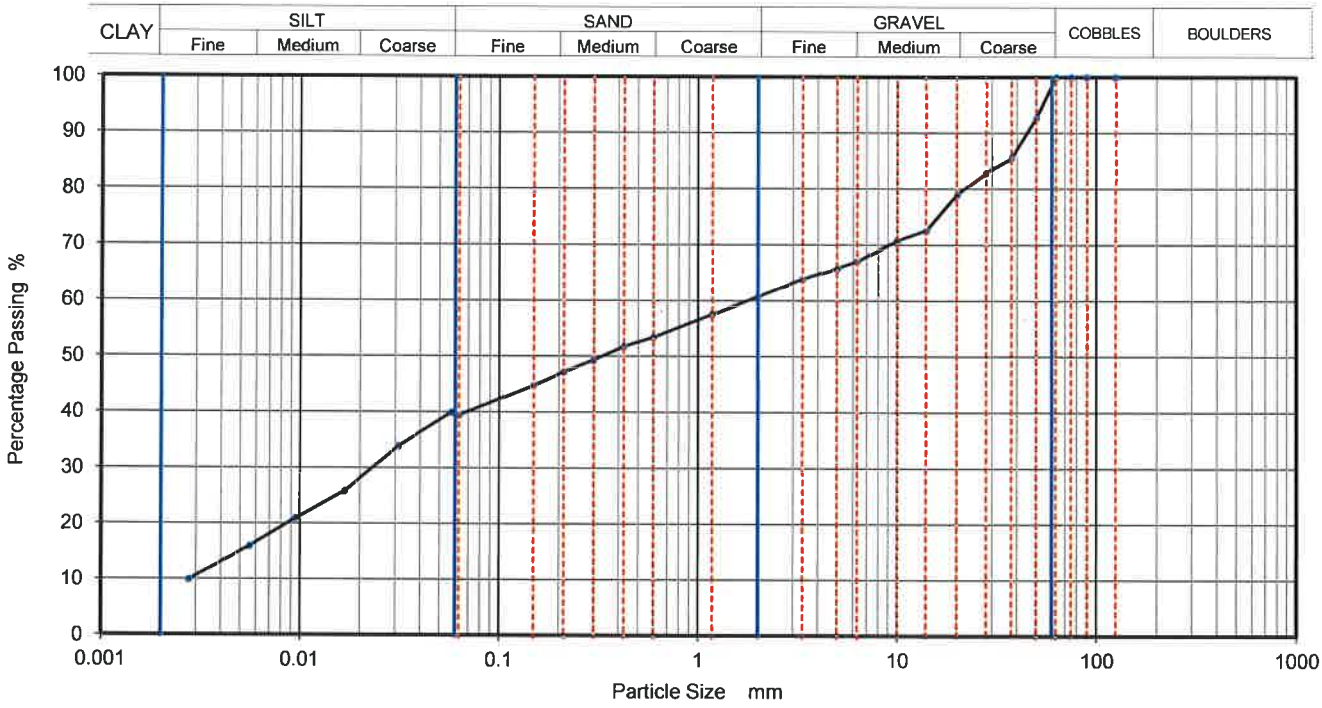
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	BH123
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	B01
Soil Description	Firm to stiff dark brown sandy gravelly CLAY with occasional cobbles and boulders.			Depth, m	0.25
Specimen Reference	12	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645BH123B01



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0575	40
90	100	0.0313	34
75	100	0.0169	26
63	100	0.0095	21
50	93	0.0056	16
37.5	86	0.0028	10
28	83		
20	79		
14	73		
10	71		
6.3	67		
5	66		
3.35	64		
2	61		
1.18	58		
0.6	54	Particle density	(assumed)
0.425	52	1.50	Mg/m3
0.3	49		
0.212	47		
0.15	45		
0.063	40		

Dry Mass of sample, g	5218

Sample Proportions	% dry mass
Very coarse	0
Gravel	39
Sand	21
Fines <0.063mm	39

Grading Analysis		
D100	mm	
D60	mm	1.75
D30	mm	0.0237
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377 unless noted below

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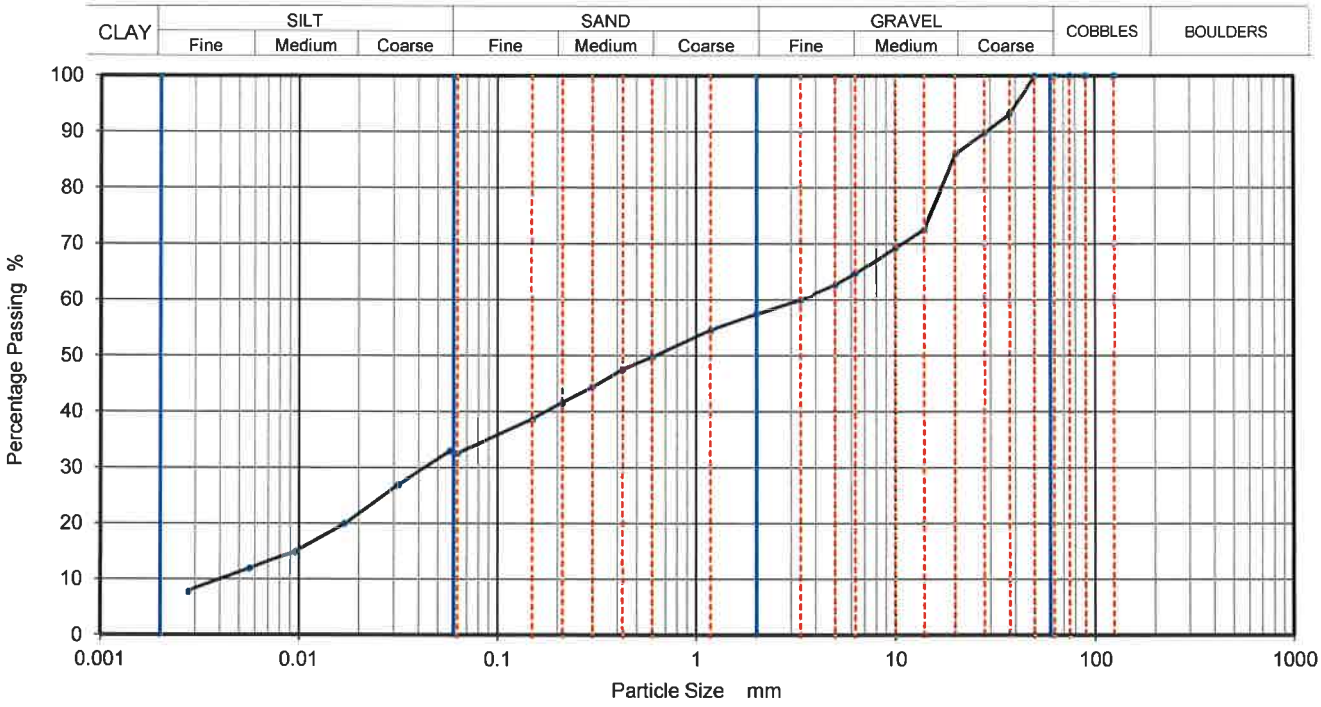
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	BH123
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	B03
Soil Description	Very stiff dark grey to black sandy gravelly CLAY with occasional cobbles and boulders.			Depth, m	2.50
Specimen Reference	12	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645BH123B03



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0575	33
90	100	0.0315	27
75	100	0.0170	20
63	100	0.0096	15
50	100	0.0057	12
37.5	93	0.0028	8
28	90		
20	86		
14	73		
10	69		
6.3	65		
5	63		
3.35	60		
2	58		
1.18	55		
0.6	50	Particle density	(assumed)
0.425	48	1.50	Mg/m3
0.3	45		
0.212	42		
0.15	39		
0.063	33		

Dry Mass of sample, g	5031

Sample Proportions	% dry mass
Very coarse	0
Gravel	43
Sand	25
Fines <0.063mm	33

Grading Analysis		
D100	mm	
D60	mm	3.33
D30	mm	0.0439
D10	mm	0.00429
Uniformity Coefficient		780
Curvature Coefficient		0.13

Remarks

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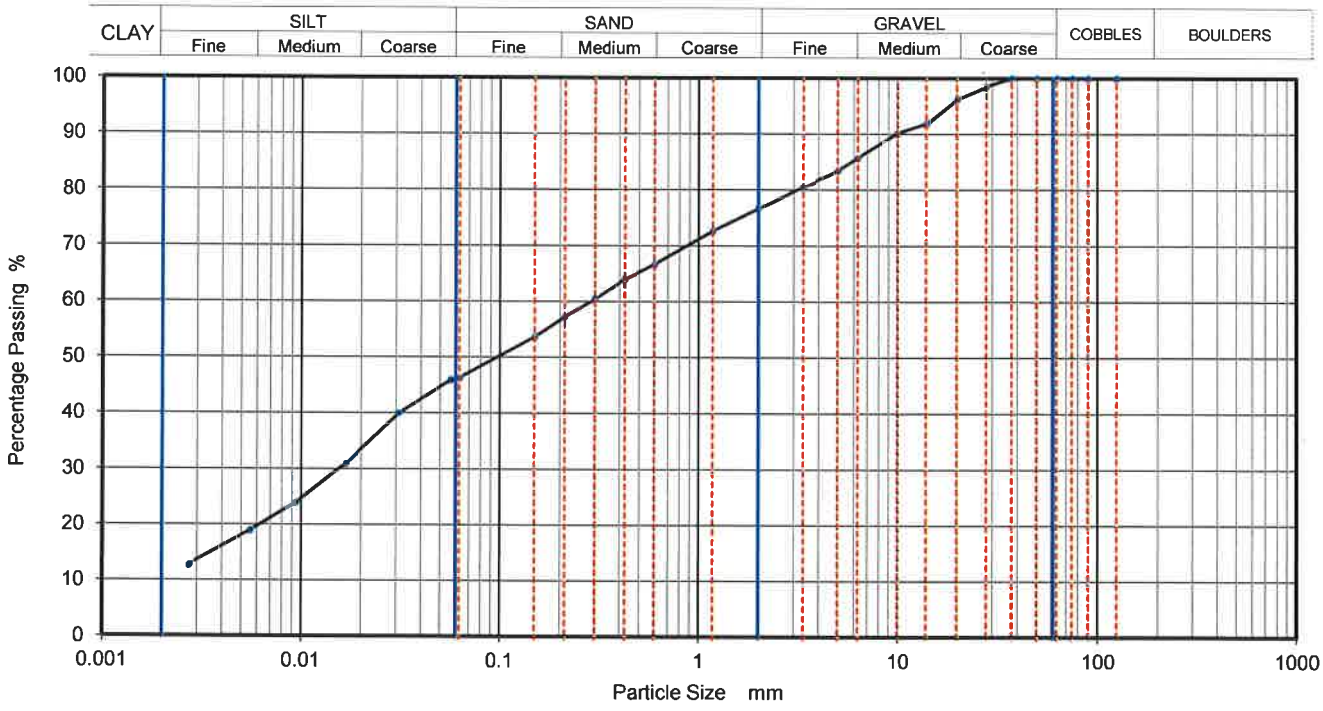
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	BH124
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	1
Soil Description	Firm brown gravelly CLAY			Depth, m	0.00
Specimen Reference	12	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645BH124B1



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0567	46
90	100	0.0309	40
75	100	0.0167	31
63	100	0.0094	24
50	100	0.0056	19
37.5	100	0.0028	13
28	99		
20	96		
14	92		
10	90		
6.3	86		
5	84		
3.35	81		
2	77		
1.18	73		
0.6	67	Particle density (assumed)	
0.425	64	1.50	Mg/m3
0.3	61		
0.212	57		
0.15	54		
0.063	46		

Dry Mass of sample, g	2706

Sample Proportions	% dry mass
Very coarse	0
Gravel	23
Sand	30
Fines <0.063mm	46

Grading Analysis		
D100	mm	
D60	mm	0.283
D30	mm	0.0154
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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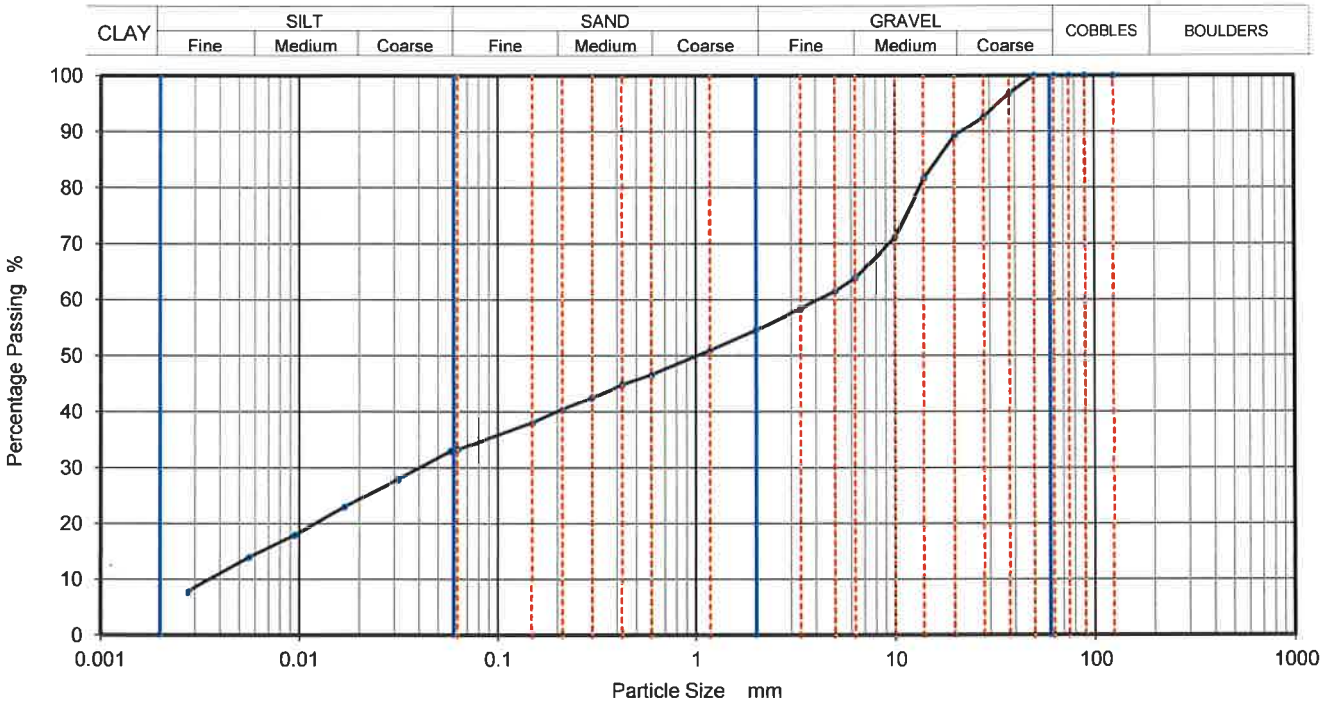
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	BH125
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	3
Soil Description	Very stiff black sandy gravelly CLAY.			Depth, m	3.50
Specimen Reference	6	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645BH125B3



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0580	33
90	100	0.0315	28
75	100	0.0168	23
63	100	0.0095	18
50	100	0.0056	14
37.5	97	0.0028	8
28	93		
20	89		
14	82		
10	71		
6.3	64		
5	62		
3.35	59		
2	55		
1.18	51		
0.6	47	Particle density	(assumed)
0.425	45	1.50	Mg/m3
0.3	43		
0.212	41		
0.15	38		
0.063	33		

Dry Mass of sample, g	4469

Sample Proportions	% dry mass
Very coarse	0
Gravel	45
Sand	21
Fines <0.063mm	33

Grading Analysis		
D100	mm	
D60	mm	4.06
D30	mm	0.0389
D10	mm	0.00348
Uniformity Coefficient		1200
Curvature Coefficient		0.11

Remarks

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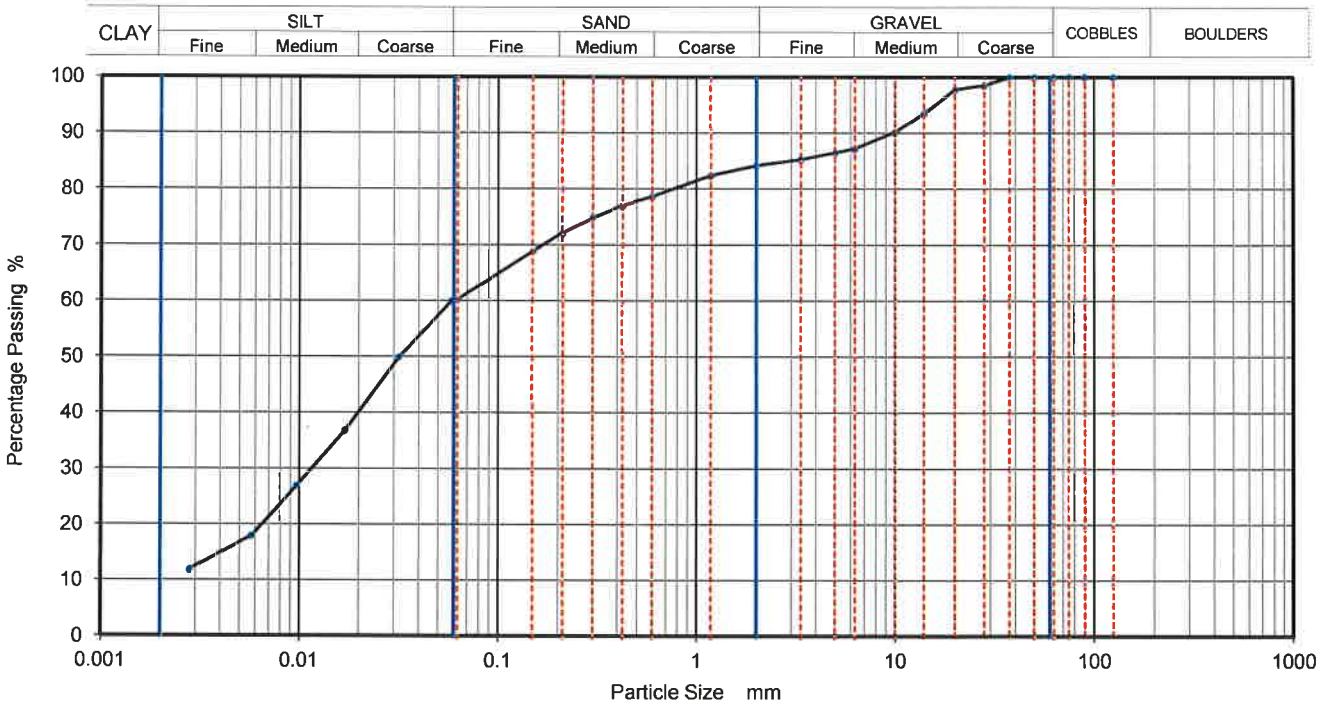
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	BH127
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	1
Soil Description	Stiff brown grey sandy gravelly CLAY			Depth, m	0.30
Specimen Reference	12	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645BH127B1



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0584	60
90	100	0.0319	50
75	100	0.0172	37
63	100	0.0097	27
50	100	0.0058	18
37.5	100	0.0028	12
28	99		
20	98		
14	94		
10	90		
6.3	87		
5	87		
3.35	85		
2	84		
1.18	82		
0.6	79	Particle density (assumed)	
0.425	77	1.50	Mg/m3
0.3	75		
0.212	72		
0.15	69		
0.063	60		

Dry Mass of sample, g	2277

Sample Proportions	% dry mass
Very coarse	0
Gravel	16
Sand	24
Fines <0.063mm	60

Grading Analysis		
D100	mm	
D60	mm	0.0571
D30	mm	0.0116
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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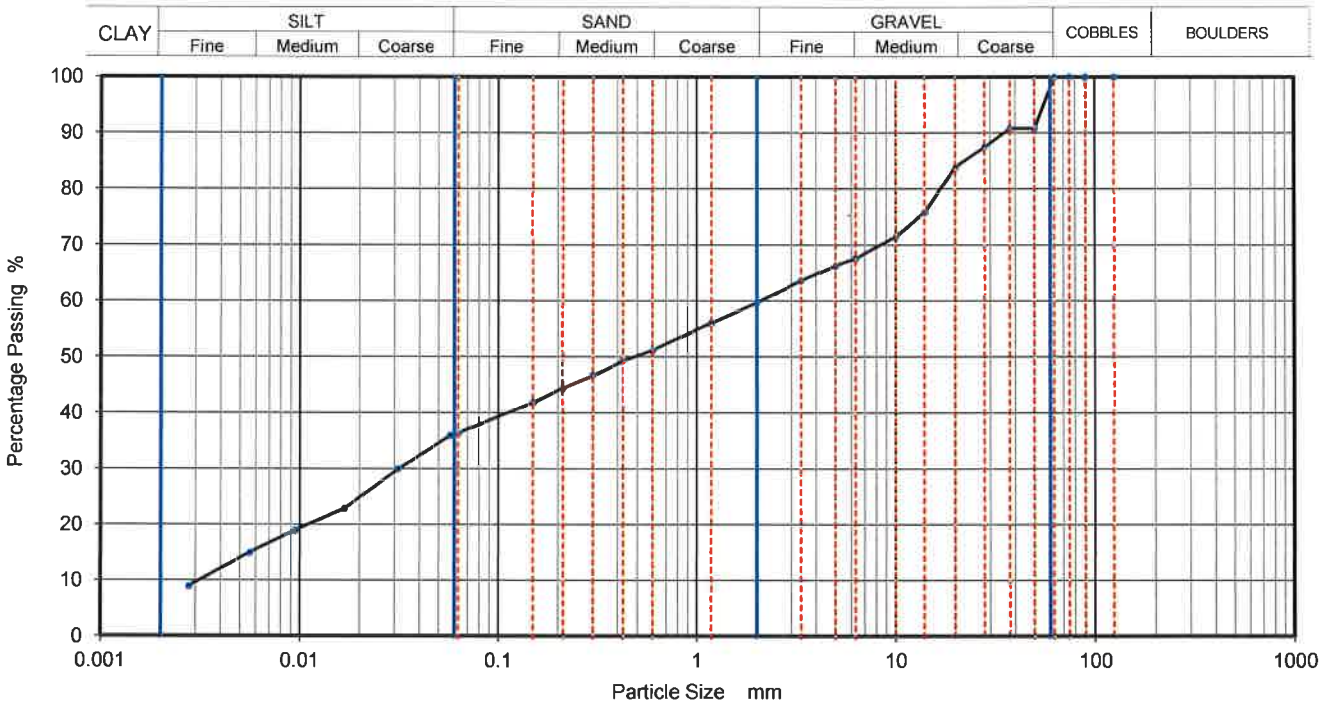
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	BH127
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	3
Soil Description	Very stiff black sandy gravelly CLAY.			Depth, m	2.50
Specimen Reference	12	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645BH127B3



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0571	36
90	100	0.0313	30
75	100	0.0169	23
63	100	0.0095	19
50	91	0.0056	15
37.5	91	0.0028	9
28	88		
20	84		
14	76		
10	72		
6.3	68		
5	66		
3.35	64		
2	60		
1.18	56		
0.6	51	Particle density	(assumed)
0.425	49	1.50	Mg/m3
0.3	47		
0.212	45		
0.15	42		
0.063	36		

Dry Mass of sample, g	6617

Sample Proportions	% dry mass
Very coarse	0
Gravel	40
Sand	23
Fines <0.063mm	36

Grading Analysis		
D100	mm	
D60	mm	2.08
D30	mm	0.0309
D10	mm	0.00302
Uniformity Coefficient		690
Curvature Coefficient		0.15

Remarks

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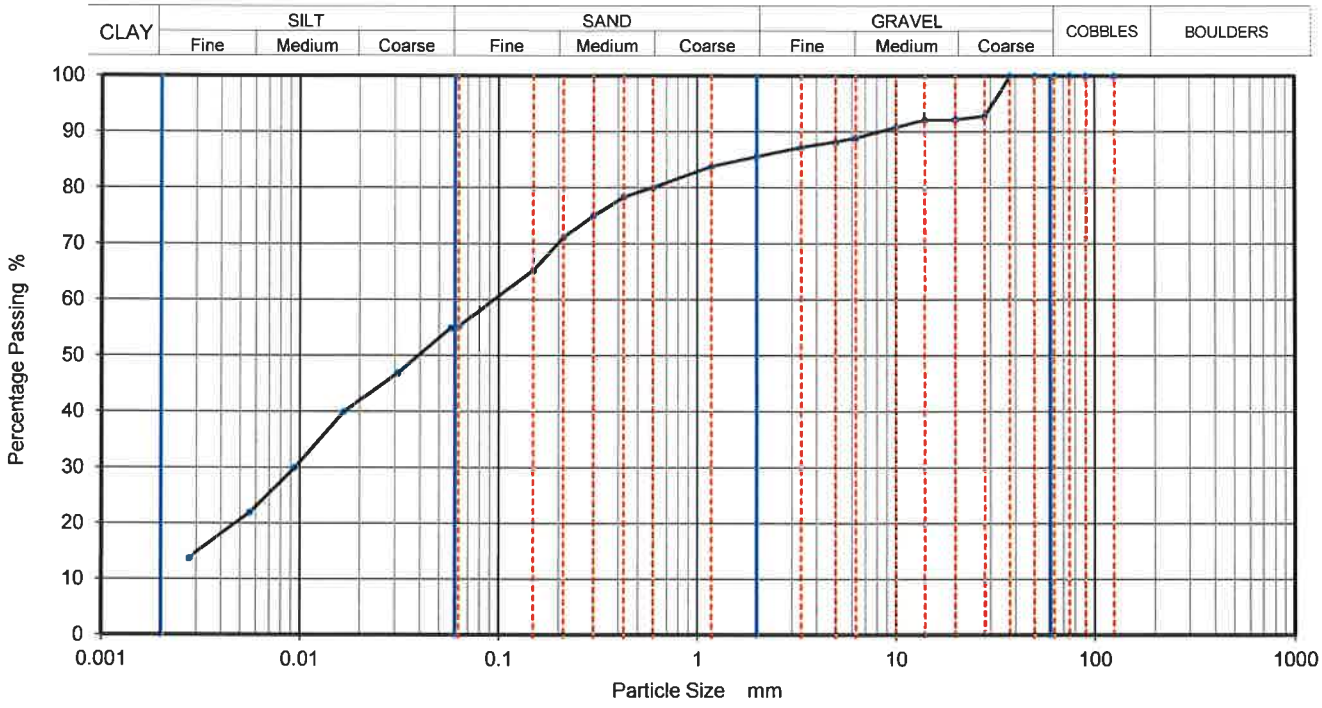
CAUSEWAY GEOTECH

PARTICLE SIZE DISTRIBUTION

				Job Ref	14-645
				Borehole/Pit No.	BH128
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	B02
Soil Description	Firm to stiff light brown gravelly CLAY with occasional cobbles and boulders.			Depth, m	0.30
Specimen Reference	12	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645BH128B02



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0571	55
90	100	0.0311	47
75	100	0.0166	40
63	100	0.0094	30
50	100	0.0056	22
37.5	100	0.0028	14
28	93		
20	92		
14	92		
10	91		
6.3	89		
5	88		
3.35	87		
2	86		
1.18	84		
0.6	80	Particle density	(assumed)
0.425	78	1.50	Mg/m3
0.3	75		
0.212	71		
0.15	65		
0.063	55		

Dry Mass of sample, g	2304

Sample Proportions	% dry mass
Very coarse	0
Gravel	14
Sand	30
Fines <0.063mm	55

Grading Analysis		
D100	mm	
D60	mm	0.0943
D30	mm	0.00943
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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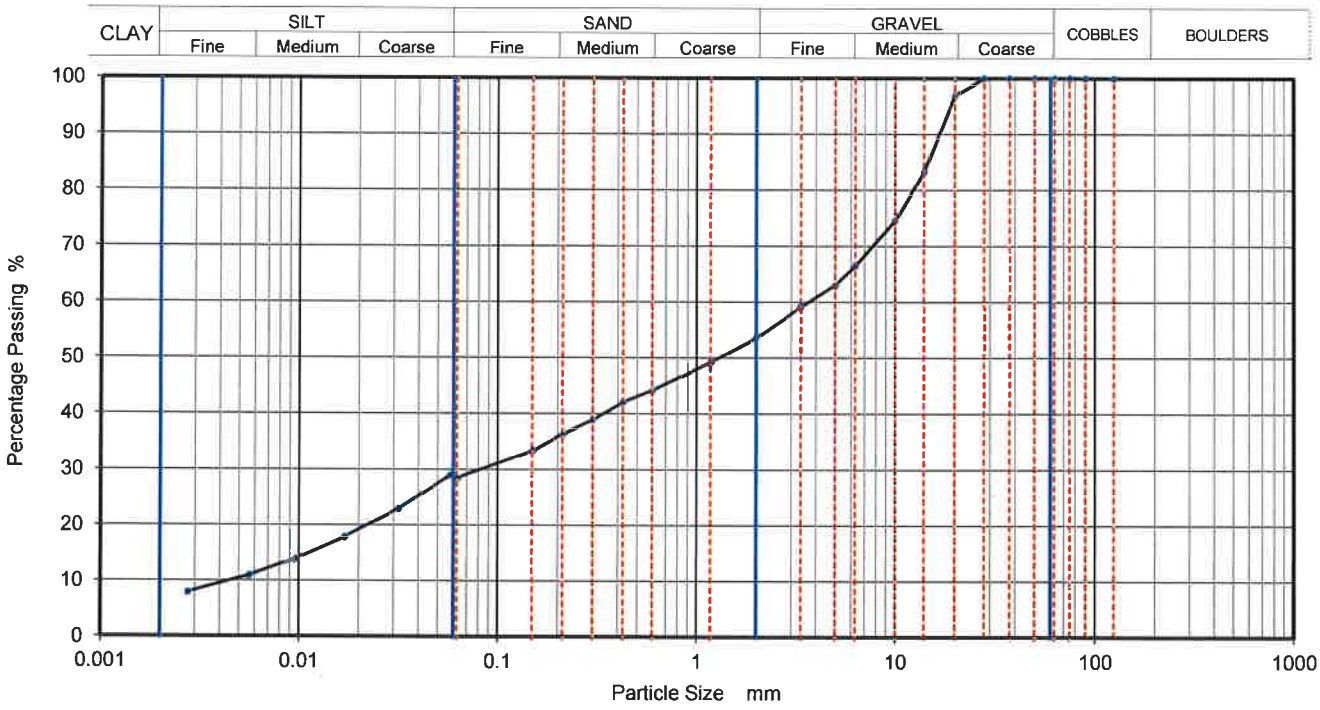
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	BH128
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	B03
Soil Description	Very stiff black gravelly CLAY with occasional cobbles and boulders.			Depth, m	1.10
Specimen Reference	12	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645BH128B03



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0580	29
90	100	0.0317	23
75	100	0.0170	18
63	100	0.0096	14
50	100	0.0056	11
37.5	100	0.0028	8
28	100		
20	97		
14	83		
10	75		
6.3	67		
5	63		
3.35	59		
2	54		
1.18	49		
0.6	44	Particle density	(assumed)
0.425	42	1.50	Mg/m3
0.3	39		
0.212	36		
0.15	33		
0.063	29		

Dry Mass of sample, g	3950

Sample Proportions	% dry mass
Very coarse	0
Gravel	46
Sand	25
Fines <0.063mm	28

Grading Analysis		
D100	mm	
D60	mm	3.65
D30	mm	0.082
D10	mm	0.00438
Uniformity Coefficient		830
Curvature Coefficient		0.42

Remarks

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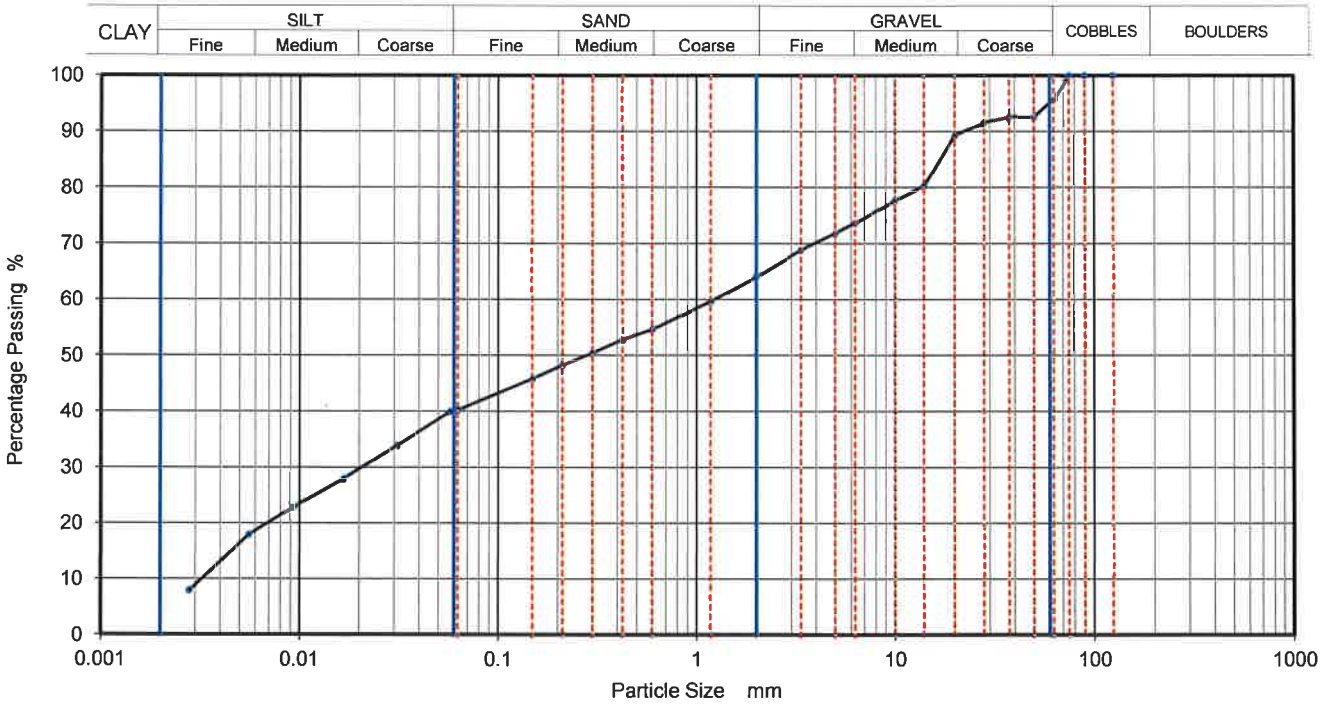
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	BH130
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	2
Soil Description	Firm brown mottled grey slightly gravelly CLAY.			Depth, m	1.20
Specimen Reference	6	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645BH130B2



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0575	40
90	100	0.0313	34
75	100	0.0167	28
63	96	0.0094	23
50	93	0.0056	18
37.5	93	0.0028	8
28	92		
20	89		
14	80		
10	78		
6.3	74		
5	72		
3.35	69		
2	64		
1.18	60		
0.6	55	Particle density	(assumed)
0.425	53	1.50	Mg/m3
0.3	51		
0.212	48		
0.15	46		
0.063	40		

Dry Mass of sample, g	5961

Sample Proportions	% dry mass
Very coarse	4
Gravel	32
Sand	24
Fines <0.063mm	40

Grading Analysis		
D100	mm	
D60	mm	1.22
D30	mm	0.0197
D10	mm	0.00317
Uniformity Coefficient		390
Curvature Coefficient		0.1

Remarks

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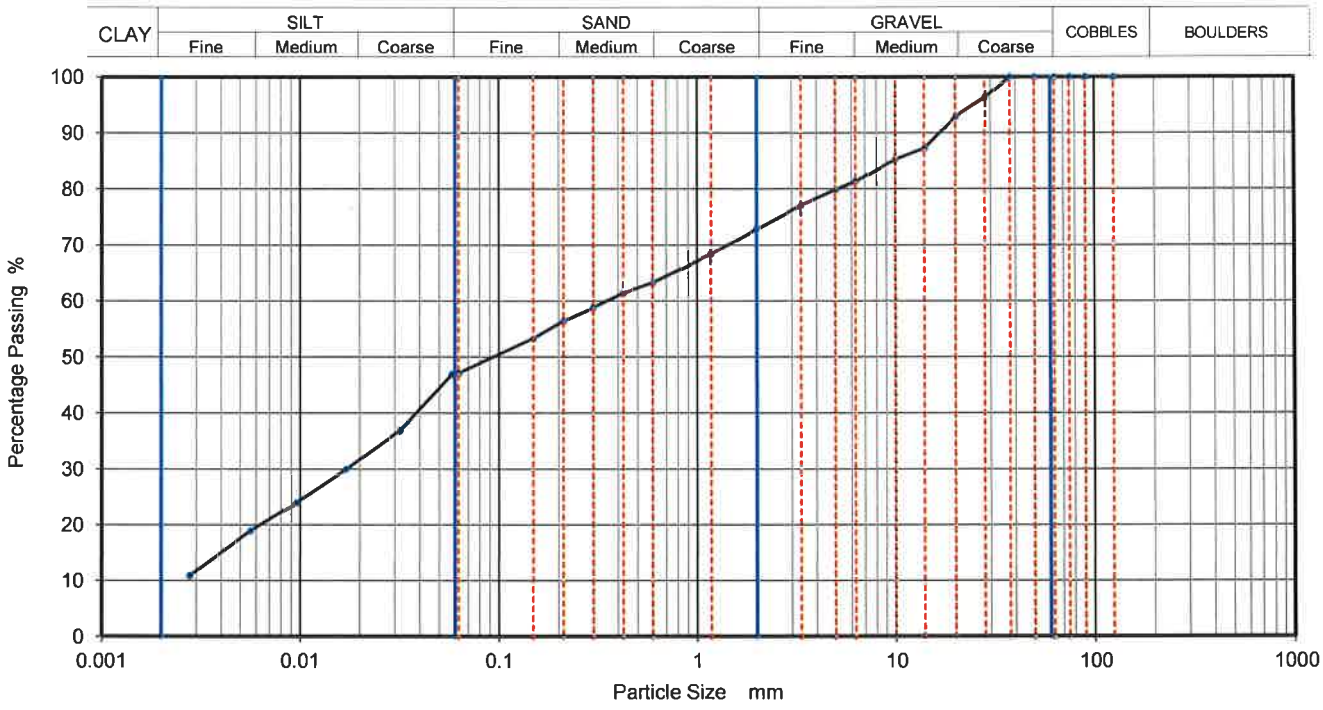
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	BH130
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	6
Soil Description	Very stiff dark grey slightly sandy slightly gravelly CLAY.			Depth, m	5.00
Specimen Reference	6	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645BH130B6



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0580	47
90	100	0.0320	37
75	100	0.0170	30
63	100	0.0095	24
50	100	0.0056	19
37.5	100	0.0028	11
28	96		
20	93		
14	87		
10	85		
6.3	81		
5	80		
3.35	77		
2	73		
1.18	68		
0.6	63	Particle density	(assumed)
0.425	62	1.50	Mg/m3
0.3	59		
0.212	57		
0.15	53		
0.063	47		

Dry Mass of sample, g	2508

Sample Proportions	% dry mass
Very coarse	0
Gravel	27
Sand	26
Fines <0.063mm	47

Grading Analysis		
D100	mm	
D60	mm	0.347
D30	mm	0.017
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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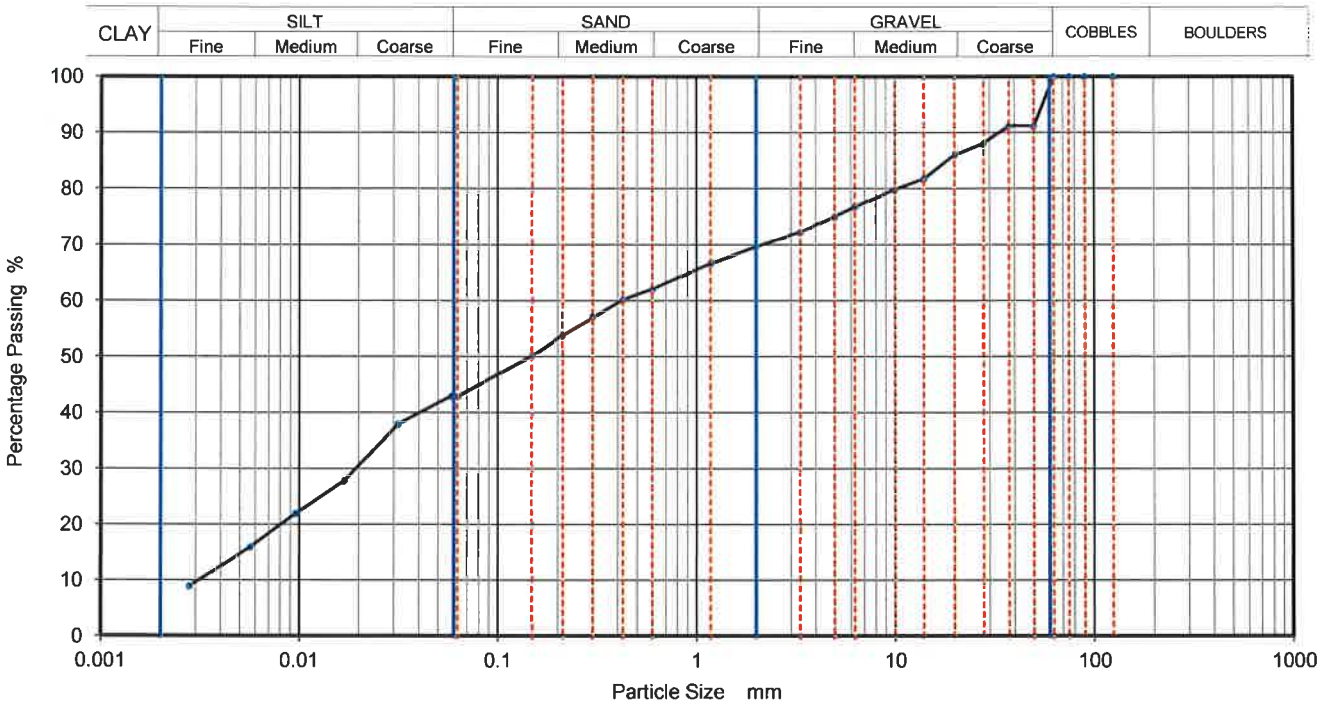
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	BH135
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	2
Soil Description	Brown mottled grey sandy gravelly CLAY			Depth, m	1.20
Specimen Reference	3	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645BH135B2



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0584	43
90	100	0.0315	38
75	100	0.0170	28
63	100	0.0096	22
50	91	0.0057	16
37.5	91	0.0028	9
28	88		
20	86		
14	82		
10	80		
6.3	77		
5	75		
3.35	72		
2	70		
1.18	67		
0.6	62	Particle density	(assumed)
0.425	60	1.50	Mg/m3
0.3	57		
0.212	54		
0.15	50		
0.063	43		

Dry Mass of sample, g	3168

Sample Proportions	% dry mass
Very coarse	0
Gravel	30
Sand	27
Fines <0.063mm	43

Grading Analysis		
D100	mm	
D60	mm	0.415
D30	mm	0.0191
D10	mm	0.00298
Uniformity Coefficient		140
Curvature Coefficient		0.3

Remarks

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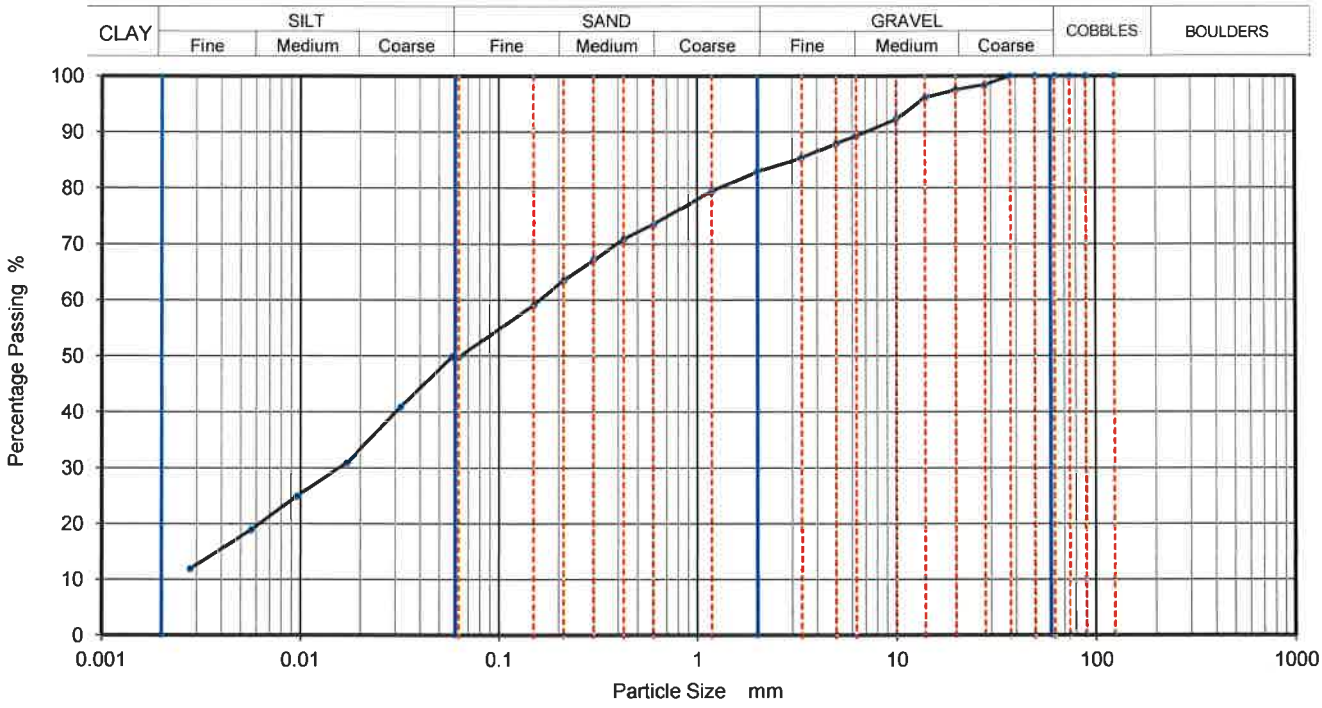
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	BH135
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	6
Soil Description	Stiff dark grey sandy gravelly CLAY.			Depth, m	5.00
Specimen Reference	3	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645BH135B6



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0584	50
90	100	0.0320	41
75	100	0.0171	31
63	100	0.0096	25
50	100	0.0057	19
37.5	100	0.0028	12
28	98		
20	98		
14	96		
10	92		
6.3	89		
5	88		
3.35	86		
2	83		
1.18	80		
0.6	74	Particle density	(assumed)
0.425	71	1.50	Mg/m3
0.3	67		
0.212	64		
0.15	59		
0.063	50		

Dry Mass of sample, g	3067

Sample Proportions	% dry mass
Very coarse	0
Gravel	17
Sand	33
Fines <0.063mm	50

Grading Analysis		
D100	mm	
D60	mm	0.159
D30	mm	0.0153
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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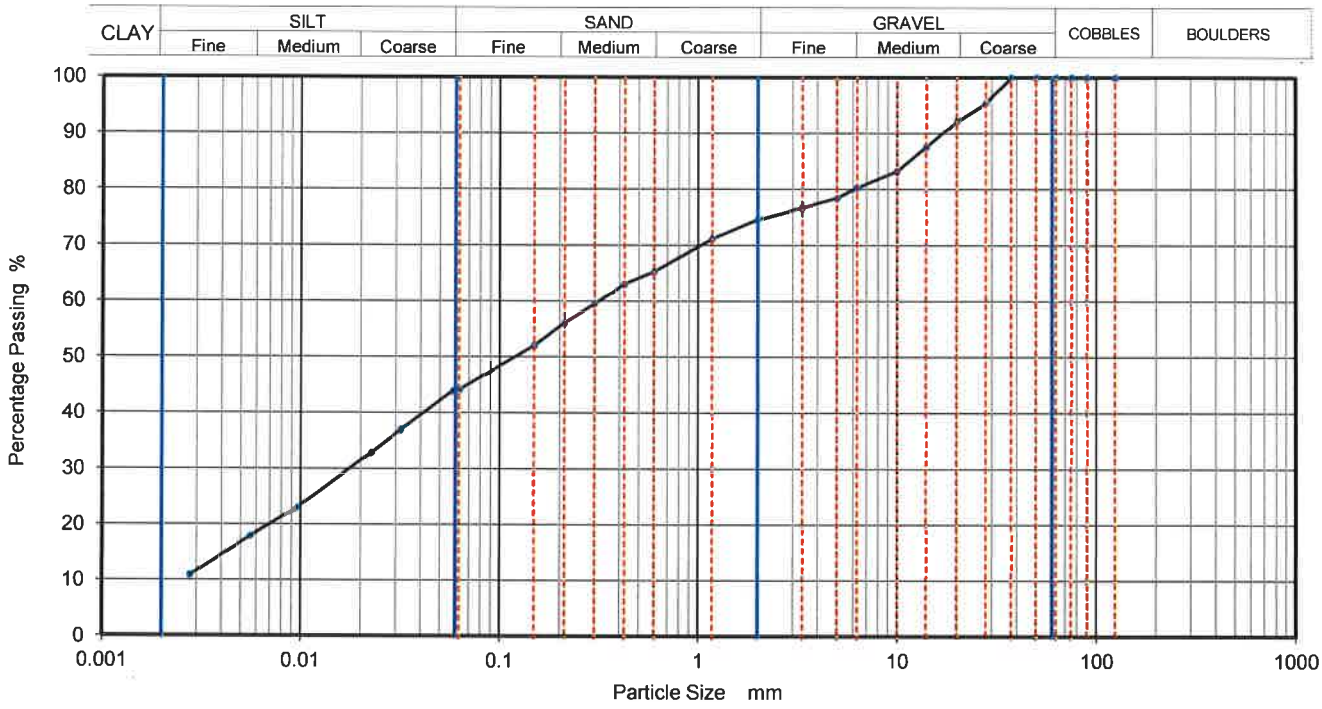
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	BH137
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	2
Soil Description	Firm to soft brown sandy gravelly CLAY.			Depth, m	1.20
Specimen Reference	3	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645BH137B2



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0584	44
90	100	0.0317	37
75	100	0.0227	33
63	100	0.0095	23
50	100	0.0056	18
37.5	100	0.0028	11
28	96		
20	92		
14	88		
10	83		
6.3	80		
5	79		
3.35	77		
2	75		
1.18	71		
0.6	65	Particle density (assumed)	
0.425	63	1.50	Mg/m3
0.3	60		
0.212	56		
0.15	52		
0.063	44		

Dry Mass of sample, g	3667

Sample Proportions	% dry mass
Very coarse	0
Gravel	25
Sand	30
Fines <0.063mm	44

Grading Analysis		
D100	mm	
D60	mm	0.313
D30	mm	0.0171
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377 unless noted below

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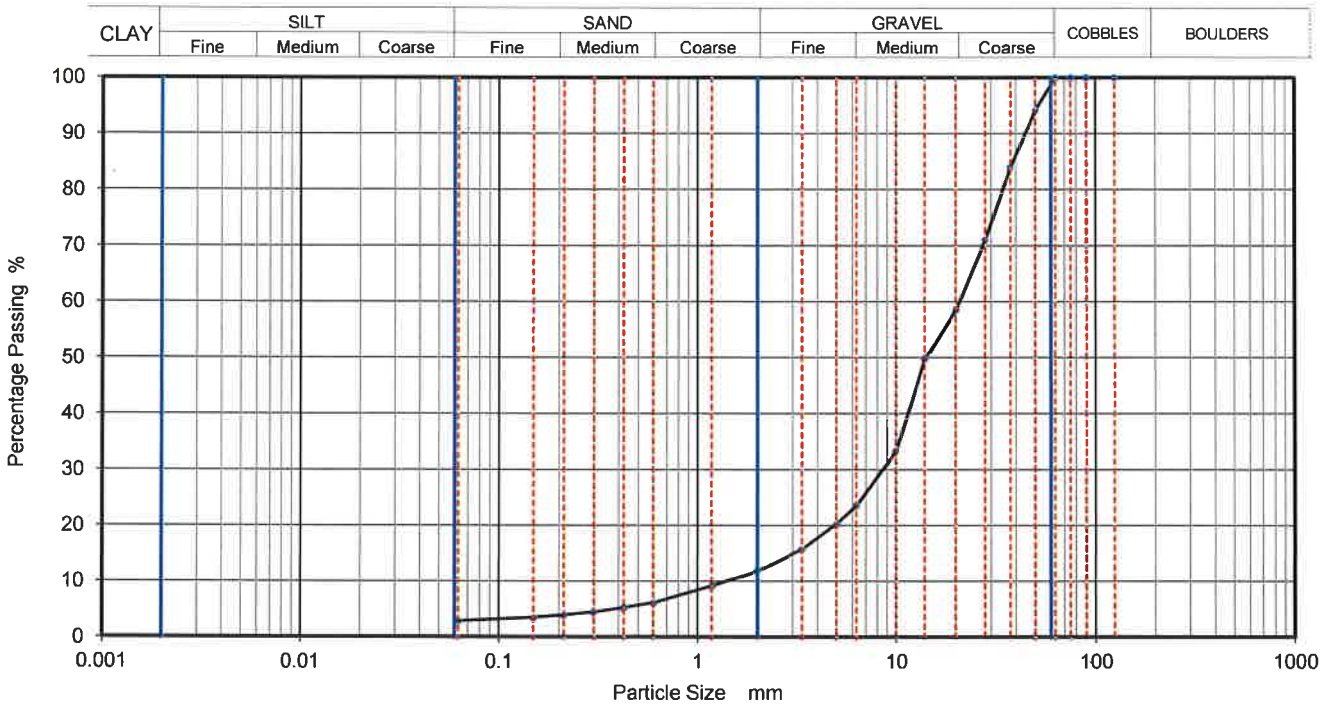
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	BH138
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	B02
Soil Description	Medium dense grey slightly sandy subangular to rounded fine to medium GRAVEL.			Depth, m	0.90
Specimen Reference	12	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	14645BH138B02



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	94		
37.5	84		
28	71		
20	59		
14	50		
10	33		
6.3	24		
5	20		
3.35	16		
2	12		
1.18	9		
0.6	6		
0.425	5		
0.3	5		
0.212	4		
0.15	4		
0.063	3		

Dry Mass of sample, g	10851

Sample Proportions	% dry mass
Very coarse	0
Gravel	88
Sand	9
Fines <0.063mm	3

Grading Analysis		
D100	mm	
D60	mm	20.8
D30	mm	8.51
D10	mm	1.39
Uniformity Coefficient		15
Curvature Coefficient		2.5

Remarks

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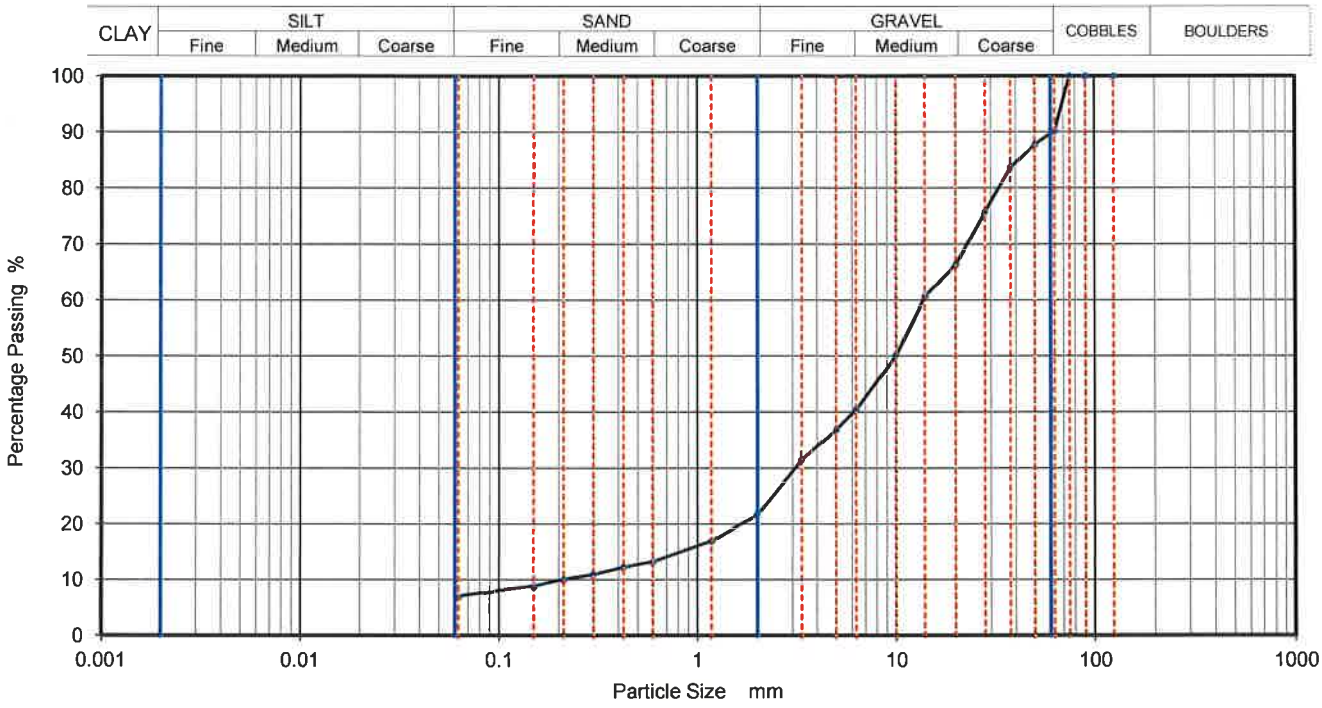
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	BH138
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	B03
Soil Description	Medium dense grey slightly sandy subangular to rounded fine to medium GRAVEL.			Depth, m	2.50
Specimen Reference	8	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	14645BH138B03



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	90		
50	88		
37.5	84		
28	76		
20	66		
14	61		
10	50		
6.3	41		
5	37		
3.35	32		
2	22		
1.18	17		
0.6	13		
0.425	12		
0.3	11		
0.212	10		
0.15	9		
0.063	7		

Dry Mass of sample, g: 11596

Sample Proportions	% dry mass
Very coarse	10
Gravel	68
Sand	15
Fines <0.063mm	7

Grading Analysis		
D100	mm	
D60	mm	13.6
D30	mm	3.08
D10	mm	0.207
Uniformity Coefficient		66
Curvature Coefficient		3.4

Remarks

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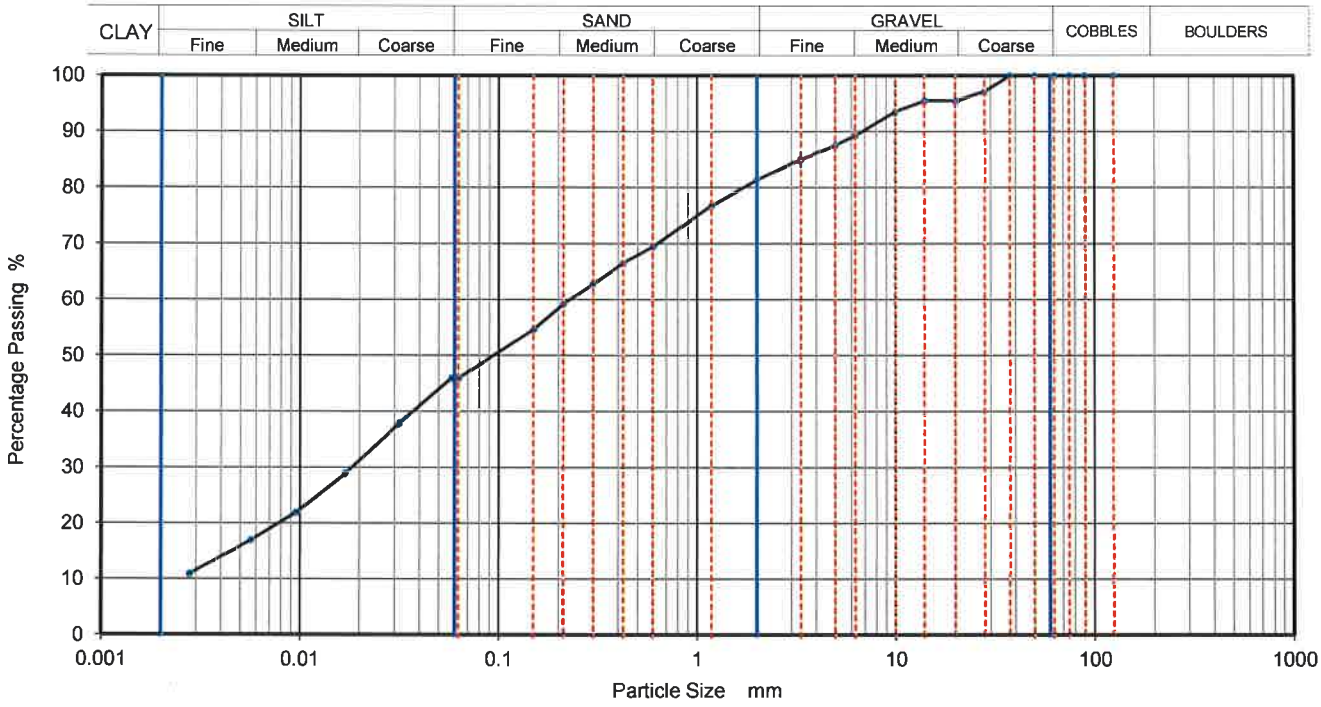
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	BH139
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	3
Soil Description	Firm to stiff brown slightly sandy slightly gravelly CLAY			Depth, m	2.00
Specimen Reference	3	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645BH139B3



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0580	46
90	100	0.0317	38
75	100	0.0170	29
63	100	0.0096	22
50	100	0.0057	17
37.5	100	0.0028	11
28	97		
20	96		
14	96		
10	94		
6.3	89		
5	88		
3.35	85		
2	81		
1.18	77		
0.6	70	Particle density	(assumed)
0.425	67	1.50	Mg/m3
0.3	63		
0.212	59		
0.15	55		
0.063	46		

Dry Mass of sample, g	2880

Sample Proportions	% dry mass
Very coarse	0
Gravel	19
Sand	35
Fines <0.063mm	46

Grading Analysis		
D100	mm	
D60	mm	0.226
D30	mm	0.018
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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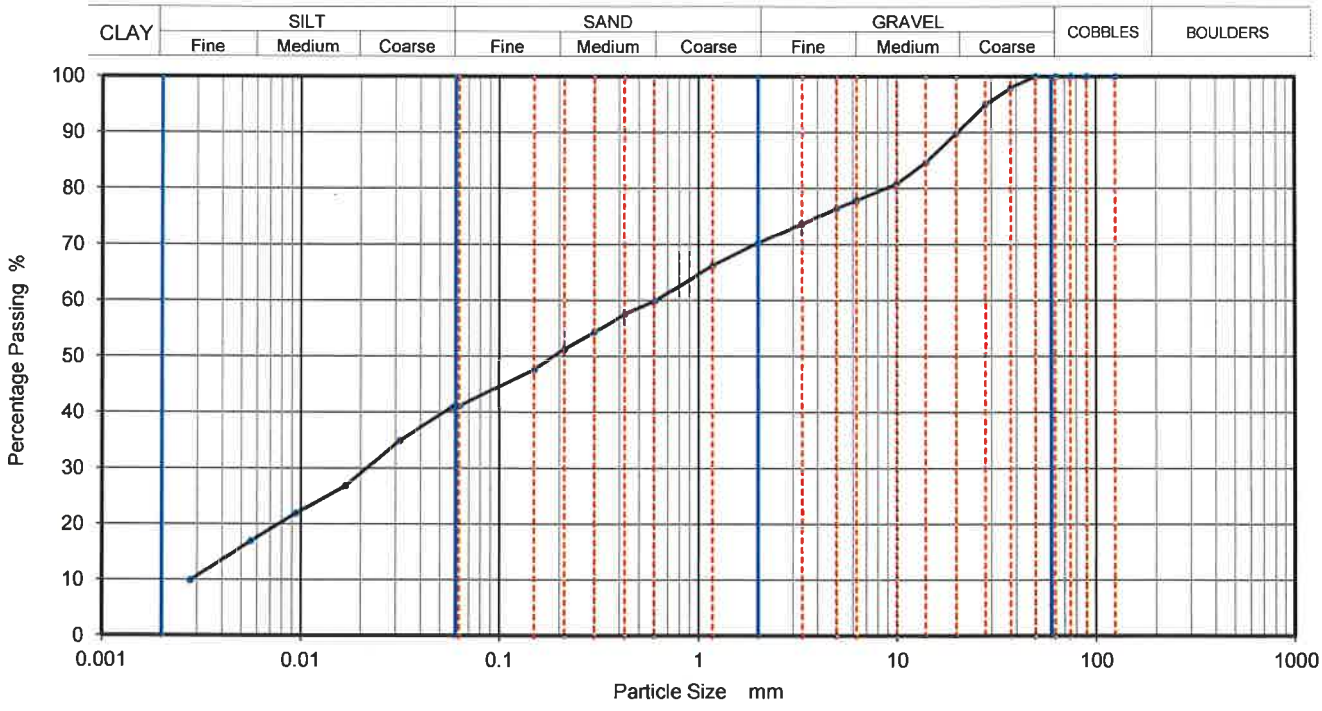
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	BH139
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	7
Soil Description	Stiff black slightly sandy slightly gravelly CLAY with occasional cobbles.			Depth, m	6.00
Specimen Reference	3	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645BH139B7



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0580	41
90	100	0.0315	35
75	100	0.0169	27
63	100	0.0095	22
50	100	0.0056	17
37.5	98	0.0028	10
28	95		
20	90		
14	85		
10	81		
6.3	78		
5	77		
3.35	74		
2	70		
1.18	66		
0.6	60	Particle density	(assumed)
0.425	58	1.50	Mg/m3
0.3	54		
0.212	51		
0.15	48		
0.063	41		

Dry Mass of sample, g	4709

Sample Proportions	% dry mass
Very coarse	0
Gravel	30
Sand	29
Fines <0.063mm	41

Grading Analysis		
D100	mm	
D60	mm	0.608
D30	mm	0.0209
D10	mm	0.00279
Uniformity Coefficient		220
Curvature Coefficient		0.26

Remarks

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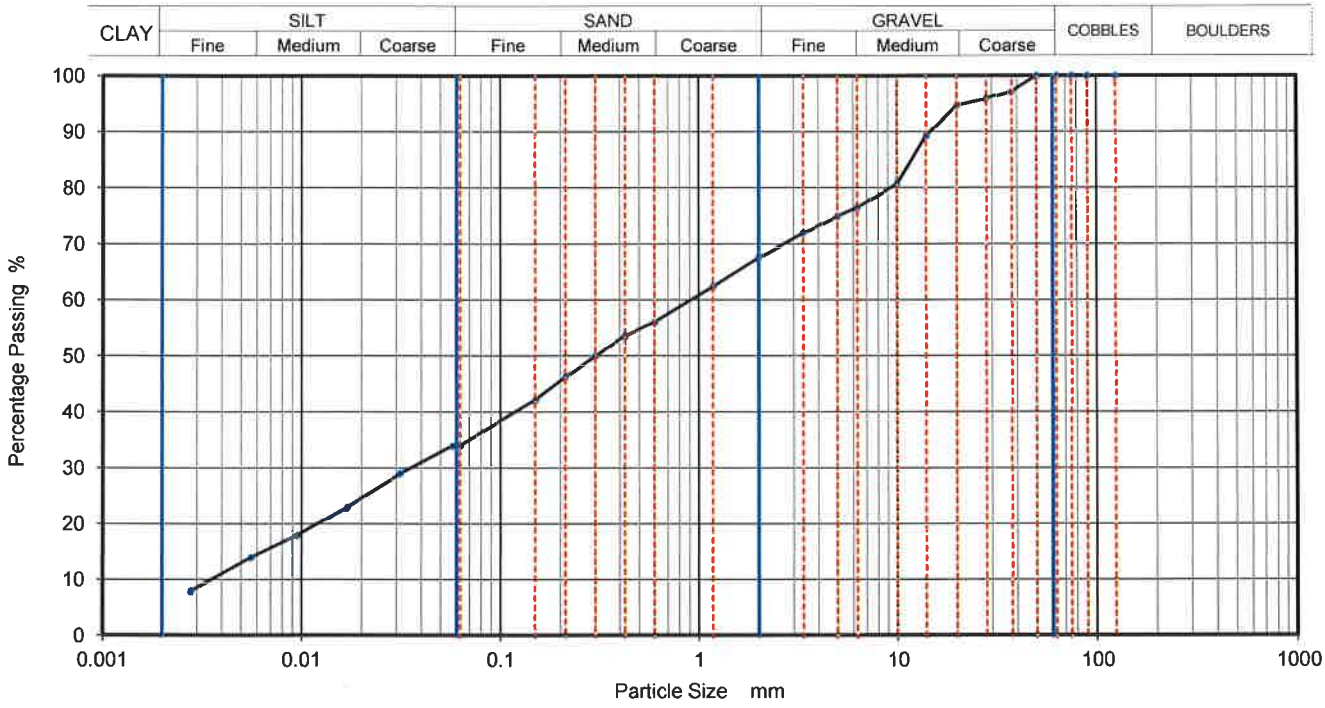
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	BH139
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	8
Soil Description	Firm to stiff dark grey slightly sandy gravelly CLAY with occasional cobbles.			Depth, m	8.00
Specimen Reference	3	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645BH139B8



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0575	34
90	100	0.0313	29
75	100	0.0168	23
63	100	0.0095	18
50	100	0.0056	14
37.5	97	0.0028	8
28	96		
20	95		
14	89		
10	81		
6.3	77		
5	75		
3.35	72		
2	68		
1.18	62		
0.6	56	Particle density	(assumed)
0.425	54	1.50	Mg/m3
0.3	50		
0.212	46		
0.15	42		
0.063	34		

Dry Mass of sample, g	4216

Sample Proportions	% dry mass
Very coarse	0
Gravel	32
Sand	34
Fines <0.063mm	34

Grading Analysis		
D100	mm	
D60	mm	0.911
D30	mm	0.035
D10	mm	0.0035
Uniformity Coefficient		260
Curvature Coefficient		0.38

Remarks

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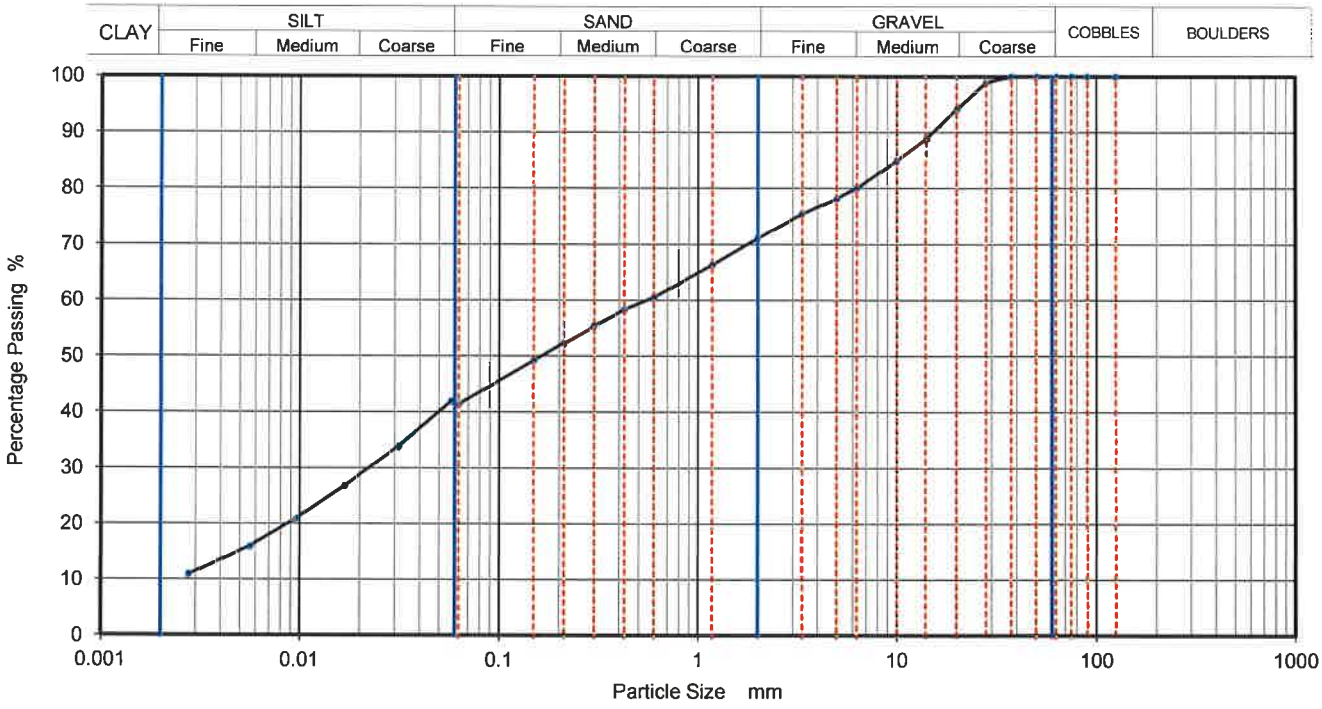
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	TP100
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	B01
Soil Description	MADE GROUND - Firm brown grey gravelly CLAY with fragments of plastic timber and gravel.			Depth, m	0.50
Specimen Reference	12	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645TP100B01



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0575	42
90	100	0.0315	34
75	100	0.0169	27
63	100	0.0095	21
50	100	0.0056	16
37.5	100	0.0028	11
28	99		
20	94		
14	89		
10	85		
6.3	80		
5	78		
3.35	76		
2	71		
1.18	66		
0.6	61	Particle density	(assumed)
0.425	58	1.50	Mg/m3
0.3	56		
0.212	53		
0.15	49		
0.063	42		

Dry Mass of sample, g	3510

Sample Proportions	% dry mass
Very coarse	0
Gravel	29
Sand	30
Fines <0.063mm	42

Grading Analysis		
D100	mm	
D60	mm	0.546
D30	mm	0.0221
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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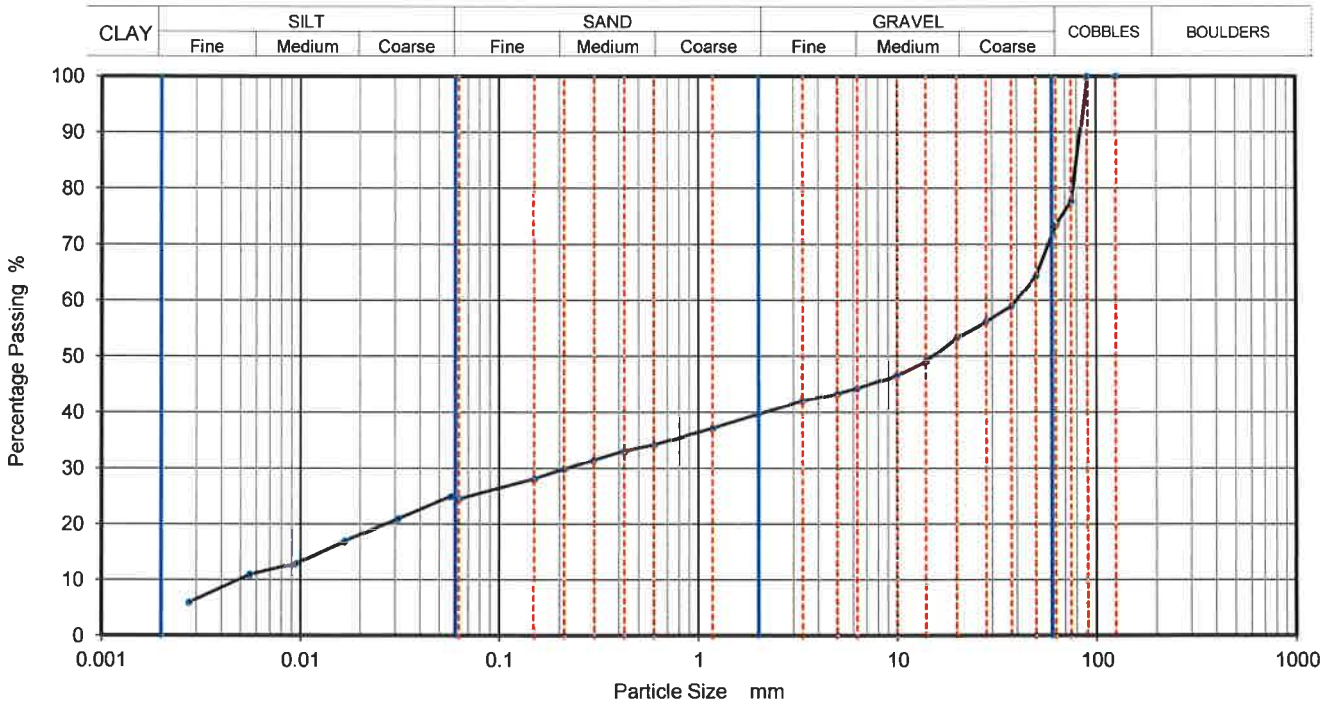
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	TP100
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	B02
Soil Description	Firm brown gravelly CLAY.			Depth, m	1.50
Specimen Reference	12	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645TP100B02



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0571	25
90	100	0.0311	21
75	78	0.0167	17
63	74	0.0095	13
50	64	0.0056	11
37.5	59	0.0028	6
28	56		
20	53		
14	49		
10	47		
6.3	44		
5	43		
3.35	42		
2	40		
1.18	37		
0.6	34	Particle density	(assumed)
0.425	33	1.50	Mg/m3
0.3	32		
0.212	30		
0.15	28		
0.063	25		

Dry Mass of sample, g	8346

Sample Proportions	% dry mass
Very coarse	27
Gravel	34
Sand	15
Fines <0.063mm	25

Grading Analysis		
D100	mm	
D60	mm	39.5
D30	mm	0.218
D10	mm	0.00513
Uniformity Coefficient		7700
Curvature Coefficient		0.23

Remarks

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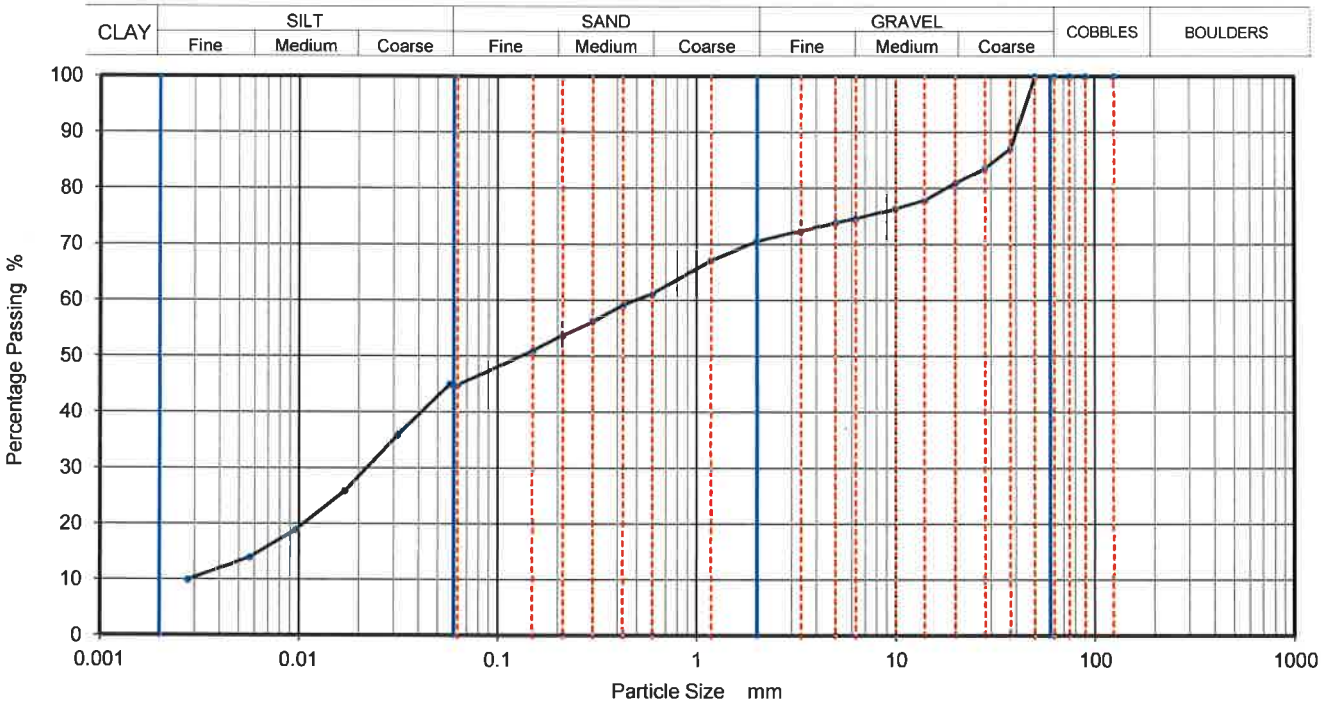
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	TP101
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	B01
Soil Description	MADE GROUND - Soft to firm light brown gravelly CLAY with fragments of plastic and glass.			Depth, m	0.50
Specimen Reference	3	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645TP101B01



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0571	45
90	100	0.0315	36
75	100	0.0171	26
63	100	0.0097	19
50	100	0.0057	14
37.5	87	0.0028	10
28	84		
20	81		
14	78		
10	76		
6.3	75		
5	74		
3.35	73		
2	71		
1.18	67		
0.6	61	Particle density	(assumed)
0.425	59	1.50	Mg/m3
0.3	56		
0.212	54		
0.15	51		
0.063	45		

Dry Mass of sample, g	3864

Sample Proportions	% dry mass
Very coarse	0
Gravel	29
Sand	26
Fines <0.063mm	45

Grading Analysis		
D100	mm	
D60	mm	0.491
D30	mm	0.0222
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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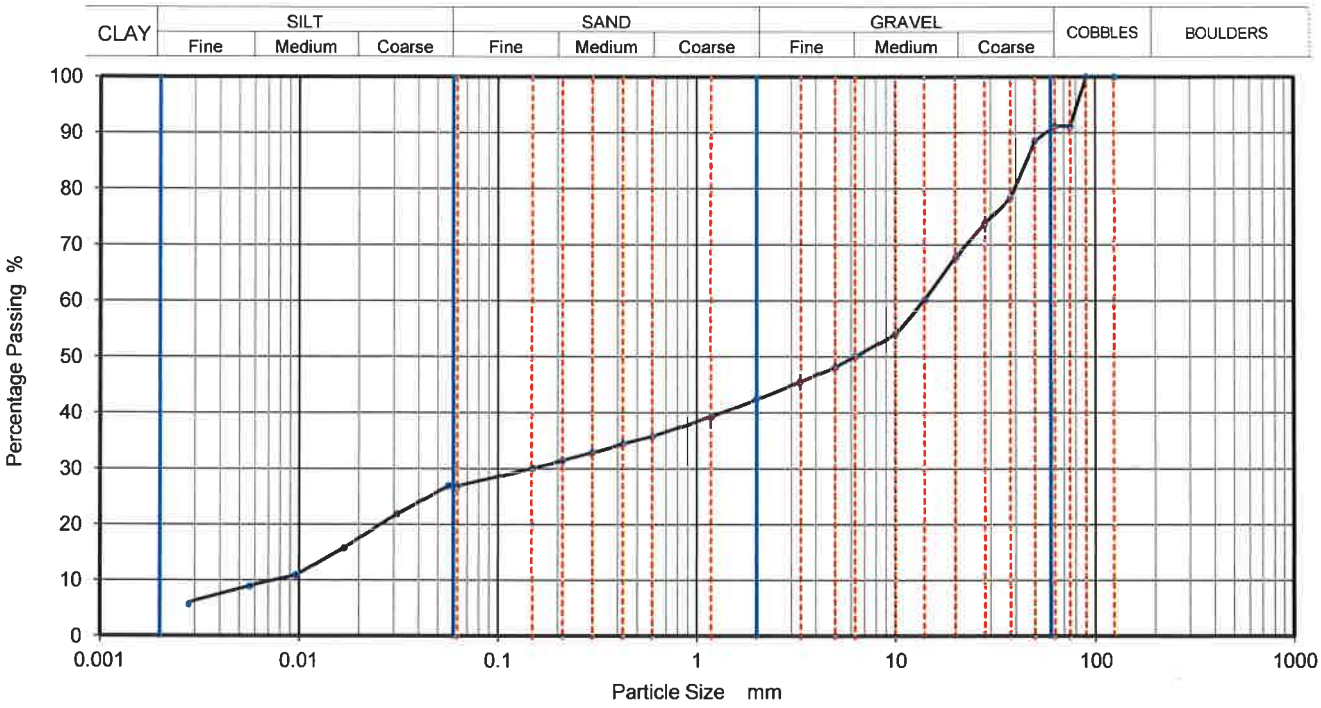
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	TP102
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	B01
Soil Description	Firm brown gravelly CLAY.			Depth, m	0.50
Specimen Reference	12	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645TP102B01



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0567	27
90	100	0.0313	22
75	91	0.0170	16
63	91	0.0097	11
50	89	0.0057	9
37.5	78	0.0028	6
28	74		
20	68		
14	60		
10	54		
6.3	50		
5	48		
3.35	46		
2	43		
1.18	39		
0.6	36	Particle density	(assumed)
0.425	35	1.50	Mg/m3
0.3	33		
0.212	32		
0.15	30		
0.063	27		

Dry Mass of sample, g	6955

Sample Proportions	% dry mass
Very coarse	9
Gravel	49
Sand	16
Fines <0.063mm	27

Grading Analysis		
D100	mm	
D60	mm	13.9
D30	mm	0.146
D10	mm	0.00725
Uniformity Coefficient		1900
Curvature Coefficient		0.21

Remarks

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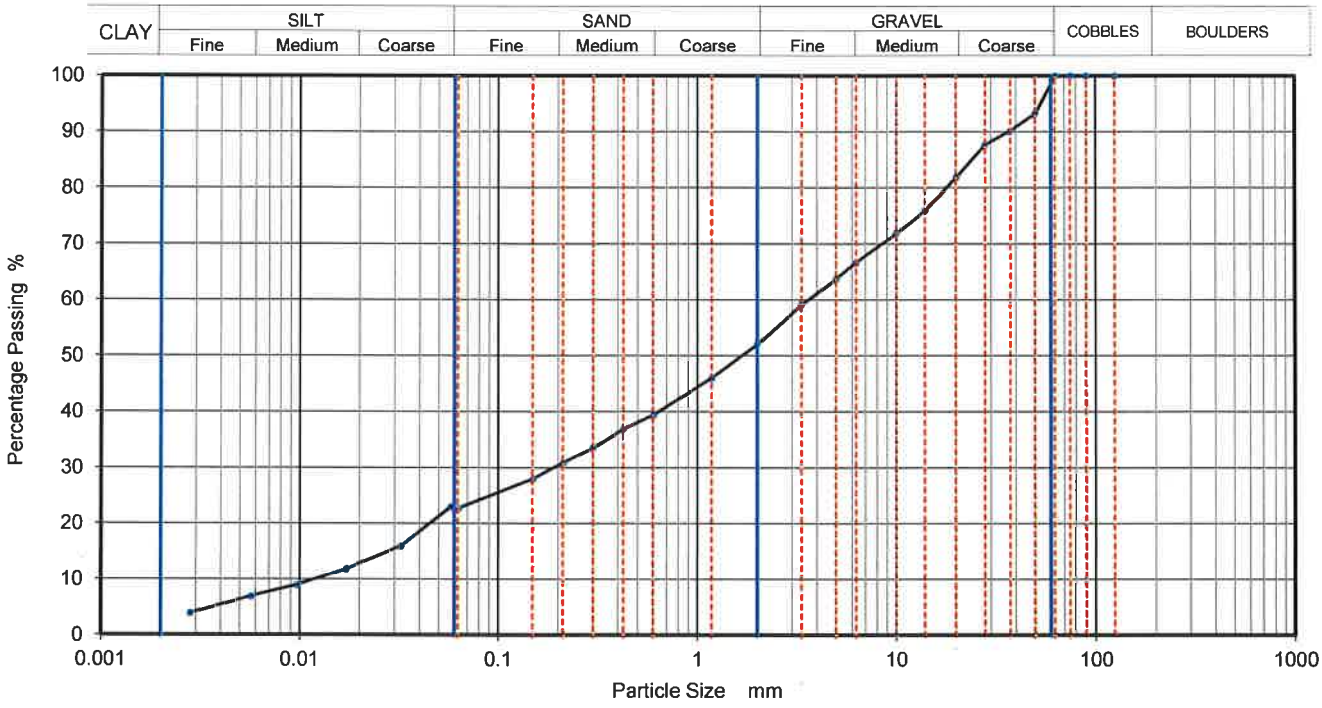
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	TP102
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	2
Soil Description	Firm grey gravelly CLAY with fragments of weathered roots.			Depth, m	1.50
Specimen Reference	12	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645TP102B02



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0575	23
90	100	0.0324	16
75	100	0.0173	12
63	100	0.0098	9
50	93	0.0057	7
37.5	90	0.0028	4
28	88		
20	82		
14	76		
10	72		
6.3	67		
5	64		
3.35	59		
2	52		
1.18	46		
0.6	39	Particle density 1.50	(assumed) Mg/m3
0.425	37		
0.3	34		
0.212	31		
0.15	28		
0.063	23		

Dry Mass of sample, g	5729

Sample Proportions	% dry mass
Very coarse	0
Gravel	48
Sand	29
Fines <0.063mm	23

Grading Analysis		
D100	mm	
D60	mm	3.58
D30	mm	0.191
D10	mm	0.0123
Uniformity Coefficient		290
Curvature Coefficient		0.83

Remarks

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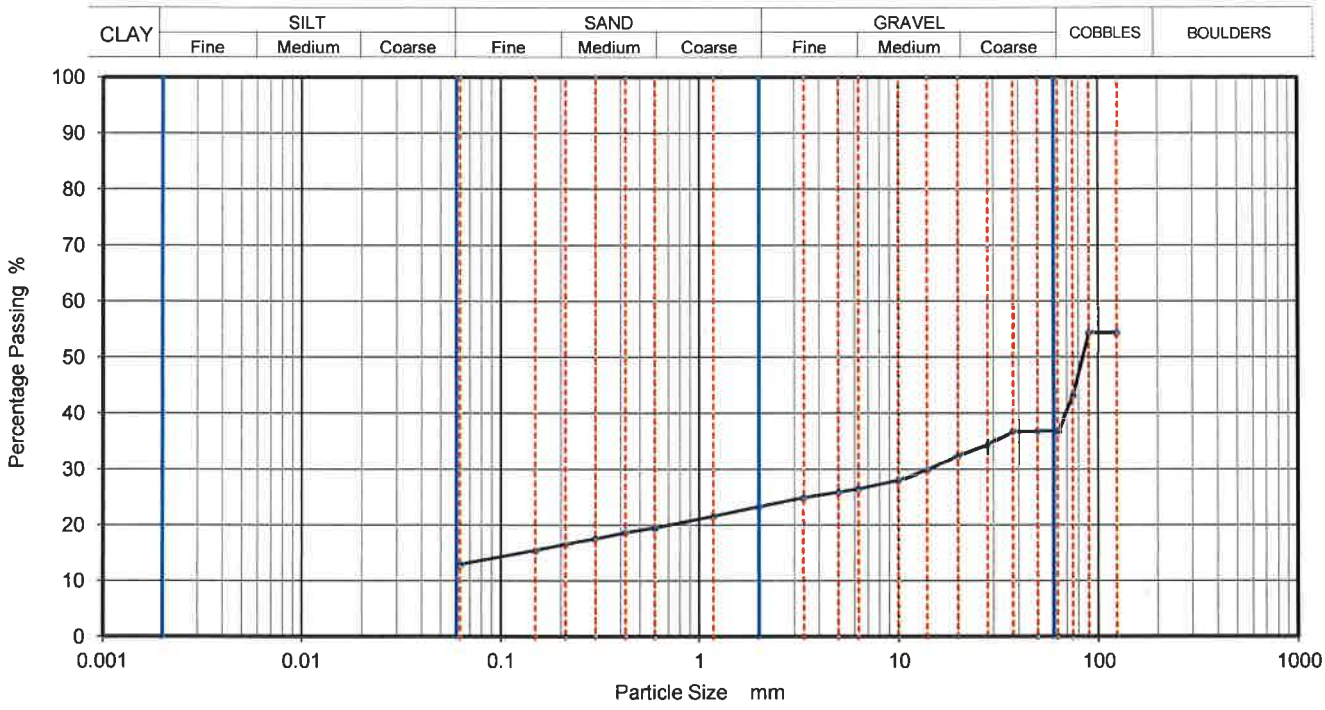
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	TP103
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	B02
Soil Description	Firm brown gravelly CLAY with fragments of weathered roots.			Depth, m	0.90
Specimen Reference	12	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	14645TP103B02



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	54		
90	54		
75	43		
63	37		
50	37		
37.5	37		
28	35		
20	33		
14	30		
10	28		
6.3	27		
5	26		
3.35	25		
2	23		
1.18	22		
0.6	20		
0.425	19		
0.3	18		
0.212	17		
0.15	16		
0.063	13		

Dry Mass of sample, g: 10867

Sample Proportions	% dry mass
Very coarse	63
Gravel	14
Sand	10
Fines <0.063mm	13

Grading Analysis		
D100	mm	
D60	mm	
D30	mm	14.2
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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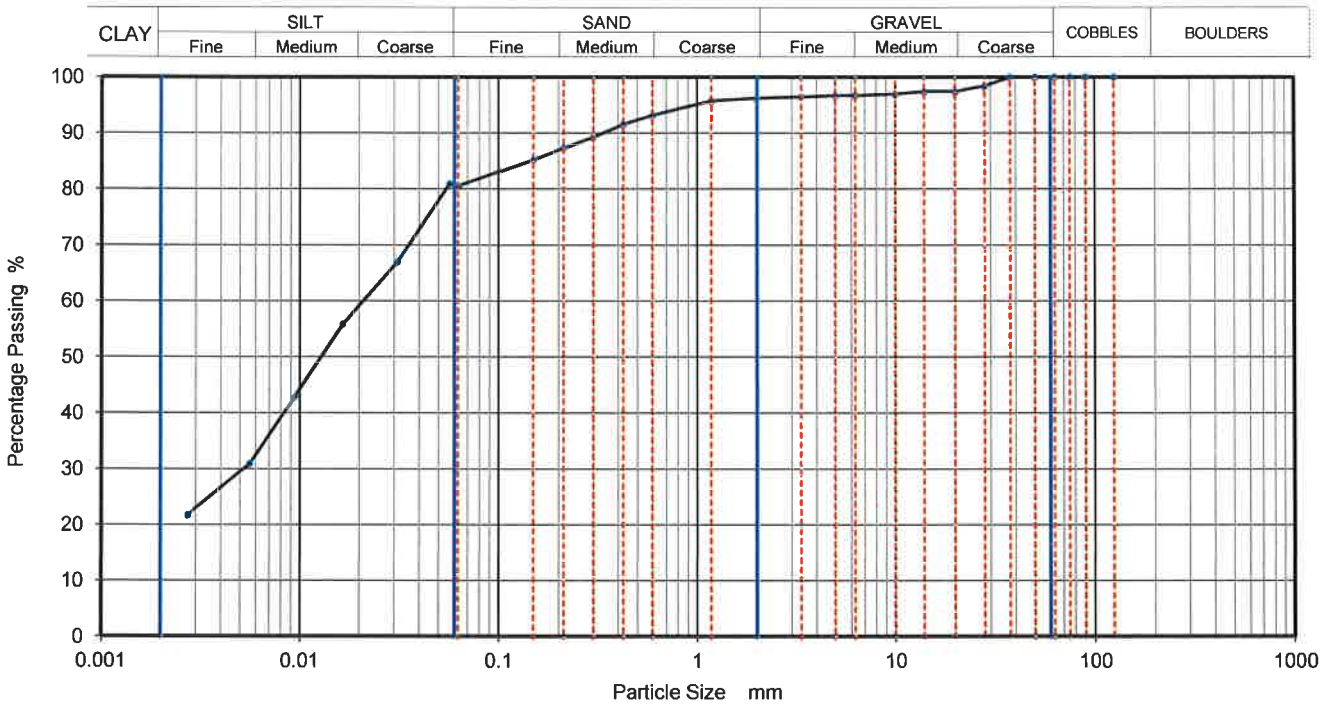
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	TP104
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	B01
Soil Description	Firm brown gravelly CLAY with occasional cobbles.			Depth, m	0.50
Specimen Reference	12	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645TP104B01



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0567	81
90	100	0.0311	67
75	100	0.0166	56
63	100	0.0094	43
50	100	0.0056	31
37.5	100	0.0028	22
28	98		
20	97		
14	97		
10	97		
6.3	97		
5	97		
3.35	97		
2	96		
1.18	96		
0.6	93	Particle density	(assumed)
0.425	92	1.50	Mg/m3
0.3	89		
0.212	87		
0.15	85		
0.063	81		

Dry Mass of sample, g	1935

Sample Proportions	% dry mass
Very coarse	0
Gravel	4
Sand	16
Fines <0.063mm	81

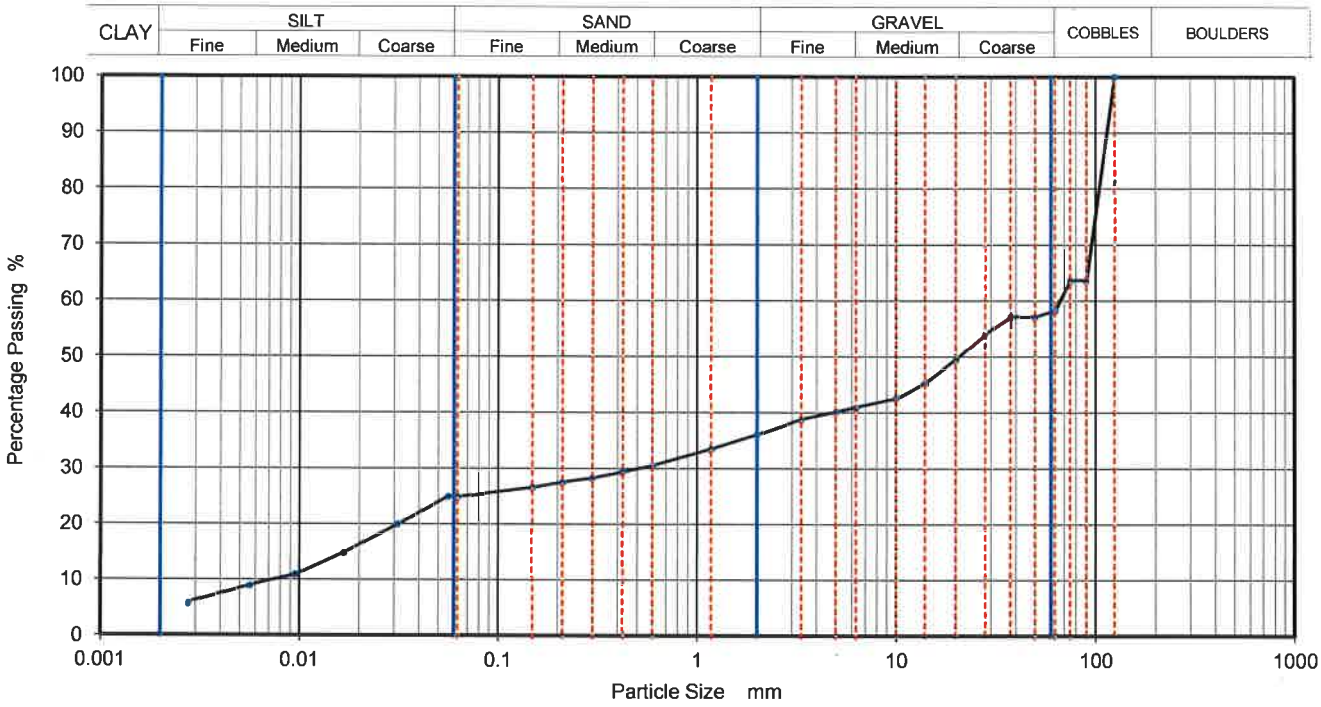
Grading Analysis		
D100	mm	
D60	mm	0.0208
D30	mm	0.00504
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	Fig 11
Stephen.Watson	25/02/2015 10:11	Sheet

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	TP104
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	B02
Soil Description	Firm grey brown gravelly CLAY with occasional cobbles.			Depth, m	1.00
Specimen Reference	12	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645TP104B02



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0563	25
90	64	0.0313	20
75	64	0.0169	15
63	58	0.0095	11
50	57	0.0056	9
37.5	57	0.0028	6
28	54		
20	50		
14	45		
10	43		
6.3	41		
5	40		
3.35	39		
2	36		
1.18	34		
0.6	31	Particle density	(assumed)
0.425	29	1.50	Mg/m3
0.3	28		
0.212	28		
0.15	27		
0.063	25		

Dry Mass of sample, g	7597

Sample Proportions	% dry mass
Very coarse	42
Gravel	22
Sand	11
Fines <0.063mm	25

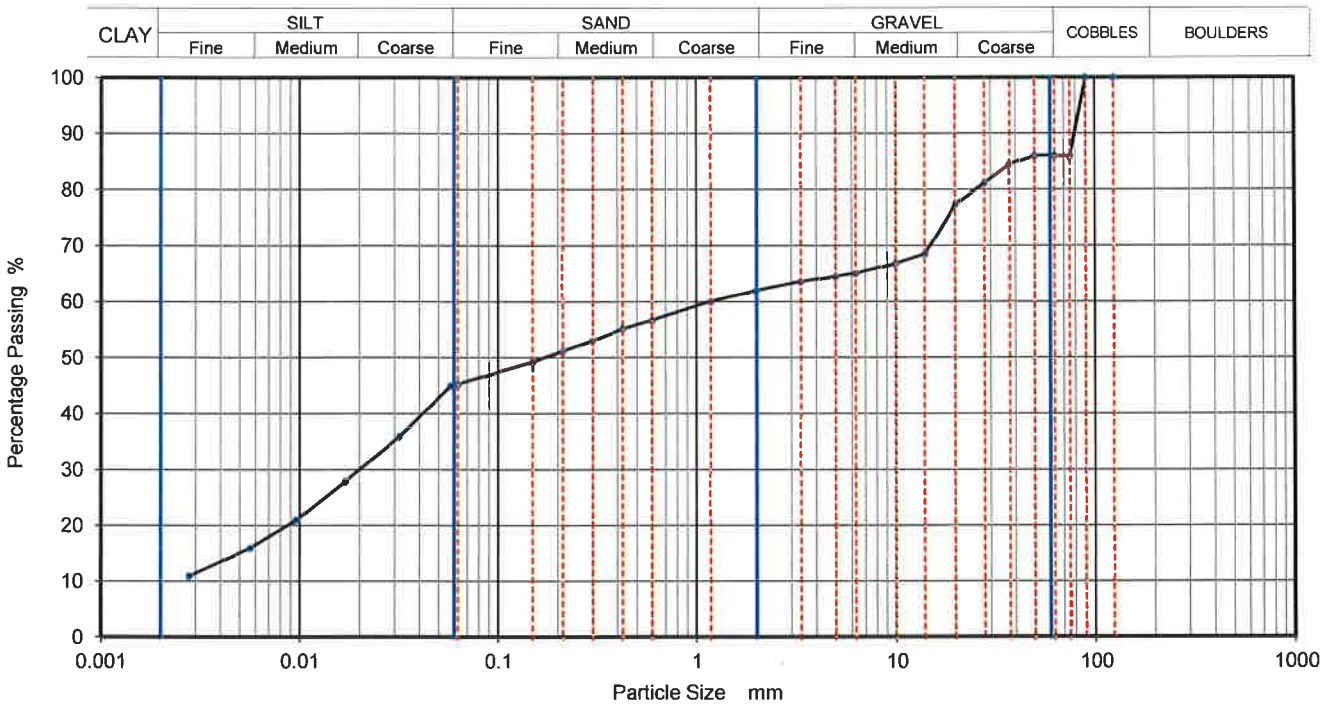
Grading Analysis		
D100	mm	125
D60	mm	66.6
D30	mm	0.511
D10	mm	0.0072
Uniformity Coefficient		9200
Curvature Coefficient		0.54

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	Fig 15
Stephen.Watson	25/02/2015 10:11	Sheet

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	TP105
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	B02
Soil Description	Firm brown gravelly CLAY.			Depth, m	0.80
Specimen Reference	12	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645TP105B02



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0575	45
90	100	0.0317	36
75	86	0.0170	28
63	86	0.0096	21
50	86	0.0057	16
37.5	85	0.0028	11
28	81		
20	77		
14	69		
10	67		
6.3	65		
5	65		
3.35	64		
2	62		
1.18	60		
0.6	57	Particle density	(assumed)
0.425	55	1.50	Mg/m3
0.3	53		
0.212	51		
0.15	49		
0.063	45		

Dry Mass of sample, g	5438

Sample Proportions	% dry mass
Very coarse	14
Gravel	24
Sand	17
Fines <0.063mm	45

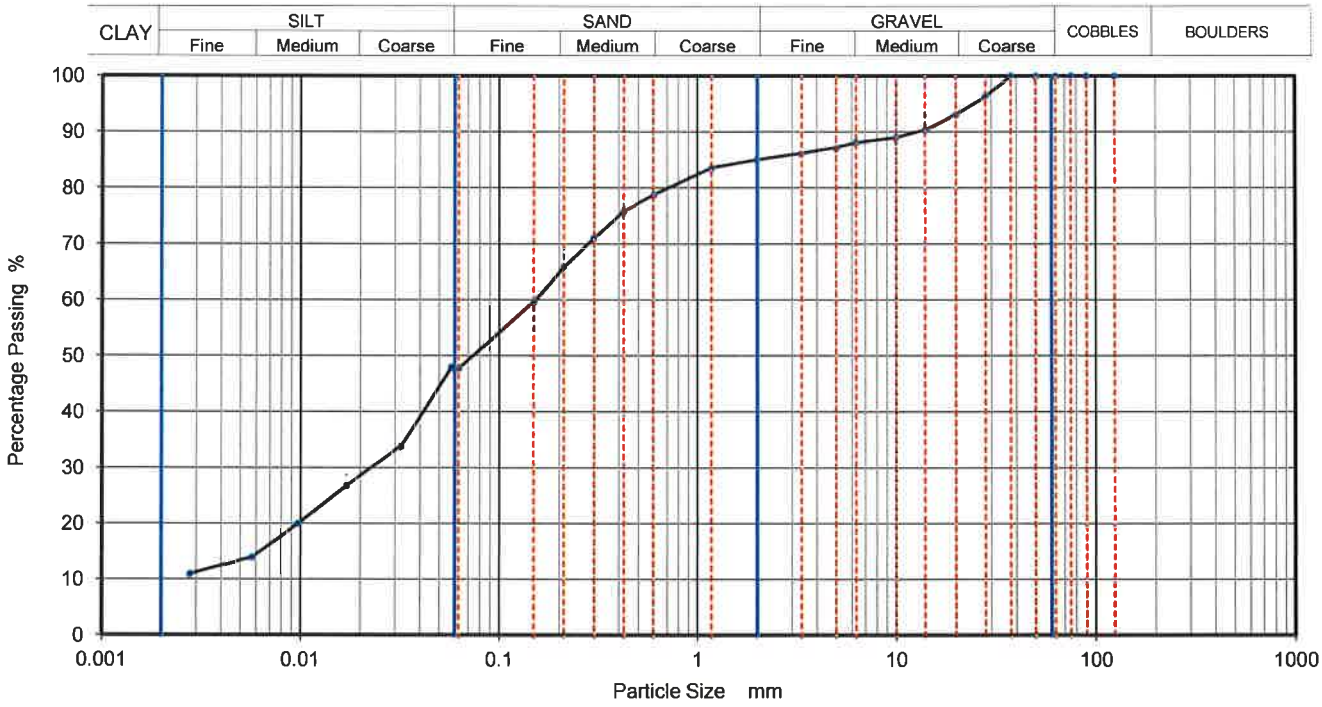
Grading Analysis		
D100	mm	
D60	mm	1.15
D30	mm	0.0199
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	Fig 12
Stephen.Watson	25/02/2015 10:11	Sheet

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	TP106
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	B01
Soil Description	MADE GROUND - Firm brown gravelly CLAY with fragments of brick,glass and timbers.			Depth, m	0.30
Specimen Reference	12	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645TP106B01



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0575	48
90	100	0.0324	34
75	100	0.0172	27
63	100	0.0097	20
50	100	0.0057	14
37.5	100	0.0028	11
28	96		
20	93		
14	90		
10	89		
6.3	88		
5	87		
3.35	86		
2	85		
1.18	84		
0.6	79	Particle density	(assumed)
0.425	76	1.50	Mg/m3
0.3	71		
0.212	66		
0.15	60		
0.063	48		

Dry Mass of sample, g	2507

Sample Proportions	% dry mass
Very coarse	0
Gravel	15
Sand	37
Fines <0.063mm	48

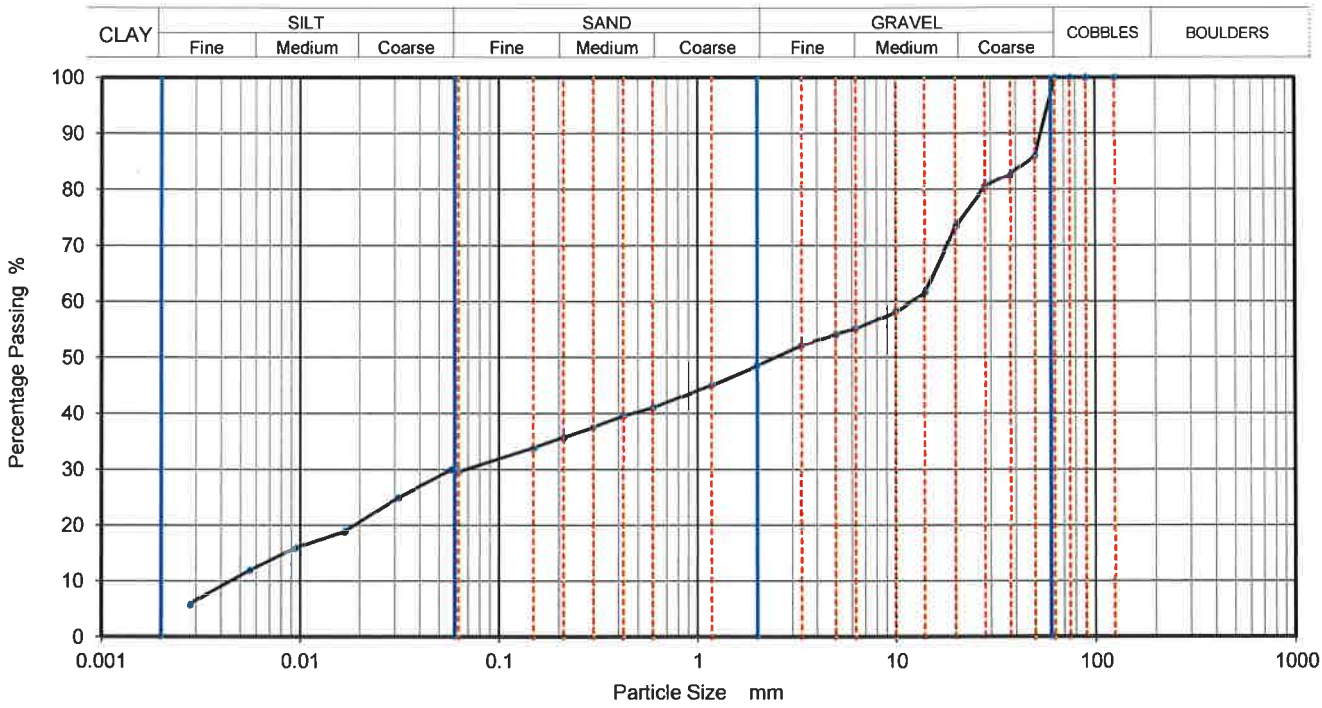
Grading Analysis		
D100	mm	
D60	mm	0.153
D30	mm	0.0231
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	Fig 5
Stephen.Watson	25/02/2015 10:11	Sheet

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	TP108
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	2
Soil Description	Firm to stiff dark grey gravelly CLAY with occasional cobbles			Depth, m	2.00
Specimen Reference	3	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645TP108B2



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0575	30
90	100	0.0313	25
75	100	0.0169	19
63	100	0.0095	16
50	86	0.0056	12
37.5	83	0.0028	6
28	81		
20	74		
14	62		
10	58		
6.3	55		
5	54		
3.35	52		
2	49		
1.18	45		
0.6	41	Particle density	(assumed)
0.425	40	1.50	Mg/m3
0.3	38		
0.212	36		
0.15	34		
0.063	30		

Dry Mass of sample, g	6641

Sample Proportions	% dry mass
Very coarse	0
Gravel	51
Sand	19
Fines <0.063mm	30

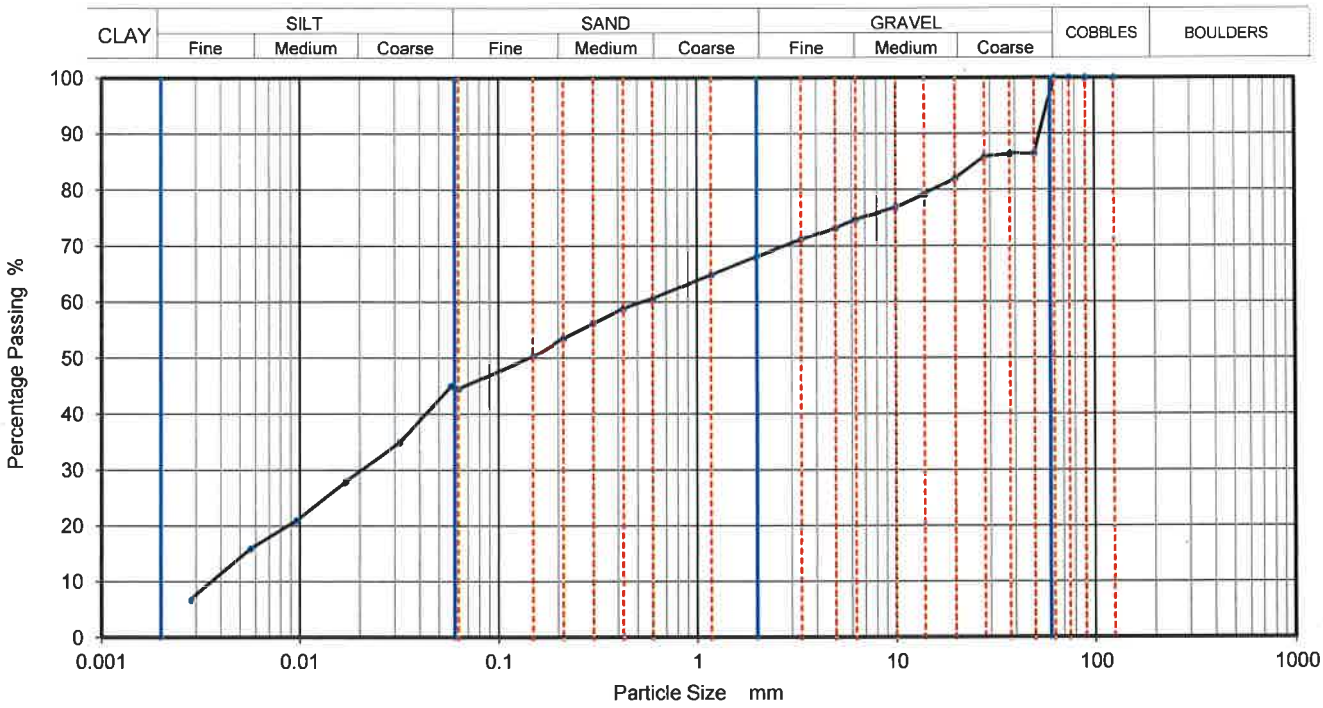
Grading Analysis		
D100	mm	
D60	mm	11.9
D30	mm	0.0689
D10	mm	0.00437
Uniformity Coefficient		2700
Curvature Coefficient		0.091

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	Fig 25
Stephen.Watson	25/02/2015 10:11	Sheet

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	TP109
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	7
Soil Description	Soft grey gravelly CLAY.			Depth, m	3.00
Specimen Reference	3	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645TP109B7



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0575	45
90	100	0.0317	35
75	100	0.0170	28
63	100	0.0096	21
50	87	0.0057	16
37.5	87	0.0028	7
28	86		
20	82		
14	79		
10	77		
6.3	75		
5	73		
3.35	71		
2	68		
1.18	65		
0.6	61	Particle density	(assumed)
0.425	59	1.50	Mg/m3
0.3	56		
0.212	54		
0.15	50		
0.063	45		

Dry Mass of sample, g	3680

Sample Proportions	% dry mass
Very coarse	0
Gravel	32
Sand	24
Fines <0.063mm	45

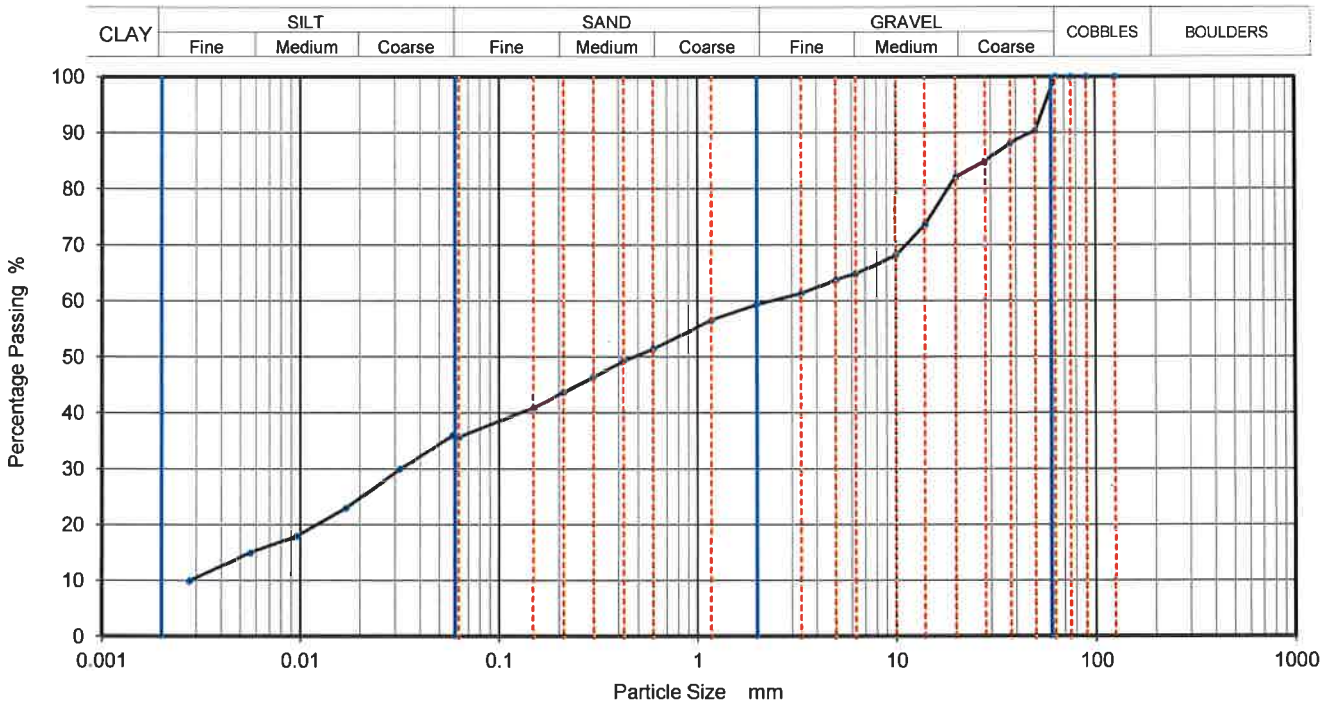
Grading Analysis		
D100	mm	
D60	mm	0.525
D30	mm	0.0207
D10	mm	0.00367
Uniformity Coefficient		140
Curvature Coefficient		0.22

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	Fig 31
Stephen.Watson	25/02/2015 10:12	Sheet

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	TP110
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	5
Soil Description	Firm brown gravelly CLAY with occasional cobbles and boulders.			Depth, m	1.50
Specimen Reference	3	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645TP110B5



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0584	36
90	100	0.0317	30
75	100	0.0170	23
63	100	0.0096	18
50	90	0.0056	15
37.5	88	0.0028	10
28	85		
20	82		
14	74		
10	68		
6.3	65		
5	64		
3.35	61		
2	59		
1.18	57		
0.6	52	Particle density	(assumed)
0.425	49	1.50	Mg/m3
0.3	47		
0.212	44		
0.15	41		
0.063	36		

Dry Mass of sample, g	4010

Sample Proportions	% dry mass
Very coarse	0
Gravel	41
Sand	24
Fines <0.063mm	36

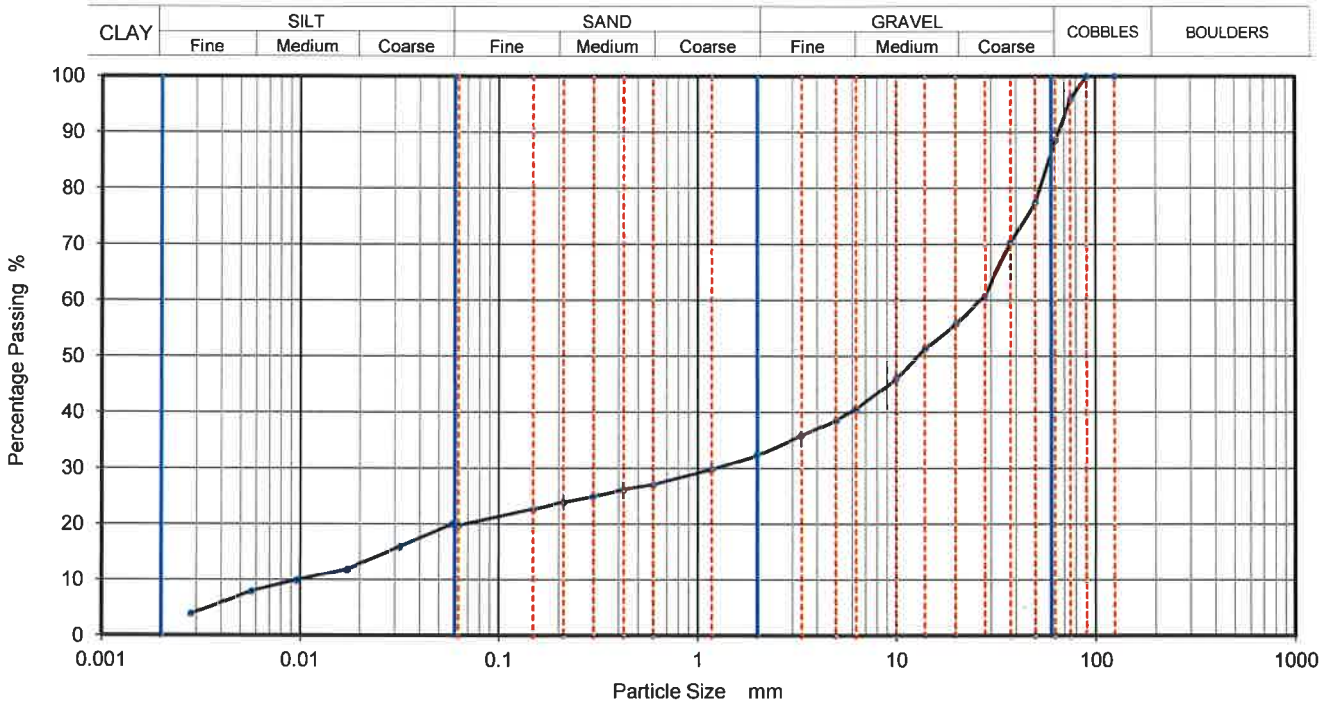
Grading Analysis		
D100	mm	
D60	mm	2.32
D30	mm	0.0314
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	Fig 22
Stephen.Watson	25/02/2015 10:11	Sheet

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	TP112
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	2
Soil Description	Firm to stiff dark grey gravelly CLAY with cobbles and boulders.			Depth, m	1.50
Specimen Reference	3	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645TP112B2



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0584	20
90	100	0.0320	16
75	96	0.0172	12
63	89	0.0097	10
50	78	0.0057	8
37.5	70	0.0028	4
28	61		
20	56		
14	52		
10	46		
6.3	41		
5	39		
3.35	36		
2	32		
1.18	30		
0.6	27	Particle density	(assumed)
0.425	26	1.50	Mg/m3
0.3	25		
0.212	24		
0.15	23		
0.063	20		

Dry Mass of sample, g	8832

Sample Proportions	% dry mass
Very coarse	11
Gravel	56
Sand	13
Fines <0.063mm	20

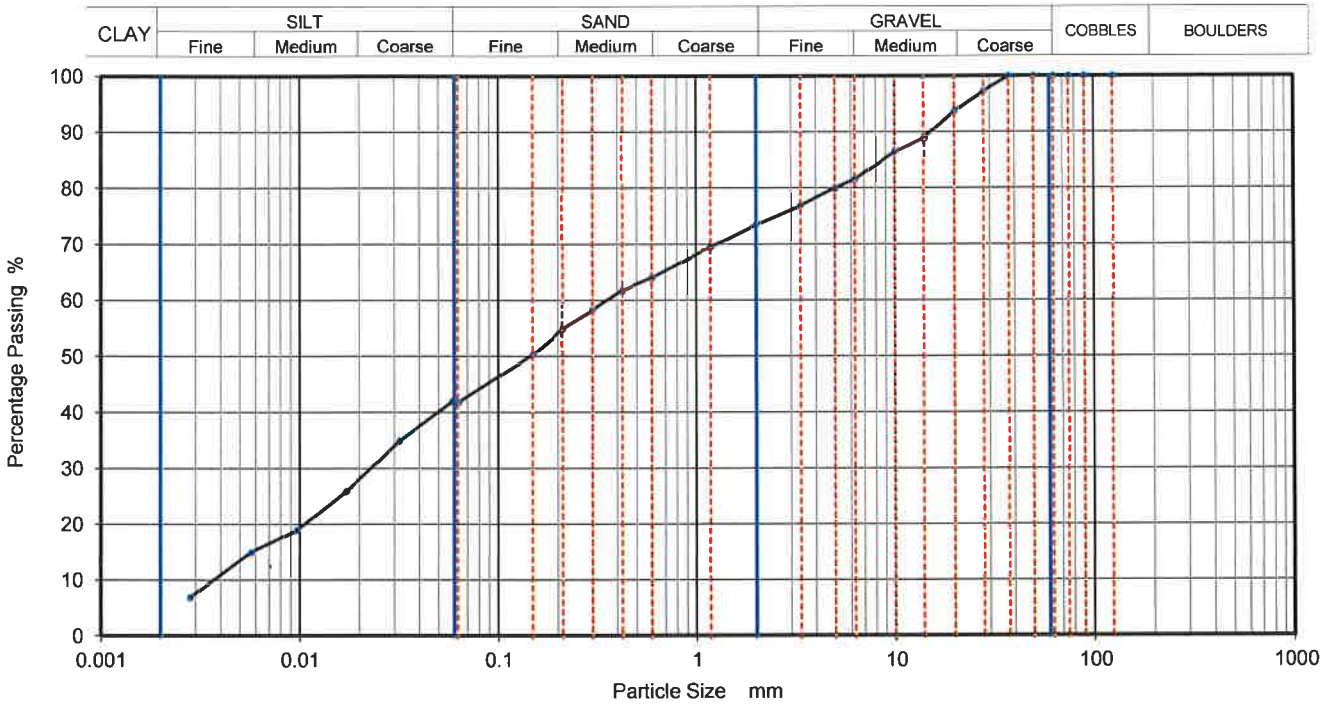
Grading Analysis		
D100	mm	
D60	mm	26.4
D30	mm	1.23
D10	mm	0.0099
Uniformity Coefficient		2700
Curvature Coefficient		5.8

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	Fig 20
Stephen.Watson	25/02/2015 10:11	Sheet

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	TP113
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	4
Soil Description	Firm to stiff dark grey gravelly CLAY with cobbles and boulders.			Depth, m	4.00
Specimen Reference	3	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645TP113B4



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0588	42
90	100	0.0320	35
75	100	0.0172	26
63	100	0.0097	19
50	100	0.0057	15
37.5	100	0.0028	7
28	97		
20	94		
14	89		
10	87		
6.3	82		
5	80		
3.35	77		
2	74		
1.18	70		
0.6	64	Particle density	(assumed)
0.425	62	1.50	Mg/m3
0.3	58		
0.212	55		
0.15	50		
0.063	42		

Dry Mass of sample, g	3729

Sample Proportions	% dry mass
Very coarse	0
Gravel	27
Sand	32
Fines <0.063mm	42

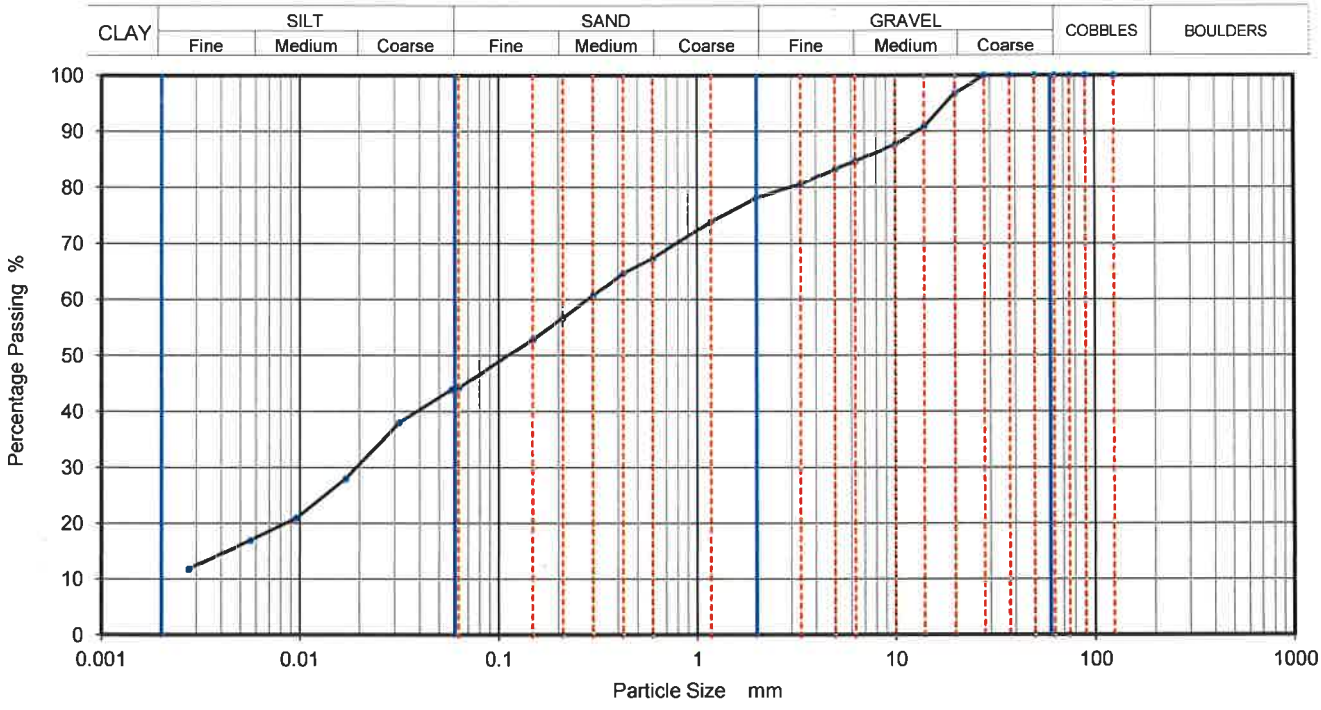
Grading Analysis		
D100	mm	
D60	mm	0.351
D30	mm	0.023
D10	mm	0.00375
Uniformity Coefficient		94
Curvature Coefficient		0.4

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	Fig 35
Stephen.Watson	25/02/2015 10:12	Sheet

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	14-645
				Borehole/Pit No.	TP114
Site Name	Greater Dublin Drainage Scheme Ground Investigation			Sample No.	4
Soil Description	Firm to stiff dark grey gravelly CLAY with occasional cobbles			Depth, m	4.00
Specimen Reference	3	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	14645TP114B4



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0580	44
90	100	0.0315	38
75	100	0.0170	28
63	100	0.0096	21
50	100	0.0056	17
37.5	100	0.0028	12
28	100		
20	97		
14	91		
10	88		
6.3	85		
5	83		
3.35	81		
2	78		
1.18	74		
0.6	67	Particle density	(assumed)
0.425	65	1.50	Mg/m3
0.3	61		
0.212	57		
0.15	53		
0.063	44		

Dry Mass of sample, g	4150

Sample Proportions	% dry mass
Very coarse	0
Gravel	22
Sand	34
Fines <0.063mm	44

Grading Analysis		
D100	mm	
D60	mm	0.28
D30	mm	0.0189
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	Fig 36
Stephen.Watson	25/02/2015 10:12	Sheet

Contract: Greater Dublin Drainage Scheme

Job No.: 14-645

UNIAXIAL COMPRESSIVE STRENGTH TEST RESULTS

D = core diameter
L = specimen length
M = specimen mass
P = applied load for failure

γ_b = Bulk Density ($4M \times 10^6 / \pi \times D^2 \times L$)
MCS = Uncorrected compressive strength ($4P \times 10^3 / \pi \times D^2$)
UCS = Size corrected uniaxial compression strength (MCS x F)
F = Size correction factor for core L/D<2 (0.89 + 0.11x(L/D - 1))

Borehole	Specimen Depth (m bgl)	Specimen Diameter D (mm)	Specimen Length L (mm)	Specimen Mass M (kg)	Failure Load P (tonf)	Failure Load P (kN)	Bulk Density γ_b (Mg/m³)	Measured Compressive Strength (MCS) (MPa)	Correction Factor F	Uniaxial Compressive Strength (UCS) (MPa)	Remarks
BH106	4.45-5.50										Testing not possible. Sample broke while attempting trimming. No suitable replacement
BH107	5.50	83	206	3.017	40.0	398.6	2.71	73.66	1.00	73.7	-
BH107	4.30	83	193	2.817	7.0	69.7	2.70	12.89	1.00	12.9	-
BH108	3.60	70	171	1.826	7.5	74.7	2.77	19.42	1.00	19.4	-
BH109	3.70	70	197	2.142	14.5	144.5	2.83	37.54	1.00	37.5	-
BH110	4.00	70	173	1.885	24.5	244.1	2.83	63.43	1.00	63.4	-
BH111	2.50	83	205	3.014	2.5	24.9	2.72	4.60	1.00	4.6	-

Contract: Greater Dublin Drainage Scheme

Job No.: 14-645

W = core diameter (Axial test) or specimen width (Irregular lump test)
D = core diameter (Diametral test) or specimen length (Axial test/Irregular lump test)
L = measured applied load for failure
P = actual applied load for failure (L x calibration factor)
D' = distance between platens at point of failure

D_e^2 = D x D' (Diametral test)
D_e^2 = 4/p (W x D') (Axial test / Irregular lump test)
I_s = Uncorrected point load strength (P/D_e^2)
$I_{s(50)}$ = Size corrected point load strength (I_s x F)
F = $(D_e/50)^{0.45}$ Size correction factor for core other than 50mm diameter

POINT LOAD STRENGTH TEST RESULTS

Borehole	Specimen Depth (m bgl)	Test Type A = Axial D = Diametral I = Irregular	W (mm)	D (mm)	D' (mm)	L (kN)	P (kN)	De^2 (mm^2)	De (mm)	Is (MPa)	F	Is(50) (MPa)	Remarks
BH106	4.50	D		83	78	12.0	12.0	6474	80.46	1.85	1.24	2.29	Invalid
BH106	5.60	D		83	80	8.3	8.3	6640	81.49	1.25	1.25	1.56	Valid
BH107	3.50	A	83	50	42	13.2	13.2	4439	66.62	2.97	1.14	3.38	Invalid
BH107	5.20	D		83	79	4.1	4.1	6557	80.98	0.62	1.24	0.78	Invalid
BH108	3.30	D		70	66	5.8	5.8	4620	67.97	1.25	1.15	1.44	Invalid
BH108	5.10	D		71	68	4.6	4.6	4828	69.48	0.95	1.16	1.10	Invalid
BH109	4.80	D		70	67	3.2	3.2	4690	68.48	0.68	1.15	0.79	Valid
BH110	5.00	D		70	67	17.4	17.4	4690	68.48	3.71	1.15	4.27	Valid
BH111	3.50	D		83	80	3.2	3.2	6640	81.49	0.48	1.25	0.60	Valid
BH111	4.50	D		83	79	6.9	6.9	6557	80.98	1.05	1.24	1.31	Valid

LABORATORY RESTRICTION REPORT

Project Reference	14-645	To	Darren O'Mahony
Project Name	Greater Dublin Drainage Scheme Ground Investigation	Position	Project Manager
TR reference	14-645 / 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			
BH113		4.5	D	Natural mositure Atterberg PSD	No sample received	Testing cancelled
BH124		1.5	D	Natural mositure Atterberg PSD	No sample received	Testing Cancelled

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

Laboratory Signature Stephen Watson	Project Manager Signature Darren O'Mahony
Date 25 February 2015	Date 25 February 2015

Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.co.uk

Final Report

Report Number:	15-01364 Issue-1
Initial Date of Issue:	29-Jan-15
Client:	Causeway Geotech Ltd
Client Address:	8 Drumahiskey Road Balnamore Ballymoney County Antrim BT53 7QL
Contact(s):	Darren O'Mahony Paul Dunlop Stephen Franey
Project:	14-645 Greater Dublin Drainage GI - Phase 2

Quotation No.:		**Date Received:**	23-Jan-15
Order No.:	47-645	**Date Instructed:**	23-Jan-15
No. of Samples:	8	**Results Due:**	29-Jan-15
Turnaround: (Weekdays)	5		
Date Approved:	29-Jan-15		

Approved By:

Details: Darrell Hall, Laboratory Director

Chemtest
The right chemistry to deliver results

Results Summary - Soil

Project: 14-645 Greater Dublin Drainage GI - Phase 2

Client: Causeway Geotech Ltd											
				Chemtest Job No.:	15-01364	15-01364	15-01364	15-01364	15-01364	15-01364	15-01364
Quotation No.:				**Chemtest Sample ID.:**	92555	92556	92557	92558	92559	92560	92561
Order No.: 47-645				Client Sample Ref.:							
				Client Sample ID.:	BH120	BH121	BH121	TP100	TP101	BH122	BH138
				Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
				Top Depth (m):	0.50	0.50	1.00	0.30	0.20	7.50	0.90
				Bottom Depth(m):							
				Date Sampled:	22-Jan-15	22-Jan-15	22-Jan-15	22-Jan-15	22-Jan-15	22-Jan-15	22-Jan-15
Determinand	**Accred.**	**SOP**	**Units**	**LOD**							
Moisture	N	2030	%	0.02	21	10	9.5	17	19	12	6.4
pH	U	2010								8.6	8.5
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.01						0.029	0.030
Arsenic	U	2450	mg/kg	1	25	26	30	38	34		
Barium	U	2450	mg/kg	10	200	140	160	130	60		
Cadmium	U	2450	mg/kg	0.1	2.1	2.7	2.5	0.55	0.35		
Chromium	U	2450	mg/kg	1	21	21	15	21	21		
Copper	U	2450	mg/kg	0.5	61	31	27	27	27		
Mercury	U	2450	mg/kg	0.1	0.39	< 0.10	< 0.10	< 0.10	< 0.10		
Molybdenum	U	2450	mg/kg	2	5.7	7.5	8.9	2.4	< 2.0		
Nickel	U	2450	mg/kg	0.5	44	64	51	72	60		
Lead	U	2450	mg/kg	0.5	94	24	21	48	43		
Antimony	N	2450	mg/kg	2	2.6	2.1	< 2.0	< 2.0	< 2.0		
Selenium	U	2450	mg/kg	0.2	0.35	< 0.20	< 0.20	< 0.20	< 0.20		
Zinc	U	2450	mg/kg	0.5	100	84	73	74	75		
LOI	U	2610	%	0.1	15	1.7	1.6	2.7	2.7		
Total Organic Carbon	U	2625	%	0.2	7.0	0.46	0.58	0.63	0.55		
TPH >C6-C10	N	2670	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0		
TPH >C10-C21	N	2670	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0		
TPH >C21-C40	N	2670	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0		
Total TPH >C6-C40	U	2670	mg/kg	10	< 10	< 10	< 10	< 10	< 10		
Naphthalene	U	2800	mg/kg	0.1	0.38	0.32	0.55	0.97	1.2		
Acenaphthylene	N	2800	mg/kg	0.1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Acenaphthene	U	2800	mg/kg	0.1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Fluorene	U	2800	mg/kg	0.1	< 0.10	< 0.10	< 0.10	0.12	0.26		
Phenanthrene	U	2800	mg/kg	0.1	0.42	0.12	0.21	0.30	0.55		
Anthracene	U	2800	mg/kg	0.1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Fluoranthene	U	2800	mg/kg	0.1	0.22	0.50	< 0.10	< 0.10	< 0.10		
Pyrene	U	2800	mg/kg	0.1	0.21	0.45	< 0.10	< 0.10	< 0.10		
Benzo[a]anthracene	U	2800	mg/kg	0.1	< 0.10	0.22	< 0.10	< 0.10	< 0.10		
Chrysene	U	2800	mg/kg	0.1	< 0.10	0.22	< 0.10	< 0.10	< 0.10		
Benzo[b]fluoranthene	N	2800	mg/kg	0.1	< 0.10	0.18	< 0.10	< 0.10	< 0.10		
Benzo[k]fluoranthene	U	2800	mg/kg	0.1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[a]pyrene	U	2800	mg/kg	0.1	< 0.10	0.12	< 0.10	< 0.10	< 0.10		
Indeno(1,2,3-c,d)Pyrene	U	2800	mg/kg	0.1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		

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Results Summary - Soil

Project: 14-645 Greater Dublin Drainage GI - Phase 2

Client: Causeway Geotech Ltd											
				Chemtest Job No.:	15-01364	15-01364	15-01364	15-01364	15-01364	15-01364	15-01364
Quotation No.:				**Chemtest Sample ID.:**	92555	92556	92557	92558	92559	92560	92561
Order No.: 47-645				Client Sample Ref.:							
				Client Sample ID.:	BH120	BH121	BH121	TP100	TP101	BH122	BH138
				Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
				Top Depth (m):	0.50	0.50	1.00	0.30	0.20	7.50	0.90
				Bottom Depth(m):							
				Date Sampled:	22-Jan-15	22-Jan-15	22-Jan-15	22-Jan-15	22-Jan-15	22-Jan-15	22-Jan-15
Determinand	**Accred.**	**SOP**	**Units**	**LOD**							
Benzo[g,h,i]perylene	U	2800	mg/kg	0.1	< 0.10	0.11	< 0.10	< 0.10	< 0.10		
Coronene	N	2800	mg/kg	0.1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Total Of 17 PAH's	N	2800	mg/kg	2	< 2.0	2.2	< 2.0	< 2.0	2.0		
PCB 28	U	2810	mg/kg	0.01	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010		
PCB 52	U	2815	mg/kg	0.01	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010		
PCB 101	U	2815	mg/kg	0.01	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010		
PCB 118	U	2815	mg/kg	0.01	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010		
PCB 153	U	2815	mg/kg	0.01	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010		
PCB 138	U	2815	mg/kg	0.01	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010		
PCB 180	U	2810	mg/kg	0.01	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010		
Total PCBs (7 Congeners)	N	2815	mg/kg	0.1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		

Results Summary - Single Stage WAC

Project: 14-645 Greater Dublin Drainage GI - Phase 2

Chemtest Job No: 15-01364 Chemtest Sample ID: 92555 Sample Ref: Sample ID: BH120 Top Depth(m): 0.50 Bottom Depth(m): Sampling Date: 22-Jan-2015					Landfill Waste Acceptance Criteria Limits		
Determinand	**SOP**	**Accred.**	**Units**		**Inert Waste Landfill**	**Stable, Non-reactive hazardous waste in non hazardous Landfill**	**Hazardous Waste Landfill**
Total Organic Carbon	2625	U	%		3	5	6
Loss on Ignition	2610	U	%		--	--	10
Total BTEX	2760	U	mg/kg		6	--	--
Total PCBs (7 congeners)	2815	U	mg/kg		1	--	--
TPH Total WAC (Mineral Oil)	2670	U	mg/kg		500	--	--
Total (of 17) PAHs	2700	N	mg/kg		100	--	--
pH	2010	U			--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg		--	To evaluate	To evaluate
Eluate Analysis			**10:1 Eluate mg/l**	**10:1 Eluate mg/kg**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg**		
Arsenic	1450	U	0.003	< 0.050	0.5	2	25
Barium	1450	U	0.014	< 0.50	20	100	300
Cadmium	1450	U	< 0.0001	< 0.010	0.04	1	5
Chromium	1450	U	0.002	< 0.050	0.5	10	70
Copper	1450	U	0.005	0.054	2	50	100
Mercury	1450	U	< 0.0005	< 0.005	0.01	0.2	2
Molybdenum	1450	U	0.007	0.068	0.5	10	30
Nickel	1450	U	0.003	< 0.050	0.4	10	40
Lead	1450	U	0.002	0.023	0.5	10	50
Antimony	1450	U	0.001	0.012	0.06	0.7	5
Selenium	1450	U	< 0.001	< 0.010	0.1	0.5	7
Zinc	1450	U	0.006	< 0.50	4	50	200
Chloride	1220	U	< 1.0	< 10	800	15000	25000
Fluoride	1220	U	0.19	1.9	10	150	500
Sulphate	1220	U	10	100	1000	20000	50000
Total Dissolved Solids	1020	N	110	1100	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	N	14	140	500	800	1000

Soild Information	
Dry mass of test portion/kg	0.09
Moisture (%)	21

Results Summary - Single Stage WAC

Project: 14-645 Greater Dublin Drainage GI - Phase 2

Chemtest Job No: 15-01364 Chemtest Sample ID: 92556 Sample Ref: Sample ID: BH121 Top Depth(m): 0.50 Bottom Depth(m): Sampling Date: 22-Jan-2015					Landfill Waste Acceptance Criteria Limits		
Determinand	**SOP**	**Accred.**	**Units**		**Inert Waste Landfill**	**Stable, Non-reactive hazardous waste in non hazardous Landfill**	**Hazardous Waste Landfill**
Total Organic Carbon	2625	U	%		3	5	6
Loss on Ignition	2610	U	%		--	--	10
Total BTEX	2760	U	mg/kg		6	--	--
Total PCBs (7 congeners)	2815	U	mg/kg		1	--	--
TPH Total WAC (Mineral Oil)	2670	U	mg/kg		500	--	--
Total (of 17) PAHs	2700	N	mg/kg		100	--	--
pH	2010	U			--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg		--	To evaluate	To evaluate
Eluate Analysis			**10:1 Eluate mg/l**	**10:1 Eluate mg/kg**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg**		
Arsenic	1450	U	< 0.001	< 0.050	0.5	2	25
Barium	1450	U	0.008	< 0.50	20	100	300
Cadmium	1450	U	< 0.0001	< 0.010	0.04	1	5
Chromium	1450	U	0.003	< 0.050	0.5	10	70
Copper	1450	U	0.001	< 0.050	2	50	100
Mercury	1450	U	< 0.0005	< 0.005	0.01	0.2	2
Molybdenum	1450	U	0.013	0.13	0.5	10	30
Nickel	1450	U	< 0.001	< 0.050	0.4	10	40
Lead	1450	U	< 0.001	< 0.010	0.5	10	50
Antimony	1450	U	< 0.001	< 0.010	0.06	0.7	5
Selenium	1450	U	< 0.001	< 0.010	0.1	0.5	7
Zinc	1450	U	0.002	< 0.50	4	50	200
Chloride	1220	U	< 1.0	< 10	800	15000	25000
Fluoride	1220	U	0.2	2	10	150	500
Sulphate	1220	U	< 1.0	< 10	1000	20000	50000
Total Dissolved Solids	1020	N	56	560	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	N	25	250	500	800	1000

Soild Information	
Dry mass of test portion/kg	0.09
Moisture (%)	10

Results Summary - Single Stage WAC

Project: 14-645 Greater Dublin Drainage GI - Phase 2

Chemtest Job No: 15-01364 Chemtest Sample ID: 92557 Sample Ref: Sample ID: BH121 Top Depth(m): 1.00 Bottom Depth(m): Sampling Date: 22-Jan-2015					Landfill Waste Acceptance Criteria Limits		
Determinand	**SOP**	**Accred.**	**Units**		**Inert Waste Landfill**	**Stable, Non-reactive hazardous waste in non hazardous Landfill**	**Hazardous Waste Landfill**
Total Organic Carbon	2625	U	%		3	5	6
Loss on Ignition	2610	U	%		--	--	10
Total BTEX	2760	U	mg/kg		6	--	--
Total PCBs (7 congeners)	2815	U	mg/kg		1	--	--
TPH Total WAC (Mineral Oil)	2670	U	mg/kg		500	--	--
Total (of 17) PAHs	2700	N	mg/kg		100	--	--
pH	2010	U			--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg		--	To evaluate	To evaluate
Eluate Analysis			**10:1 Eluate mg/l**	**10:1 Eluate mg/kg**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg**		
Arsenic	1450	U	< 0.001	< 0.050	0.5	2	25
Barium	1450	U	0.006	< 0.50	20	100	300
Cadmium	1450	U	< 0.0001	< 0.010	0.04	1	5
Chromium	1450	U	0.002	< 0.050	0.5	10	70
Copper	1450	U	0.002	< 0.050	2	50	100
Mercury	1450	U	< 0.0005	< 0.005	0.01	0.2	2
Molybdenum	1450	U	0.005	0.053	0.5	10	30
Nickel	1450	U	< 0.001	< 0.050	0.4	10	40
Lead	1450	U	< 0.001	< 0.010	0.5	10	50
Antimony	1450	U	< 0.001	< 0.010	0.06	0.7	5
Selenium	1450	U	< 0.001	< 0.010	0.1	0.5	7
Zinc	1450	U	< 0.001	< 0.50	4	50	200
Chloride	1220	U	1.1	11	800	15000	25000
Fluoride	1220	U	0.29	2.9	10	150	500
Sulphate	1220	U	4.6	46	1000	20000	50000
Total Dissolved Solids	1020	N	75	750	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	N	6.7	67	500	800	1000

Soild Information	
Dry mass of test portion/kg	0.09
Moisture (%)	9.5

Results Summary - Single Stage WAC

Project: 14-645 Greater Dublin Drainage GI - Phase 2

Chemtest Job No: 15-01364 Chemtest Sample ID: 92558 Sample Ref: Sample ID: TP100 Top Depth(m): 0.30 Bottom Depth(m): Sampling Date: 22-Jan-2015					Landfill Waste Acceptance Criteria Limits		
Determinand	**SOP**	**Accred.**	**Units**		**Inert Waste Landfill**	**Stable, Non-reactive hazardous waste in non hazardous Landfill**	**Hazardous Waste Landfill**
Total Organic Carbon	2625	U	%		3	5	6
Loss on Ignition	2610	U	%		--	--	10
Total BTEX	2760	U	mg/kg		6	--	--
Total PCBs (7 congeners)	2815	U	mg/kg		1	--	--
TPH Total WAC (Mineral Oil)	2670	U	mg/kg		500	--	--
Total (of 17) PAHs	2700	N	mg/kg		100	--	--
pH	2010	U			--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg		--	To evaluate	To evaluate
Eluate Analysis			**10:1 Eluate mg/l**	**10:1 Eluate mg/kg**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg**		
Arsenic	1450	U	< 0.001	< 0.050	0.5	2	25
Barium	1450	U	0.004	< 0.50	20	100	300
Cadmium	1450	U	< 0.0001	< 0.010	0.04	1	5
Chromium	1450	U	0.003	< 0.050	0.5	10	70
Copper	1450	U	< 0.001	< 0.050	2	50	100
Mercury	1450	U	< 0.0005	< 0.005	0.01	0.2	2
Molybdenum	1450	U	0.004	< 0.050	0.5	10	30
Nickel	1450	U	< 0.001	< 0.050	0.4	10	40
Lead	1450	U	< 0.001	< 0.010	0.5	10	50
Antimony	1450	U	< 0.001	< 0.010	0.06	0.7	5
Selenium	1450	U	< 0.001	< 0.010	0.1	0.5	7
Zinc	1450	U	< 0.001	< 0.50	4	50	200
Chloride	1220	U	< 1.0	< 10	800	15000	25000
Fluoride	1220	U	0.25	2.5	10	150	500
Sulphate	1220	U	3.7	37	1000	20000	50000
Total Dissolved Solids	1020	N	57	570	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	N	3.8	< 50	500	800	1000

Soild Information	
Dry mass of test portion/kg	0.09
Moisture (%)	17

Results Summary - Single Stage WAC

Project: 14-645 Greater Dublin Drainage GI - Phase 2

Chemtest Job No: 15-01364 Chemtest Sample ID: 92559 Sample Ref: Sample ID: TP101 Top Depth(m): 0.20 Bottom Depth(m): Sampling Date: 22-Jan-2015					Landfill Waste Acceptance Criteria Limits		
Determinand	**SOP**	**Accred.**	**Units**		**Inert Waste Landfill**	**Stable, Non-reactive hazardous waste in non hazardous Landfill**	**Hazardous Waste Landfill**
Total Organic Carbon	2625	U	%		3	5	6
Loss on Ignition	2610	U	%		--	--	10
Total BTEX	2760	U	mg/kg		6	--	--
Total PCBs (7 congeners)	2815	U	mg/kg		1	--	--
TPH Total WAC (Mineral Oil)	2670	U	mg/kg		500	--	--
Total (of 17) PAHs	2700	N	mg/kg		100	--	--
pH	2010	U			--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg		--	To evaluate	To evaluate
Eluate Analysis			**10:1 Eluate mg/l**	**10:1 Eluate mg/kg**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg**		
Arsenic	1450	U	< 0.001	< 0.050	0.5	2	25
Barium	1450	U	0.004	< 0.50	20	100	300
Cadmium	1450	U	< 0.0001	< 0.010	0.04	1	5
Chromium	1450	U	0.004	< 0.050	0.5	10	70
Copper	1450	U	0.002	< 0.050	2	50	100
Mercury	1450	U	< 0.0005	< 0.005	0.01	0.2	2
Molybdenum	1450	U	0.003	< 0.050	0.5	10	30
Nickel	1450	U	0.001	< 0.050	0.4	10	40
Lead	1450	U	< 0.001	< 0.010	0.5	10	50
Antimony	1450	U	< 0.001	< 0.010	0.06	0.7	5
Selenium	1450	U	< 0.001	< 0.010	0.1	0.5	7
Zinc	1450	U	0.002	< 0.50	4	50	200
Chloride	1220	U	< 1.0	< 10	800	15000	25000
Fluoride	1220	U	0.24	2.4	10	150	500
Sulphate	1220	U	2.5	25	1000	20000	50000
Total Dissolved Solids	1020	N	59	590	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	N	3.9	< 50	500	800	1000

Soild Information	
Dry mass of test portion/kg	0.09
Moisture (%)	19

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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, SVCOs, PCBs, Phenols
For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at our Coventry 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

Sample Retention and Disposal

All soil samples will be retained for a period of 60 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

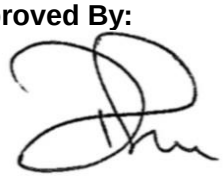
Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.co.uk

Final Report

Report Number:	15-03477 Issue-1
Initial Date of Issue:	25-Feb-2015
Client:	Causeway Geotech Ltd
Client Address:	8 Drumahiskey Road Balnamore Ballymoney County Antrim BT53 7QL
Contact(s):	Darren O'Mahony Paul Dunlop Stephen Franey
Project:	14-645 Greater Dublin Drainage GI: Phase 2

Quotation No.:		**Date Received:**	16-Feb-2015
Order No.:	14-645	**Date Instructed:**	16-Feb-2015
No. of Samples:	7		
Turnaround: (Wkdays)	5	**Results Due Date:**	20-Feb-2015
Date Approved:	19-Feb-2015		

Approved By:



Details: Darrell Hall, Laboratory Director

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Results Summary - Soil

Project: 14-645 Greater Dublin Drainage GI: Phase 2

Client: Causeway Geotech Ltd					Chemtest Job No.:	15-03477	15-03477	15-03477	15-03477	15-03477	15-03477	15-03477
Quotation No.:					Chemtest Sample ID.:	103328	103329	103330	103331	103332	103333	103334
Order No.: 14-645					Client Sample Ref.:							
					Client Sample ID.:	BH138	BH139	TP108	TP109	TP110	TP113	TP114
					Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
					Top Depth (m):	0.00	6.00	2.00	1.00	0.50	1.00	2.00
					Bottom Depth(m):							
					Date Sampled:							
Determinand	**Accred.**	**SOP**	**Units**	**LOD**								
pH	U	2010				8.3	8.2	8.1	8.2	8.4		
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.01		0.12	0.064	0.93	< 0.010	< 0.010		
Chloride (Extractable)	U	2220	g/l	0.01	< 0.010			< 0.010	< 0.010			
Organic Matter	U	2625	%	0.4	5.5			1.9	0.95	0.66	0.81	

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Report Information

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>	"greater than"

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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, SVCOs, PCBs, Phenols
For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at our Coventry 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

Sample Retention and Disposal

All soil samples will be retained for a period of 60 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

Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.co.uk

Final Report

Report Number:	15-03479 Issue-1
Initial Date of Issue:	25-Feb-2015
Client:	Causeway Geotech Ltd
Client Address:	8 Drumahiskey Road Balnamore Ballymoney County Antrim BT53 7QL
Contact(s):	Darren O'Mahony Paul Dunlop Stephen Franey
Project:	14-645 Greater Dublin Drainage GI: Phase 2

Quotation No.:		**Date Received:**	16-Feb-2015
Order No.:	14-645	**Date Instructed:**	16-Feb-2015
No. of Samples:	5		
Turnaround: (Wkdays)	7	**Results Due Date:**	24-Feb-2015
Date Approved:	24-Feb-2015		

Approved By:

Details: Keith Jones, Technical Manager

Results Summary - 2 Stage WAC

Project: 14-645 Greater Dublin Drainage GI: Phase 2

Chemtest Job No: 15-03479 Chemtest Sample ID: 103338 Sample Ref: Sample ID: BH138 Top Depth(m): 0.00 Bottom Depth(m): Sampling Date:							Landfill Waste Acceptance Criteria Limits		
							Inert Waste Landfill	Stable Non-reactive Hazardous waste in non-hazardous Landfill	Hazardous Waste Landfill
Determinand	**SOP**	**Accred.**	**Units**						
Total Organic Carbon	2625	U	%			3.4	3	5	6
Loss on Ignition	2610	U	%			6.9	--	--	10
Total BTEX	2760	U	mg/kg			A < 0.01	6	--	--
Total PCBs (7 congeners)	2815	U	mg/kg			< 0.10	1	--	--
TPH Total WAC (Mineral Oil)	2670	U	mg/kg			A < 10	500	--	--
Total (of 17) PAHs	2700	N	mg/kg			6	100	--	--
pH	2010	U				8	--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg			0.16	--	To evaluate	To evaluate
Eluate Analysis			**2:1 mg/l**	**8:1 mg/l**	**2:1 mg/kg**	**Cumulative 10:1 mg/kg**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg**		
Arsenic	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	2	25
Barium	1450	U	0.015	0.004	< 0.50	< 0.50	20	100	300
Cadmium	1450	U	< 0.0001	< 0.0001	< 0.010	< 0.010	0.04	1	5
Chromium	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	10	70
Copper	1450	U	0.002	< 0.001	< 0.050	< 0.050	2	50	100
Mercury	1450	U	< 0.0005	< 0.0005	< 0.001	< 0.005	0.01	0.2	2
Molybdenum	1450	U	0.004	0.001	< 0.050	< 0.050	0.5	10	30
Nickel	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.4	10	40
Lead	1450	U	< 0.001	< 0.001	< 0.010	< 0.010	0.5	10	50
Antimony	1450	U	< 0.001	< 0.001	< 0.010	< 0.010	0.06	0.7	5
Selenium	1450	U	0.003	0.001	< 0.010	0.016	0.1	0.5	7
Zinc	1450	U	< 0.001	< 0.001	< 0.50	< 0.50	4	50	200
Chloride	1220	U	3.3	2.7	< 10	27	800	15000	25000
Fluoride	1220	U	0.36	0.11	< 1.0	1.3	10	150	500
Sulphate	1220	U	18	< 1.0	35	18	1000	20000	50000
Total Dissolved Solids	1020	N	180	48	350	610	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.030	< 0.30	< 0.50	1	-	-
Dissolved Organic Carbon	1610	N	7.4	6.5	< 50	65	500	800	1000

Soild Information	
Dry mass of test portion/kg	0.175
Moisture (%)	23

Leachate Test Information	
Leachant volume 1st extract/l	0.298
Leachant volume 2nd extract/l	1.4
Eluant recovered from 1st extract/l	0.173

Results Summary - 2 Stage WAC

Project: 14-645 Greater Dublin Drainage GI: Phase 2

Chemtest Job No: 15-03479 Chemtest Sample ID: 103339 Sample Ref: Sample ID: TP108 Top Depth(m): 1.00 Bottom Depth(m): Sampling Date:							Landfill Waste Acceptance Criteria Limits		
							Inert Waste Landfill	Stable Non-reactive Hazardous waste in non-hazardous Landfill	Hazardous Waste Landfill
Determinand	**SOP**	**Accred.**	**Units**						
Total Organic Carbon	2625	U	%			2.9	3	5	6
Loss on Ignition	2610	U	%			6.7	--	--	10
Total BTEX	2760	U	mg/kg			A < 0.01	6	--	--
Total PCBs (7 congeners)	2815	U	mg/kg			< 0.10	1	--	--
TPH Total WAC (Mineral Oil)	2670	U	mg/kg			A 29	500	--	--
Total (of 17) PAHs	2700	N	mg/kg			< 2.0	100	--	--
pH	2010	U				8	--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg			0.19	--	To evaluate	To evaluate
Eluate Analysis			**2:1 mg/l**	**8:1 mg/l**	**2:1 mg/kg**	**Cumulative 10:1 mg/kg**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg**		
Arsenic	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	2	25
Barium	1450	U	0.012	0.003	< 0.50	< 0.50	20	100	300
Cadmium	1450	U	< 0.0001	< 0.0001	< 0.010	< 0.010	0.04	1	5
Chromium	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	10	70
Copper	1450	U	0.002	< 0.001	< 0.050	< 0.050	2	50	100
Mercury	1450	U	< 0.0005	< 0.0005	< 0.001	< 0.005	0.01	0.2	2
Molybdenum	1450	U	0.003	0.001	< 0.050	< 0.050	0.5	10	30
Nickel	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.4	10	40
Lead	1450	U	< 0.001	< 0.001	< 0.010	< 0.010	0.5	10	50
Antimony	1450	U	< 0.001	< 0.001	< 0.010	< 0.010	0.06	0.7	5
Selenium	1450	U	0.003	< 0.001	< 0.010	< 0.010	0.1	0.5	7
Zinc	1450	U	< 0.001	< 0.001	< 0.50	< 0.50	4	50	200
Chloride	1220	U	3.3	< 1.0	< 10	< 10	800	15000	25000
Fluoride	1220	U	0.4	0.14	< 1.0	1.7	10	150	500
Sulphate	1220	U	14	< 1.0	27	15	1000	20000	50000
Total Dissolved Solids	1020	N	150	43	290	540	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.030	< 0.30	< 0.50	1	-	-
Dissolved Organic Carbon	1610	N	56	7.5	110	130	500	800	1000

Soild Information	
Dry mass of test portion/kg	0.175
Moisture (%)	21

Leachate Test Information	
Leachant volume 1st extract/l	0.303
Leachant volume 2nd extract/l	1.4
Eluant recovered from 1st extract/l	0.182

Results Summary - 2 Stage WAC

Project: 14-645 Greater Dublin Drainage GI: Phase 2

Chemtest Job No: 15-03479 Chemtest Sample ID: 103340 Sample Ref: Sample ID: TP109 Top Depth(m): 0.50 Bottom Depth(m): Sampling Date:							Landfill Waste Acceptance Criteria Limits		
							Inert Waste Landfill	Stable Non-reactive Hazardous waste in non-hazardous Landfill	Hazardous Waste Landfill
Determinand	**SOP**	**Accred.**	**Units**						
Total Organic Carbon	2625	U	%			1.1	3	5	6
Loss on Ignition	2610	U	%			2.9	--	--	10
Total BTEX	2760	U	mg/kg			A < 0.01	6	--	--
Total PCBs (7 congeners)	2815	U	mg/kg			< 0.10	1	--	--
TPH Total WAC (Mineral Oil)	2670	U	mg/kg			A < 10	500	--	--
Total (of 17) PAHs	2700	N	mg/kg			12	100	--	--
pH	2010	U				7.9	--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg			0.58	--	To evaluate	To evaluate
Eluate Analysis			**2:1 mg/l**	**8:1 mg/l**	**2:1 mg/kg**	**Cumulative 10:1 mg/kg**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg**		
Arsenic	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	2	25
Barium	1450	U	0.023	0.022	< 0.50	< 0.50	20	100	300
Cadmium	1450	U	0.0001	< 0.0001	< 0.010	< 0.010	0.04	1	5
Chromium	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	10	70
Copper	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	2	50	100
Mercury	1450	U	< 0.0005	< 0.0005	< 0.001	< 0.005	0.01	0.2	2
Molybdenum	1450	U	0.004	0.006	< 0.050	0.055	0.5	10	30
Nickel	1450	U	0.003	< 0.001	< 0.050	< 0.050	0.4	10	40
Lead	1450	U	< 0.001	< 0.001	< 0.010	< 0.010	0.5	10	50
Antimony	1450	U	< 0.001	< 0.001	< 0.010	< 0.010	0.06	0.7	5
Selenium	1450	U	0.006	0.002	0.012	0.02	0.1	0.5	7
Zinc	1450	U	0.017	< 0.001	< 0.50	< 0.50	4	50	200
Chloride	1220	U	2.2	< 1.0	< 10	< 10	800	15000	25000
Fluoride	1220	U	0.14	0.24	< 1.0	2.3	10	150	500
Sulphate	1220	U	1500	150	3000	3000	1000	20000	50000
Total Dissolved Solids	1020	N	1300	300	2600	4100	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.030	< 0.30	< 0.50	1	-	-
Dissolved Organic Carbon	1610	N	14	5	< 50	60	500	800	1000

Soild Information	
Dry mass of test portion/kg	0.175
Moisture (%)	13

Leachate Test Information	
Leachant volume 1st extract/l	0.325
Leachant volume 2nd extract/l	1.4
Eluant recovered from 1st extract/l	0.196

Results Summary - 2 Stage WAC

Project: 14-645 Greater Dublin Drainage GI: Phase 2

Chemtest Job No: 15-03479 Chemtest Sample ID: 103341 Sample Ref: Sample ID: TP110 Top Depth(m): 1.00 Bottom Depth(m): Sampling Date:							Landfill Waste Acceptance Criteria Limits		
							Inert Waste Landfill	Stable Non-reactive Hazardous waste in non-hazardous Landfill	Hazardous Waste Landfill
Determinand	**SOP**	**Accred.**	**Units**						
Total Organic Carbon	2625	U	%			0.63	3	5	6
Loss on Ignition	2610	U	%			2.4	--	--	10
Total BTEX	2760	U	mg/kg			A < 0.01	6	--	--
Total PCBs (7 congeners)	2815	U	mg/kg			< 0.10	1	--	--
TPH Total WAC (Mineral Oil)	2670	U	mg/kg			A < 10	500	--	--
Total (of 17) PAHs	2700	N	mg/kg			3	100	--	--
pH	2010	U				8.1	--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg			0.34	--	To evaluate	To evaluate
Eluate Analysis			**2:1 mg/l**	**8:1 mg/l**	**2:1 mg/kg**	**Cumulative 10:1 mg/kg**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg**		
Arsenic	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	2	25
Barium	1450	U	0.006	0.003	< 0.50	< 0.50	20	100	300
Cadmium	1450	U	< 0.0001	< 0.0001	< 0.010	< 0.010	0.04	1	5
Chromium	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	10	70
Copper	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	2	50	100
Mercury	1450	U	< 0.0005	< 0.0005	< 0.001	< 0.005	0.01	0.2	2
Molybdenum	1450	U	0.001	0.001	< 0.050	< 0.050	0.5	10	30
Nickel	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.4	10	40
Lead	1450	U	< 0.001	< 0.001	< 0.010	< 0.010	0.5	10	50
Antimony	1450	U	< 0.001	< 0.001	< 0.010	< 0.010	0.06	0.7	5
Selenium	1450	U	< 0.001	< 0.001	< 0.010	< 0.010	0.1	0.5	7
Zinc	1450	U	< 0.001	< 0.001	< 0.50	< 0.50	4	50	200
Chloride	1220	U	9.4	< 1.0	19	11	800	15000	25000
Fluoride	1220	U	0.23	0.11	< 1.0	1.2	10	150	500
Sulphate	1220	U	9.1	< 1.0	18	10	1000	20000	50000
Total Dissolved Solids	1020	N	130	43	260	530	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.030	< 0.30	< 0.50	1	-	-
Dissolved Organic Carbon	1610	N	12	12	< 50	120	500	800	1000

Soild Information	
Dry mass of test portion/kg	0.175
Moisture (%)	13

Leachate Test Information	
Leachant volume 1st extract/l	0.324
Leachant volume 2nd extract/l	1.4
Eluant recovered from 1st extract/l	0.202

Results Summary - 2 Stage WAC

Project: 14-645 Greater Dublin Drainage GI: Phase 2

Chemtest Job No: 15-03479 Chemtest Sample ID: 103342 Sample Ref: Sample ID: TP114 Top Depth(m): 1.00 Bottom Depth(m): Sampling Date:							Landfill Waste Acceptance Criteria Limits		
							Inert Waste Landfill	Stable Non-reactive Hazardous waste in non-hazardous Landfill	Hazardous Waste Landfill
Determinand	**SOP**	**Accred.**	**Units**						
Total Organic Carbon	2625	U	%			0.53	3	5	6
Loss on Ignition	2610	U	%			1.8	--	--	10
Total BTEX	2760	U	mg/kg			A < 0.01	6	--	--
Total PCBs (7 congeners)	2815	U	mg/kg			< 0.10	1	--	--
TPH Total WAC (Mineral Oil)	2670	U	mg/kg			A < 10	500	--	--
Total (of 17) PAHs	2700	N	mg/kg			3.1	100	--	--
pH	2010	U				8.3	--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg			0.32	--	To evaluate	To evaluate
Eluate Analysis			**2:1 mg/l**	**8:1 mg/l**	**2:1 mg/kg**	**Cumulative 10:1 mg/kg**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg**		
Arsenic	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	2	25
Barium	1450	U	0.014	0.003	< 0.50	< 0.50	20	100	300
Cadmium	1450	U	< 0.0001	< 0.0001	< 0.010	< 0.010	0.04	1	5
Chromium	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	10	70
Copper	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	2	50	100
Mercury	1450	U	< 0.0005	< 0.0005	< 0.001	< 0.005	0.01	0.2	2
Molybdenum	1450	U	0.008	0.002	< 0.050	< 0.050	0.5	10	30
Nickel	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.4	10	40
Lead	1450	U	< 0.001	< 0.001	< 0.010	< 0.010	0.5	10	50
Antimony	1450	U	< 0.001	< 0.001	< 0.010	< 0.010	0.06	0.7	5
Selenium	1450	U	0.005	0.001	0.011	0.017	0.1	0.5	7
Zinc	1450	U	< 0.001	< 0.001	< 0.50	< 0.50	4	50	200
Chloride	1220	U	22	< 1.0	43	29	800	15000	25000
Fluoride	1220	U	0.39	0.091	< 1.0	1.3	10	150	500
Sulphate	1220	U	17	< 1.0	33	22	1000	20000	50000
Total Dissolved Solids	1020	N	160	41	310	560	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.030	< 0.30	< 0.50	1	-	-
Dissolved Organic Carbon	1610	N	2.9	2.9	< 50	< 50	500	800	1000

Soild Information	
Dry mass of test portion/kg	0.175
Moisture (%)	19

Leachate Test Information	
Leachant volume 1st extract/l	0.31
Leachant volume 2nd extract/l	1.4
Eluant recovered from 1st extract/l	0.229

Deviations

In accordance with UKAS Policy on Deviating Samples TPS 63. Chemtest have a procedure to ensure 'upon receipt of each sample a competent laboratory shall assess whether the sample is suitable with regard to the requested test(s)'. This policy and the respective holding times applied, can be supplied upon request.The reason a sample is declared as deviating is detailed below. Where applicable the analysis remains UKAS/MCERTs accredited but the results may be compromised.

Chemtest Sample ID:	Sample Ref:	Sample ID:	Sampled Date:	Containers Received:	Deviation Code(s):
103338		BH138	None Supplied	Amber Glass 250ml	A
103338		BH138	None Supplied	Amber Glass 60ml	A
103338		BH138	None Supplied	Plastic Tub 500g	A
103339		TP108	None Supplied	Amber Glass 250ml	A
103339		TP108	None Supplied	Amber Glass 60ml	A
103339		TP108	None Supplied	Plastic Tub 500g	A
103340		TP109	None Supplied	Amber Glass 250ml	A
103340		TP109	None Supplied	Amber Glass 60ml	A
103340		TP109	None Supplied	Plastic Tub 500g	A
103341		TP110	None Supplied	Amber Glass 250ml	A
103341		TP110	None Supplied	Amber Glass 60ml	A
103341		TP110	None Supplied	Plastic Tub 500g	A
103342		TP114	None Supplied	Amber Glass 250ml	A
103342		TP114	None Supplied	Amber Glass 60ml	A
103342		TP114	None Supplied	Plastic Tub 500g	A

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, SVCOs, PCBs, Phenols
For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at our Coventry 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

Sample Retention and Disposal

All soil samples will be retained for a period of 60 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

Appendix G
SPT hammer energy measurement report

testconsult
Specialist Testing Services

SPT Hammer Energy Test Report

in accordance with BSEN ISO 22476-3:2005

Mr. David Cameron
Causeway Geotech Ltd.
8 Drumahiskey Road,
balnamore, Ballymoney,
Co Antrim, Northern Ireland.
BT 53 7QL

SPT Hammer Ref:	CG G205
Test Date:	03/01/2013
Report Date:	
File Name:	CG G205. report spt_checked.spt
Test Operator:	MR

UKAS TESTING 0955

Instrumented Rod Data

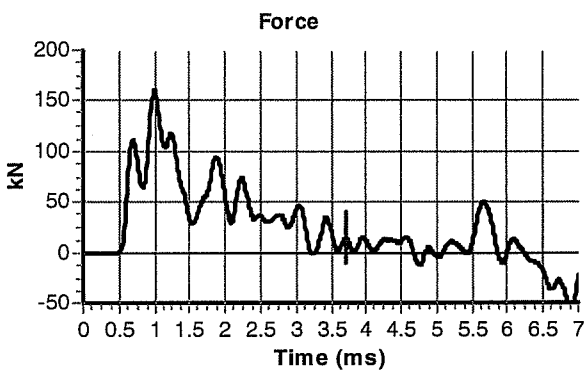
Diameter d_r (mm):	54
Wall Thickness t_r (mm):	6.6
Assumed Modulus E_a (GPa):	208
Accelerometer No.1:	5677
Accelerometer No.2:	5833

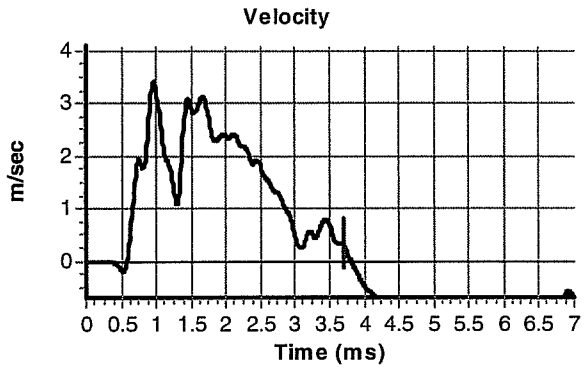
SPT Hammer Information

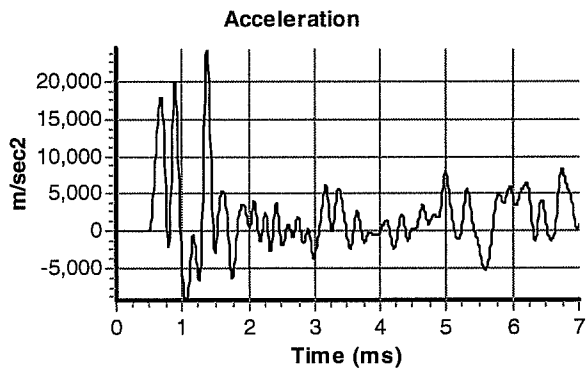
Hammer Mass m (kg):	63.5
Falling Height h (mm):	770
SPT String Length L (m):	14.0

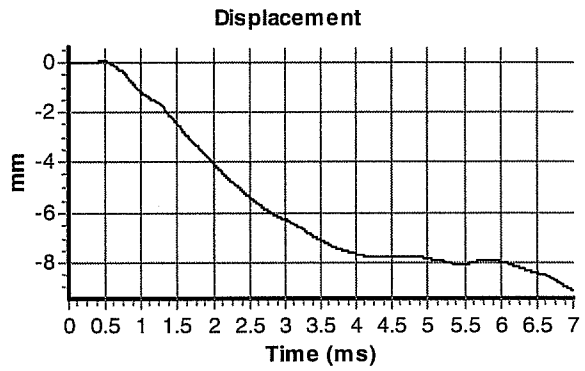
Comments / Location

T G205









Calculations

Area of Rod A (mm2):	983
Theoretical Energy E_{theor} (J):	473
Measured Energy E_{meas} (J):	323

Energy Ratio E_r (%): **68**

Signed: Michael Robinson

Title: Test Engineer

The recommended calibration interval is 12 months

testconsult
Specialist Testing Services

SPT Hammer Energy Test Report

in accordance with BSEN ISO 22476-3:2005

Mr. David Cameron
Causeway Geotech Ltd.
8 Drumahiskey Road,
Balnamore, Ballymoney,
Co Antrim, Northern Ireland.
BT 53 7QL

SPT Hammer Ref:	CG CC4
Test Date:	03/01/2013
Report Date:	07/01/2013
File Name:	CG CC4. report spt_checked.spt
Test Operator:	MR

UKAS TESTING 0955

Instrumented Rod Data

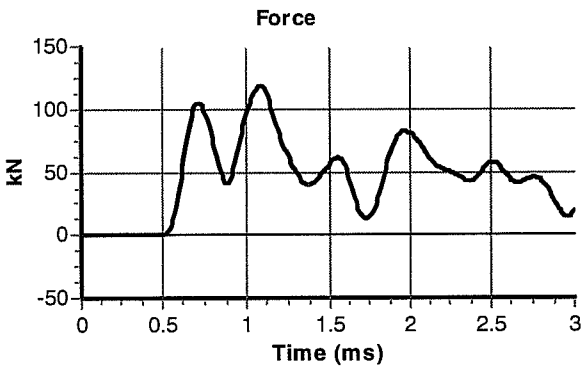
Diameter d_r (mm):	54
Wall Thickness t_r (mm):	6.6
Assumed Modulus E_a (GPa):	208
Accelerometer No.1:	5677
Accelerometer No.2:	5833

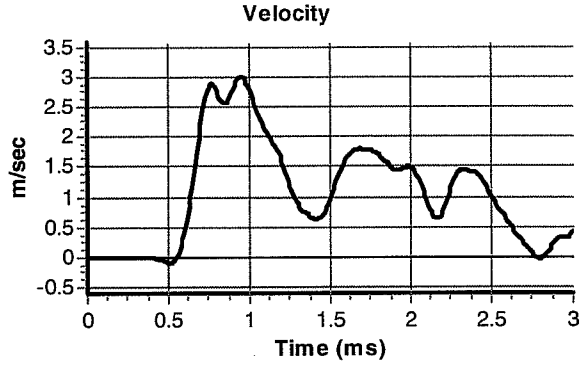
SPT Hammer Information

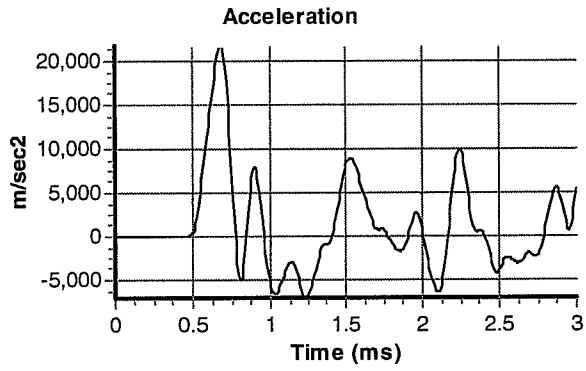
Hammer Mass m (kg):	63.5
Falling Height h (mm):	760
SPT String Length L (m):	13.0

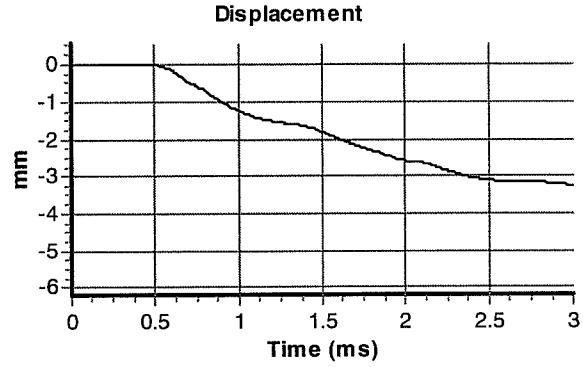
Comments / Location

TRIP CC4









Calculations

Area of Rod A (mm2):	983
Theoretical Energy E_{theor} (J):	473
Measured Energy E_{meas} (J):	272

Energy Ratio E_r (%): **58**

Signed: Michael Robinson

Title: Test Engineer

The recommended calibration interval is 12 months

Appendix H
Geophysics report (Apex Geoservices)

AGL15015_01

REPORT ON THE

GEOPHYSICAL SURVEY

FOR

GREATER DUBLIN REGIONAL DRAINAGE

FOR

CAUSEWAY GEOTECH LTD.

26TH FEBRUARY 2015

APEX Geoservices Limited
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PRIVATE AND CONFIDENTIAL

THE FINDINGS OF THIS REPORT ARE THE RESULT OF A GEOPHYSICAL SURVEY USING NON-INVASIVE SURVEY TECHNIQUES CARRIED OUT AT THE GROUND SURFACE. INTERPRETATIONS CONTAINED IN THIS REPORT ARE DERIVED FROM A KNOWLEDGE OF THE GROUND CONDITIONS, THE GEOPHYSICAL RESPONSES OF GROUND MATERIALS AND THE EXPERIENCE OF THE AUTHOR. APEX GEOSERVICES LTD. HAS PREPARED THIS REPORT IN LINE WITH BEST CURRENT PRACTICE AND WITH ALL REASONABLE SKILL, CARE AND DILIGENCE IN CONSIDERATION OF THE LIMITS IMPOSED BY THE SURVEY TECHNIQUES USED AND THE RESOURCES DEVOTED TO IT BY AGREEMENT WITH THE CLIENT. THE INTERPRETATIVE BASIS OF THE CONCLUSIONS CONTAINED IN THIS REPORT SHOULD BE TAKEN INTO ACCOUNT IN ANY FUTURE USE OF THIS REPORT.

PROJECT NUMBER	AGL15015		
AUTHOR	**CHECKED**	**REPORT STATUS**	**DATE**
EURGEOL SHANE O`ROURKE P.GEO., M.SC (GEOPHYSICS)	TONY LOMBARD M.SC (GEOPHYSICS)	V.01	26TH FEBRUARY 2015

CONTENTS

1. EXECUTIVE SUMMARY

APEX Geoservices Limited was requested by Causeway Geotech Ltd. to carry out a geophysical investigation as part of the site investigation at three locations along the proposed pipeline route for the Greater Dublin Regional Drainage Scheme.

The objectives of the survey were to produce depth to bedrock sections for the sites, to provide information on the type and quality of the bedrock, to provide information on the thickness and stiffness of the superficial deposits and to provide locations for targeted intrusive investigation.

The investigation consisted of 2D Electrical Resistivity Tomography (ERT) and Seismic Refraction Profiling at three locations; GEO-1, GEO-2 and GEO-3.

GEO-1 is in the area of Dubber Cross and c.3km to the west of GEO-2 and GEO-3 which are both in Ballymun. Each area is just to the north of the M50 motorway.

The results for GEO-1 generally indicate made ground followed by firm-very stiff sandy gravelly clay to 1.6-8.2m bgl followed by thin discontinuous highly-moderately weathered bedrock followed by slightly weathered-fresh bedrock.

The results for GEO-2 generally indicate made ground followed by firm-very stiff sandy gravelly clay to 4.9-10.1m bgl followed by thin discontinuous highly-moderately weathered bedrock followed by slightly weathered-fresh bedrock.

The results for GEO-3 generally indicate made ground followed by firm-very stiff sandy gravelly clay to 7.2-8.2m bgl followed by slightly weathered-fresh bedrock.

The invert level for all three areas is within slightly weathered-fresh muddy limestone and shale.

2. INTRODUCTION

APEX Geoservices Limited was requested by Causeway Geotech Ltd. to carry out a geophysical investigation as part of the site investigation at three locations along the proposed invert for the Greater Dublin Regional Drainage Scheme.

2.1 Survey Objectives

The objectives of the survey were to:

1.Produce depth to bedrock sections for the sites.

2.Provide information on the type and quality of the bedrock.

3.Provide information on the thickness and stiffness of the superficial deposits.

4.Provide locations for targeted intrusive investigation.

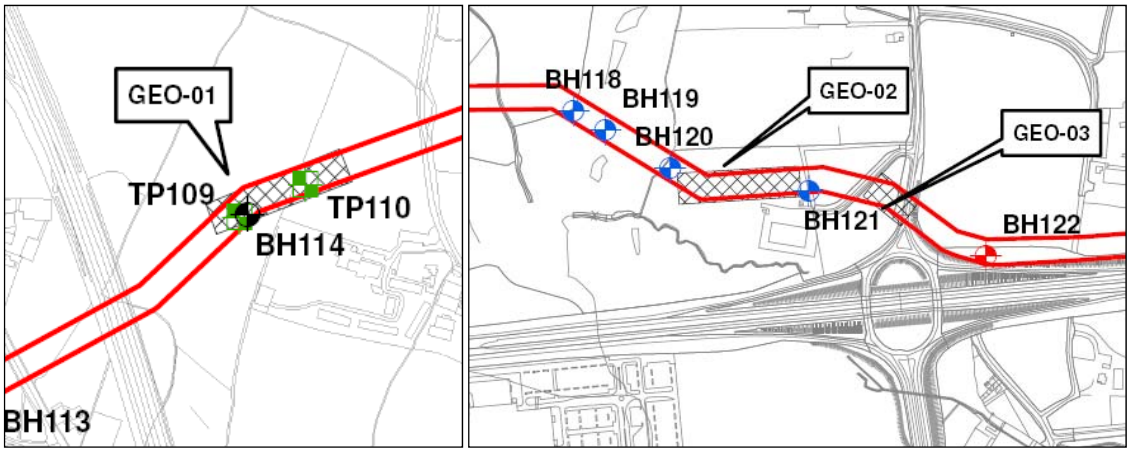
2.2 Site Background

ERT and Seismic Refraction Profiling has been carried out at three locations along the Greater Dublin Regional Drainage Scheme, namely GEO-1, GEO-2 and GEO-3. The three areas are located immediately north of the M50 motorway in north county Dublin.

GEO-1 is 200m east of the N2 roadway and comprises 200m of continuous ERT and Seismic Refraction Profiling in a generally flat area of grass/made ground.

GEO-2 is 2.6km east of GEO-1 and 200m west of the R108 roadway and comprises 200m of continuous ERT and Seismic Refraction Profiling in a generally flat area of grass/made ground

GEO-3 is 140m east of GEO-2 and comprises two cross-profiles within a confined area of made ground immediately west of the R108.



2.3 Geology

The GSI 1:100k Bedrock Geology map for GEO-1 (Fig.2.1) indicates that the site is located at the boundary of calcareous shale & limestone conglomerate of the Tober Colleen Formation and massive unbedded lime-mudstone of the Waulsortian Limestones.

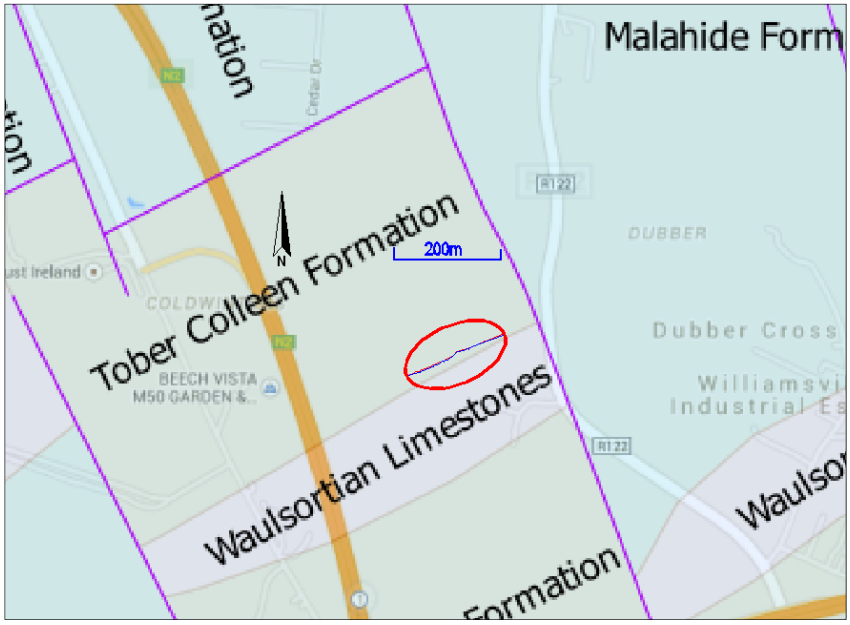


Fig.2.1. Geological map for the GEO-1 site.

Fig.2.2 indicates that the GEO-2 and GEO-3 sites are located within calcareous shale & limestone conglomerate of the Tober Colleen Formation.

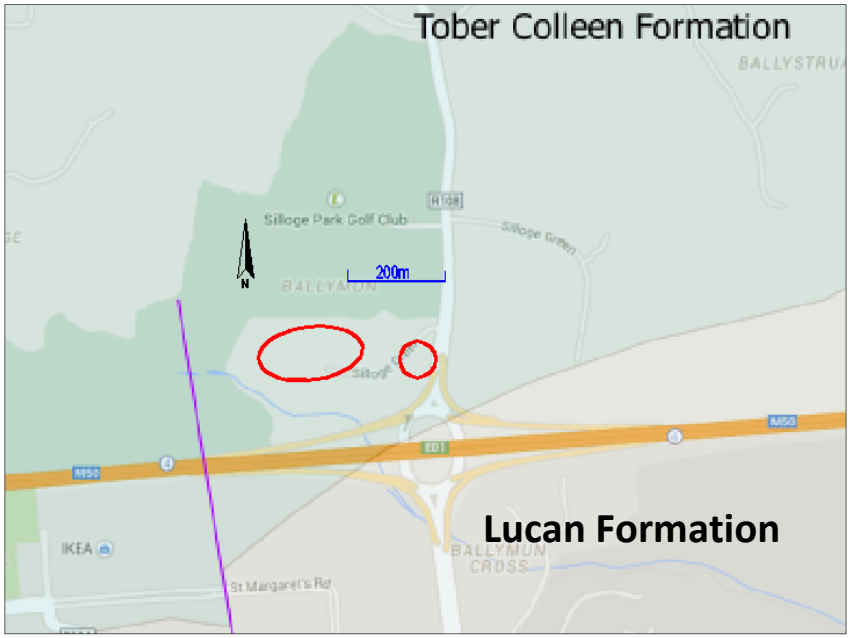


Fig.2.2. Geological map for the GEO-2 and GEO-3 sites.

2.4 Soils

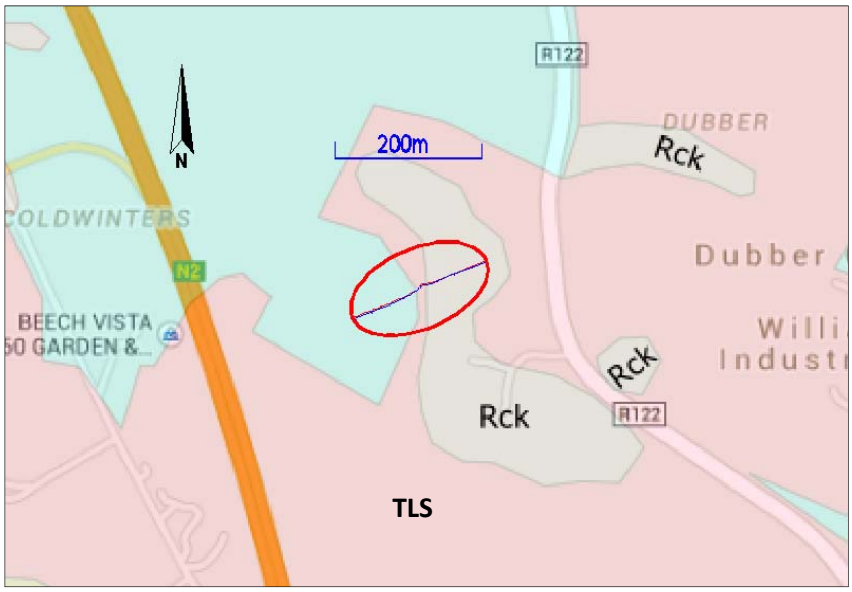


Fig.2.3. Soils map for the GEO-1 site.

Fig.2.4. Soils map for the GEO-2 and GEO-3 sites.

The Teagasc soils map for GEO-1 (Fig.2.3) indicates made ground to the west, followed by till derived from limestone, with outcrop for the eastern 100m of the section. The map shows made ground (Fig.2.4) for GEO-2 and GEO-3.

2.5 Vulnerability

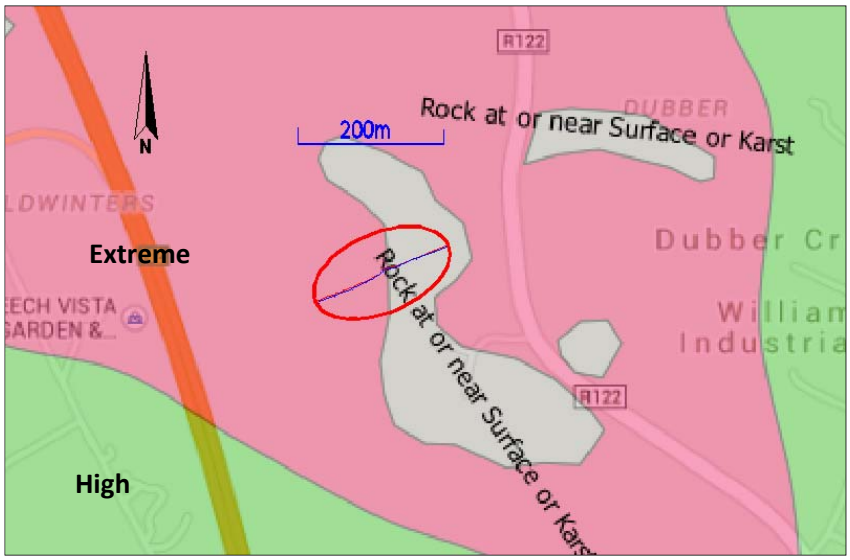


Fig.2.5. Vulnerability map for the GEO-1 site.

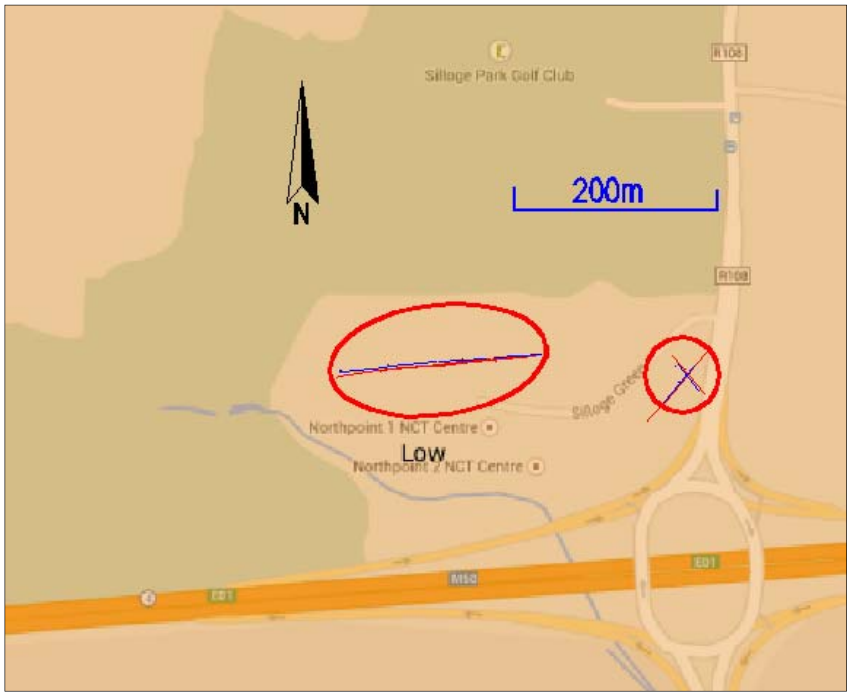


Fig.2.6. Vulnerability map for the GEO-2 and GEO-3 sites.

The vulnerability map for GEO-1 (Fig.2.5) indicates extreme vulnerability to the west and rock at or near surface or karst to the east. The map shows low vulnerability (Fig.2.6) for GEO-2 and GEO-3.

2.6 Historical Data

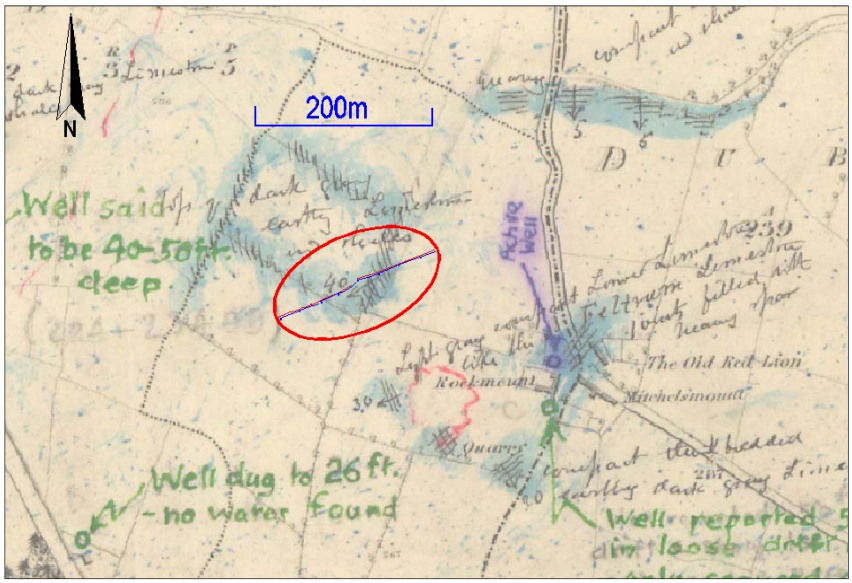


Fig.2.7. 6" Sheet for the GEO-1 site.

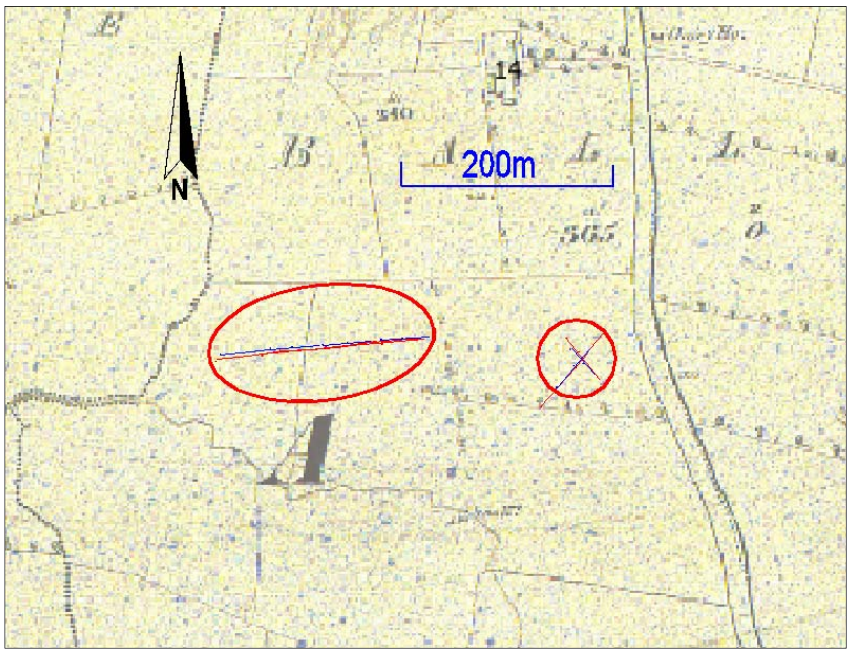


Fig.2.8. 6" Sheet for the GEO-2 and GEO-3 sites.

The 6" Sheet for GEO-1 (Fig.2.7) shows outcrop at the location of the survey comprising dark grey earthy limestones dipping by 40® to the west.

2.7 Site Investigation

BH114 has been drilled at GEO-1 and records made ground followed by stiff clay to 8.5m followed by weathered bedrock to 11.5, and then bedrock.

TP109 at GEO-1 records made ground to 2.2m followed by soft clay to 3.4m. TP110 at GEO-1 records firm to stiff clay to 1.9m followed by weathered bedrock.

BH120-BH121 were both drilled 47-58m to the north of GEO-2 and record firm-hard clay to 11.5-11.9m bgl.

2.8 Survey Rationale

Electrical Resistivity Tomography (ERT) soundings will image the resistivity of the materials in the subsurface along a profile to produce a pseudo-section showing the variation in resistivity to 25m bgl, depending on the length of the profile. Each pseudo-section will be interpreted to determine the material type along the profile at increasing depth, based on the typical resistivities returned for Irish ground materials.

Seismic Refraction Profiling measures the velocity of refracted seismic waves through the overburden and rock material and allows an assessment of the thickness and quality of the materials present to be made. Stiffer and stronger materials usually have higher seismic velocities while soft, loose or fractured materials have lower velocities. Readings are taken using geophones connected via multi-core cable to a seismograph. This method should allow us to profile the depth to the top of the bedrock, along profiles across the sites.

3. RESULTS & INTERPRETATION

3.1 2D Electrical Resistivity Tomography (ERT)

ERT Profiles R1-R7 have been acquired across the sites (Drawings AGL15015_02, AGL15015_03 and AGL15015_04). The profiles have been interpreted on the following basis:

Resistivity (Ohm.m)	Interpretation
30-50	SILT / CLAY
50-245	Sandy Gravelly Clay
110-145	Weathered Muddy LIMESTONE & SHALE
145-1181	Muddy LIMESTONE & SHALE

3.2 Seismic Refraction Profiling

Ten seismic refraction spreads were recorded throughout the sites, with four at spreads at each of GEO-1 and GEO-2 and two cross-profiles at GEO-3.

The seismic data has outlined four velocity layers and has been generally interpreted on the following basis:

Layer	Seismic Velocity (m/s)	Average Seismic Velocity (m/s)	Thickness (m)	Interpretation	Stiffness/Rock Quality	Excavatability
1	118-753	376	0.3-1.9	Overburden/ Made Ground	Soft-Firm	Diggable
2	533-1296	879	0.1-5.9	Overburden/ Made Ground	Firm-Stiff	Diggable
3	1046-2398	1739	0.1-8.7	Overburden	Stiff-very Stiff	Diggable
				Highly-Moderately Weathered Bedrock	Poor-Fair	Rippable-Break/Blast
4	2455-5030	3283		Slightly Weathered-Fresh Bedrock	Good	Break/Blast

3.3 Discussion

Material with a resistivity of 30-50 and 50-245 ohm.m has been interpreted as silt/clay and sandy gravelly clay respectively. Bedrock with a resistivity of 110-245 and 145-1181 ohm.m has been interpreted as weathered muddy limestone & shale and muddy limestone & shale respectively.

Layer 1. Material with a velocity of 118-753 m/s has been interpreted as soft-firm overburden and made ground which will be diggable.

Layer 2. Material with a velocity of 533-879 m/s has been interpreted as firm-stiff overburden and made ground which will be diggable.

Layer 3. Material with a velocity of 1046-2398 m/s has mainly been interpreted as stiff-very stiff overburden. Some parts of Layer 3 for GEO-1 and GEO-2 have been interpreted as highly-moderately weathered bedrock, which will be rippable to requiring breaking/blasting.

Layer 4. Material with a velocity of 2455-5030 m/s has mainly been interpreted as slightly-weathered to fresh bedrock which will require breaking/blasting upon excavation.

3.3.1 GEO-1

Drawing AGL15015_02

The western half of GEO-1 from 0-90m (local distance along section) has been interpreted as made ground followed by firm-very stiff mainly sandy gravelly clay to 4.0-8.2m bgl. This is followed by thin discontinuous highly-moderately weathered bedrock with a maximum thickness of 3.0m and then slightly weathered-fresh bedrock.

The eastern half of GEO-1 from 90-180m has been interpreted as by soft-very stiff mainly sandy gravelly clay to 1.6-4.0m bgl. This is followed by thin highly-moderately weathered bedrock with a maximum thickness of 3.0m and then slightly weathered-fresh bedrock.

The seismic velocity of Layer 3 will provide an indication as to the excavatibility of the weathered bedrock. All of the Layer 3 velocities for GEO-1 are generally 1200-1500 m/s which is indicative of rippable-marginally rippable bedrock.

The invert level for GEO-1 is 9.5-13.6m below the current ground level (based on survey elevations which should be checked against the project datum), which is within interpreted slightly weathered-fresh bedrock.

3.3.2 GEO-2

Drawing AGL15015_03

GEO-2 has been interpreted as made ground followed by firm-very stiff sandy gravelly clay to 4.9-10.1m bgl. A zone of thin highly-moderately weathered bedrock has been interpreted from 93-130m with a maximum thickness of 1.8m. The Layer 3 velocities for this zone range from 2204-2385 m/s which is indicative of bedrock requiring breaking/blasting.

This is then followed by slightly weathered-fresh bedrock.

The invert level for GEO-2 is 8.9-10.3m below the current ground level (based on survey elevations which should be checked against the project datum) which is within interpreted slightly weathered-fresh bedrock.

3.3.3 GEO-3

Drawing AGL15015_04

GEO-3 has been interpreted as made ground followed by firm-very stiff mainly sandy gravelly clay to 6.0-9.5m bgl (7.2-8.2m bgl at the locations of the pipeline on R6 and R7 respectively). This is then followed by slightly weathered-fresh bedrock.

The invert level for GEO-3 is 10.0m below the current ground level (based on survey elevations which should be checked against the project datum) which is within interpreted as slightly weathered-fresh bedrock.

Profile R7 is characterised by resistivities which are generally very low for the interpreted material types. These low resistivities are also present to a lesser extent on Profile R6 where it crosses Profile R7. These resistivities are anomalous and may be due to a contaminant material and further investigation is recommended below to determine their cause as low soil resistivities can be indicative of potentially corrosive material.

4. RECOMMENDATIONS

A trial pit and a borehole are recommended at GEO-3 at ITM 715265E, 741468N to investigate the cause of the low resistivities returned at this location.

The geophysical results should be reviewed upon the completion of any further site investigation.

5. REFERENCES

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6. APPENDIX A: DETAILED METHODOLOGY

6.1 Electrical Resistivity Tomography (ERT)

6.1.1 Principles

This surveying technique makes use of the Wenner resistivity array. The 2D-resistivity profiling method records a large number of resistivity readings in order to map lateral and vertical changes in material types. The 2D-resistivity profiling method involves the use of 1-32 electrodes connected to a resistivity meter, using computer software to control the process of data collection and storage.

6.1.2 Data Collection

Profiles R1-R7 were recorded using a ABEM resistivity meter, imaging software, one 32 takeout multicore cables and up to 32 stainless steel electrodes. Saline solution was used at the electrode\ground interface in order to gain a good electrical contact required for the technique to work effectively. The recorded data were processed and viewed immediately after the survey. The data was acquired on 3-4th January 2015.

6.1.3 Data Processing

The field readings were stored in computer files and inverted using the RES2DINV package (Campus Geophysical Instruments, 1997) with up to 5 iterations of the measured data carried out for each profile to obtain a 2D-Depth model of the resistivities.

The inverted 2D-Resistivity models and corresponding interpreted geology are displayed on the accompanying drawings. Distance is indicated along the horizontal axis of the profiles. Profiles have been contoured using the same contour intervals and colour codes.

6.1.4 Relocation

All data were referenced using a Pro-XR Differential GPS system with c.20mm accuracy.

6.2 Seismic Refraction Profiling

6.2.1 Principles

The seismic refraction profiling method measures the velocity of refracted seismic waves through the overburden and rock material and allows an assessment of the thickness and quality of the materials present to be made. Stiffer and stronger materials usually have higher seismic velocities while soft, loose or fractured materials have lower velocities. Readings are taken using geophones connected via multi-core cable to a seismograph.

6.2.2 Data Collection

Ten seismic spreads were recorded on the 3-4th February 2015 using a Geode high-resolution 24 channel digital seismograph with geophone spacings of 2m (with the

exception of Profile S9 which had a 1.5m spacing). The source of the seismic waves was a sledgehammer.

6.2.3 Data Processing

The recorded data was interpreted using the ray-tracing and intercept time methods, to acquire depths to layer boundaries and the P-wave velocities of these layers, using the FIRSTPIX and GREMIX programs.

GREMIX interprets seismic refraction data as a laterally varying layered earth structure. It incorporates the slope-intercept method, parts of the Plus-Minus Method of Hagedoorn (1959), Time-Delay Method, and features the Generalized Reciprocal Method (GRM) of Palmer (1980). Up to four layers can be mapped, one deduced from direct arrivals and three deduced from refractions. Phantoming of all possible travel time pairs can be carried out by adjusting reciprocal times of off shots.

6.2.4 Relocation

All data were referenced using a Pro-XS Differential GPS system with c.20mm accuracy.

7. APPENDIX B: SEISMIC REFRACTION PLATES

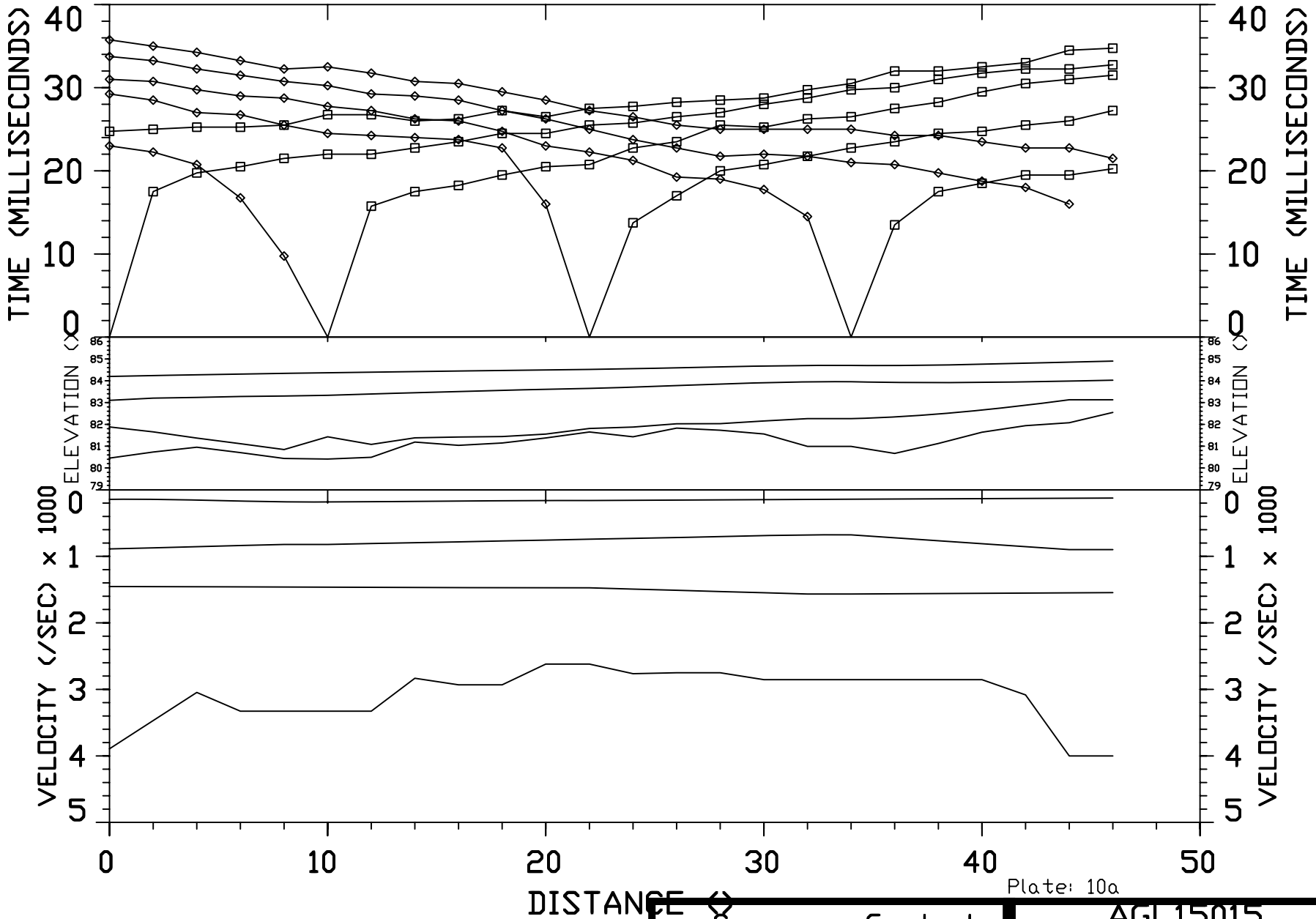

Plate: 10a

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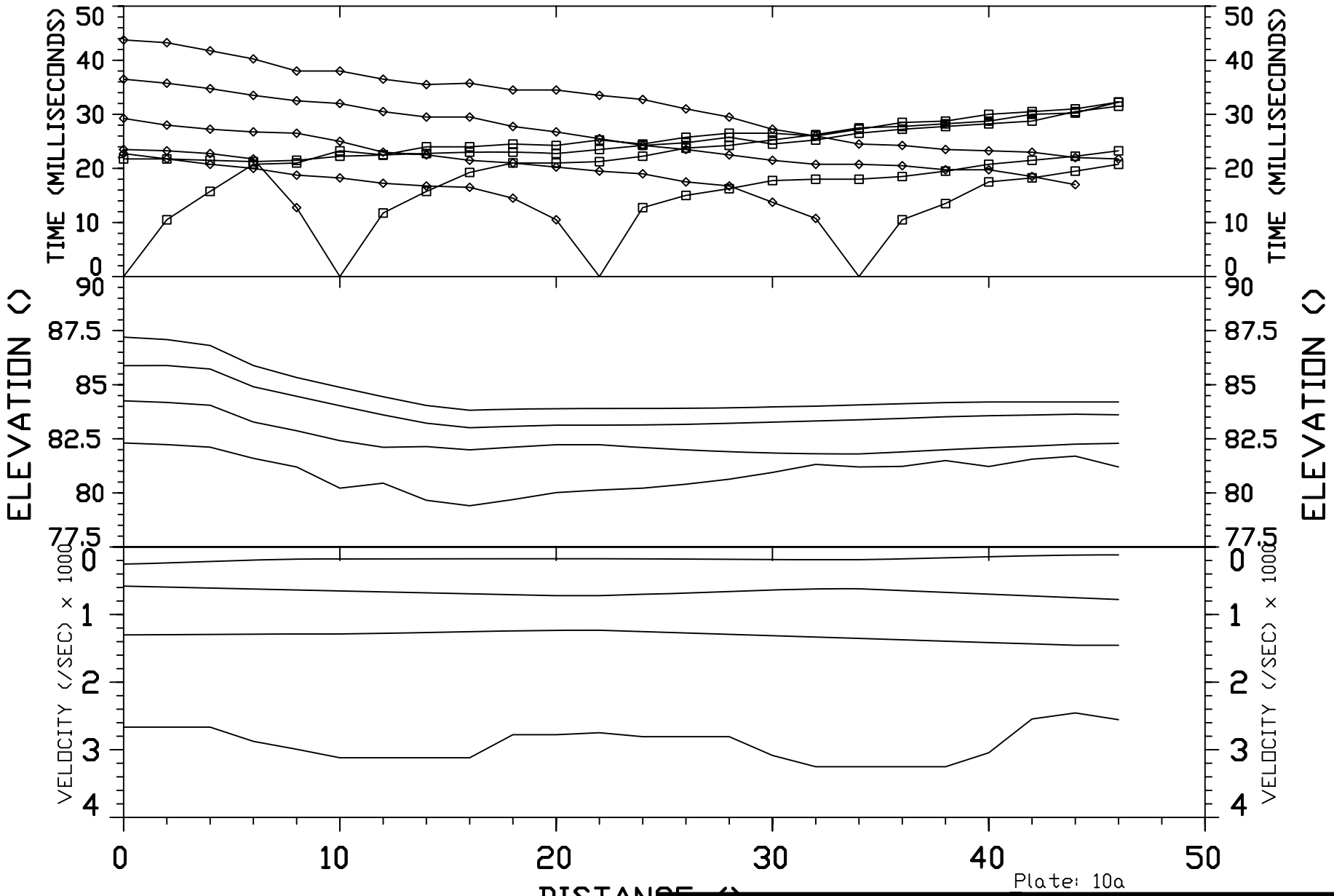
Equipment: / Spread: S1	Azimuth:



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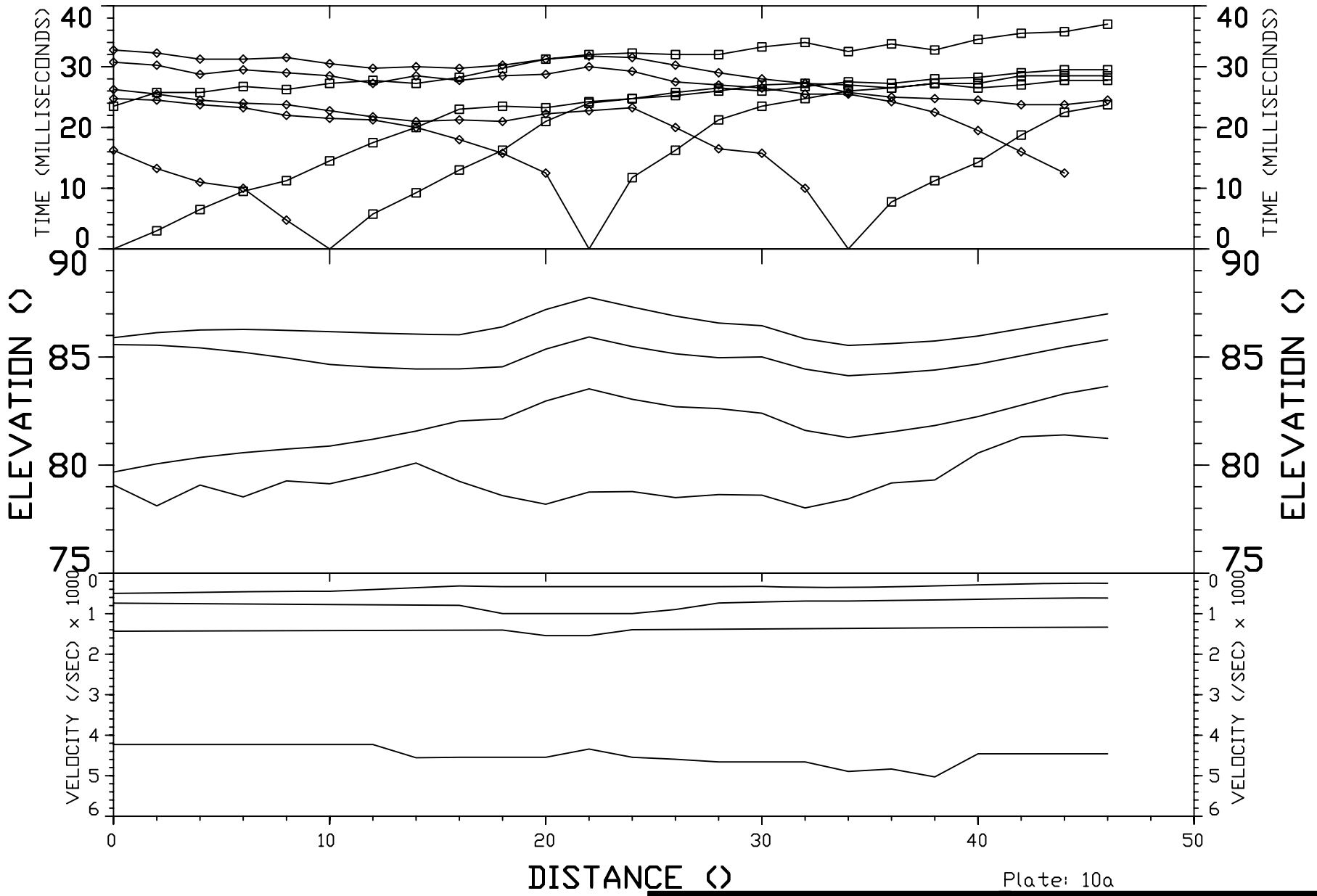

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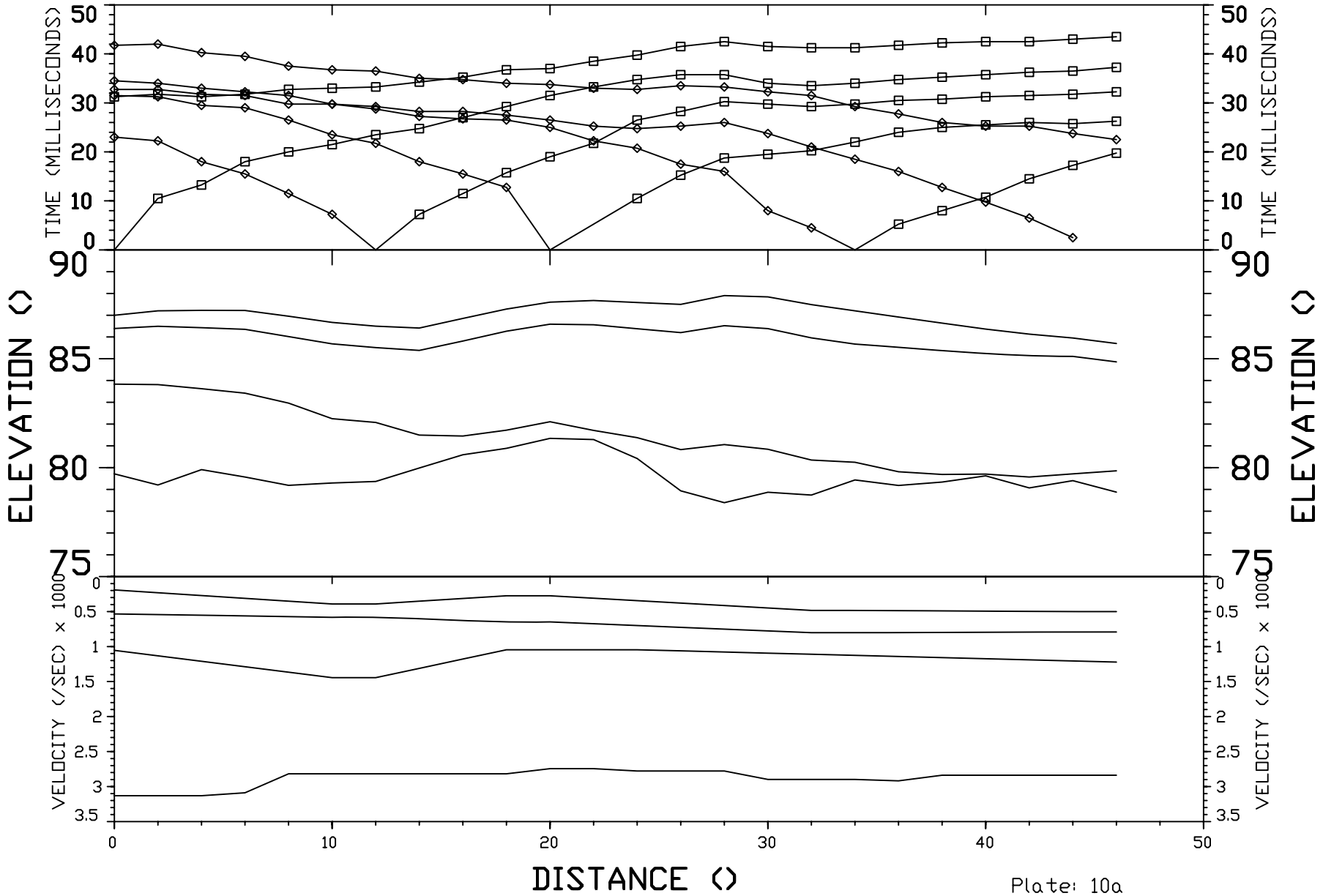

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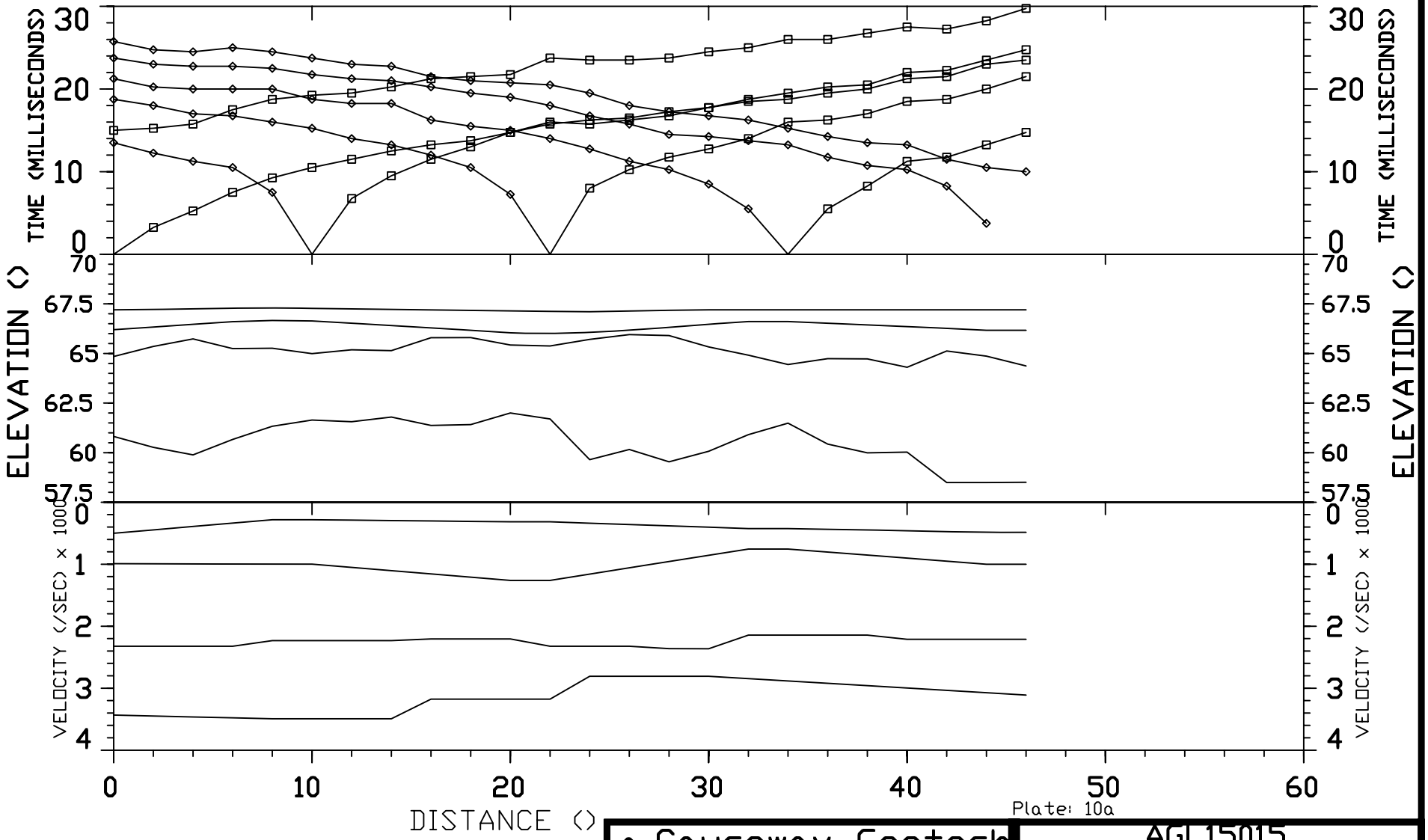

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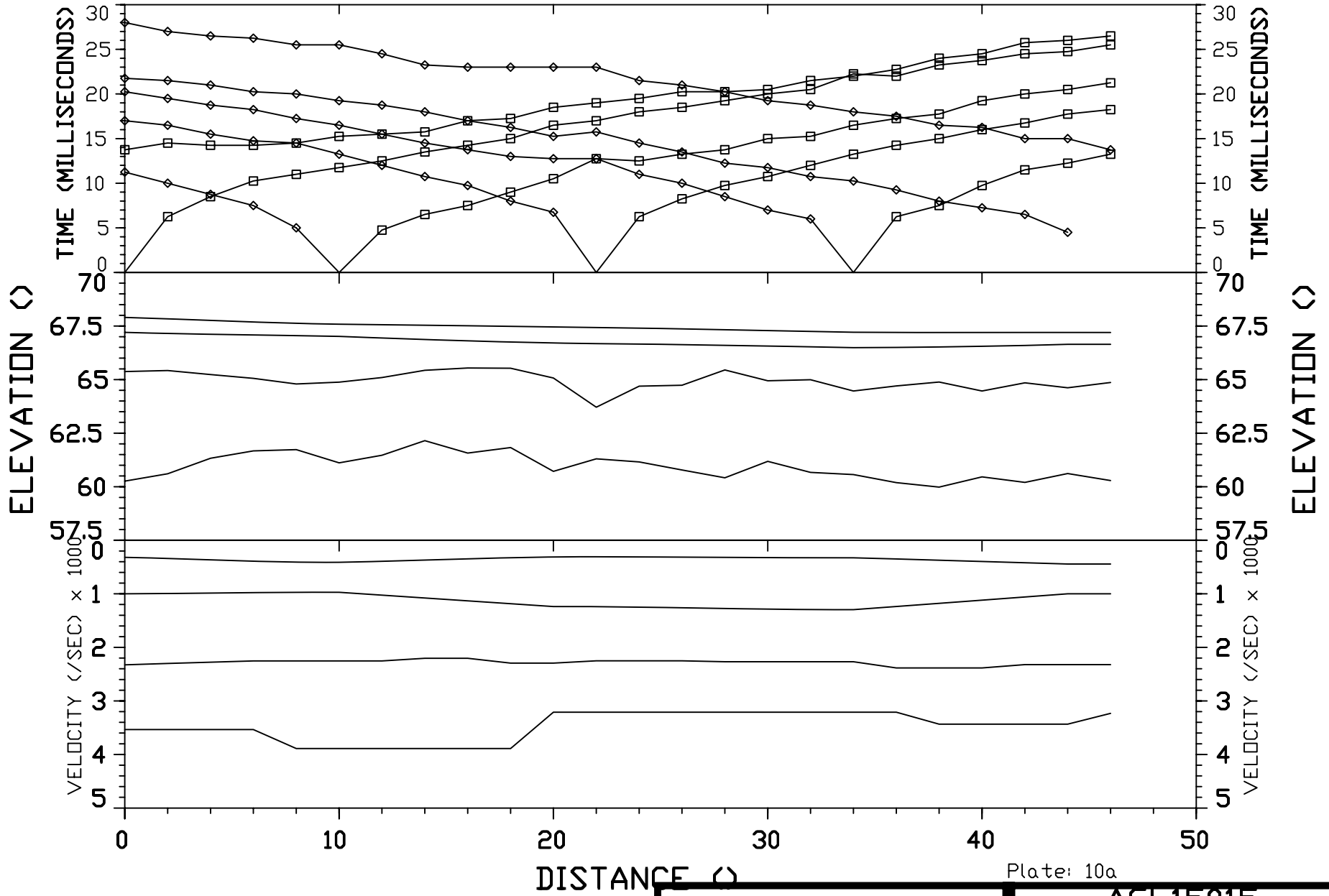

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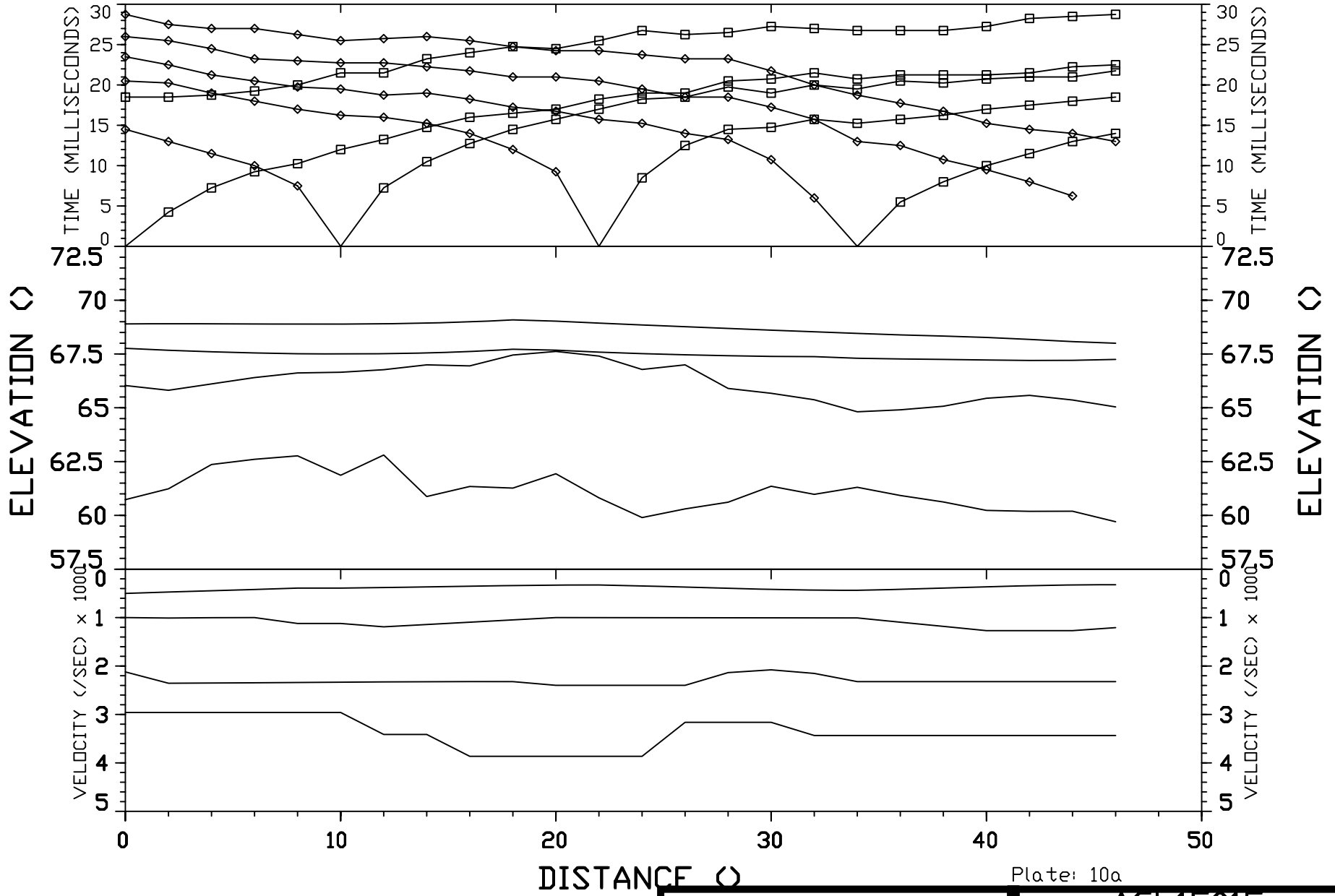

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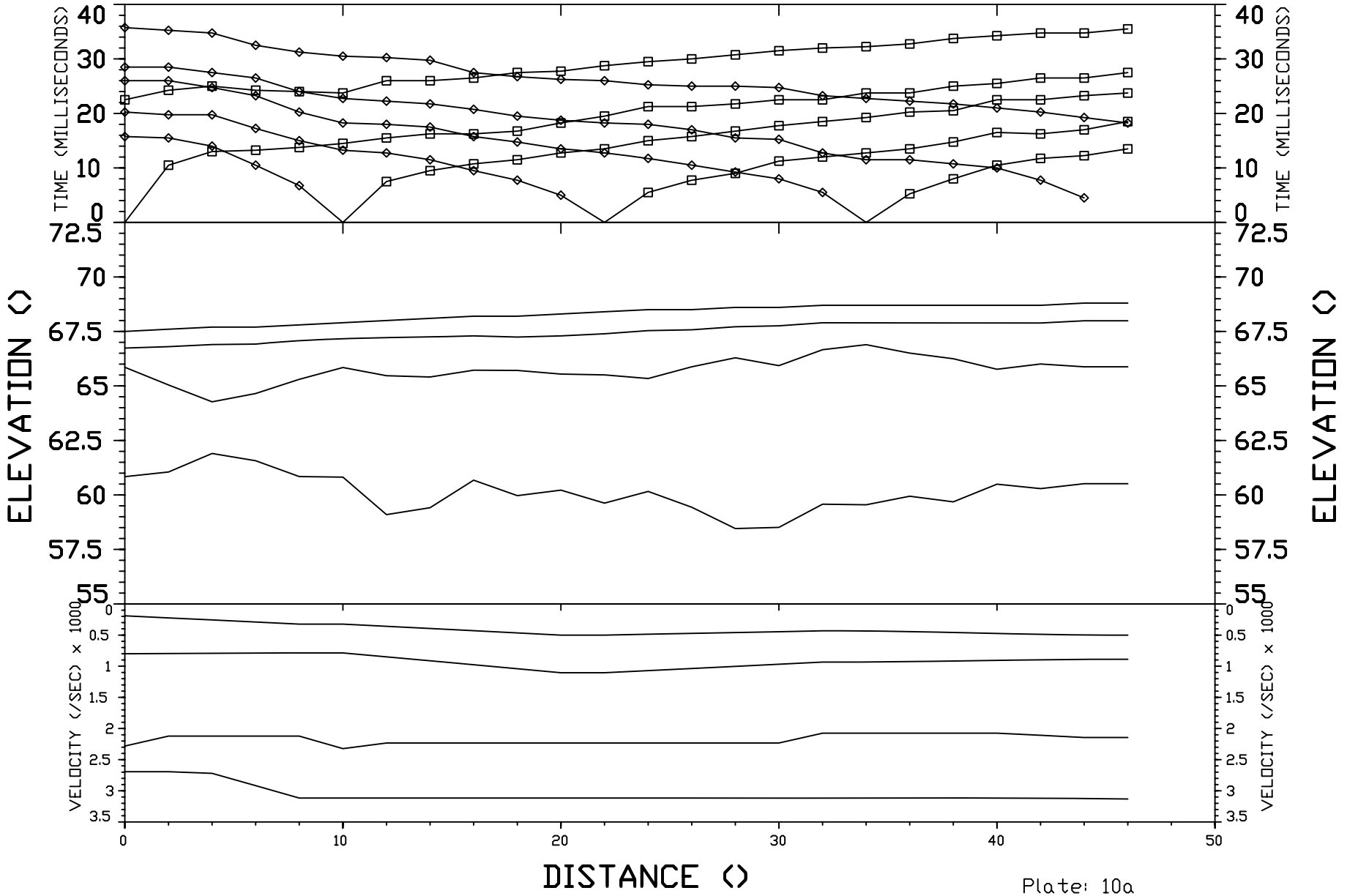

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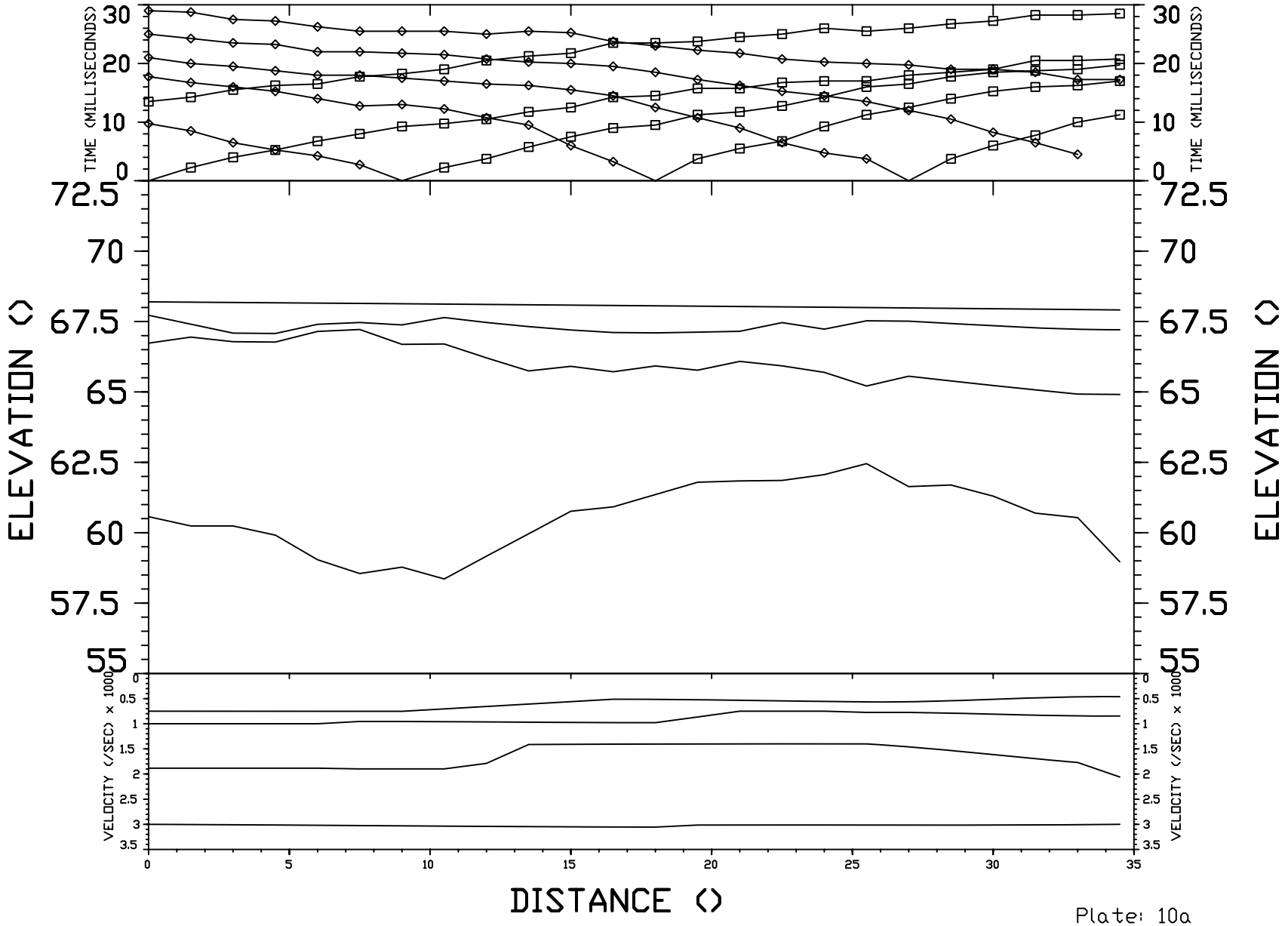

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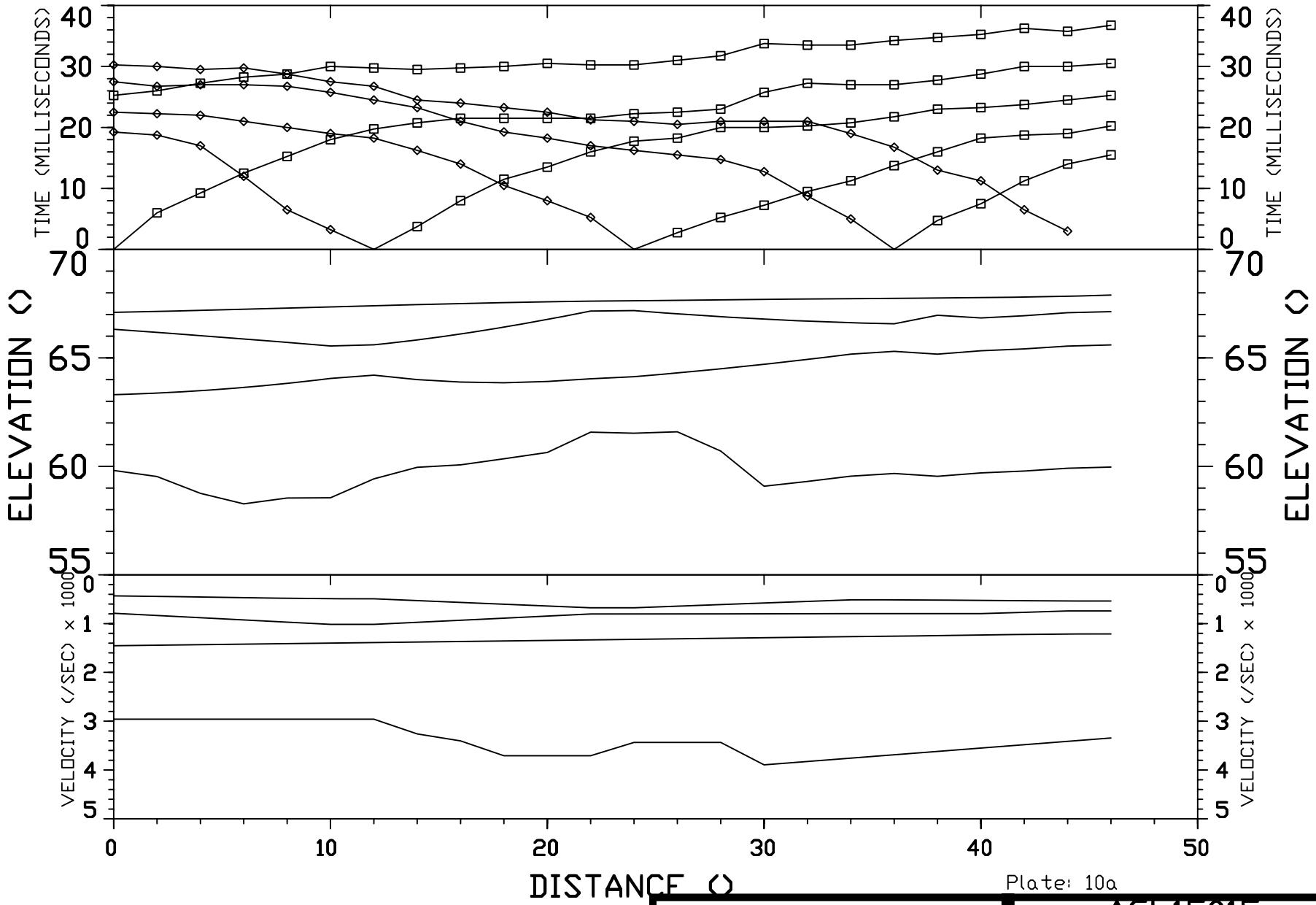


Plate: 10a

for: Causeway Geotech	AGL15015
by: Strata Geophysical, Inc.	Dublin Dublin
Data SetS10 / Date: Feb 2015	
Equipment: / Spread: S10	Azimuth:

8. APPENDIX C: DRAWINGS

The information derived from the geophysical investigation is presented in the following drawings:

AGL15015_01	Geophysical Location	1:4000	@ A3
AGL15015_02	GEO-1 Results	1:750	@ A3
AGL15015_03	GEO-2 Results	1:750	@ A3
AGL15015_04	GEO-3 Results	1:750	@ A3

FIGURE 1: GEO-1 LOCATION

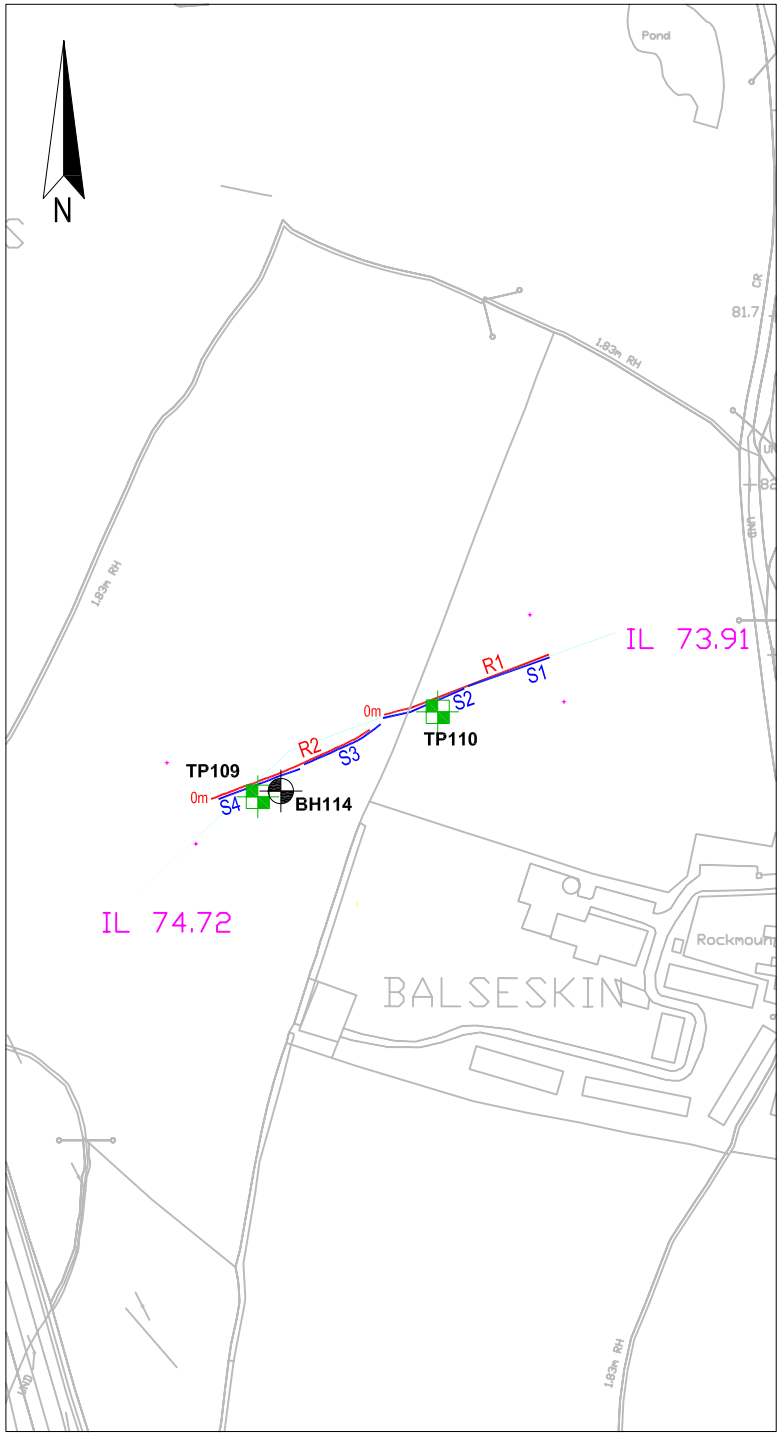
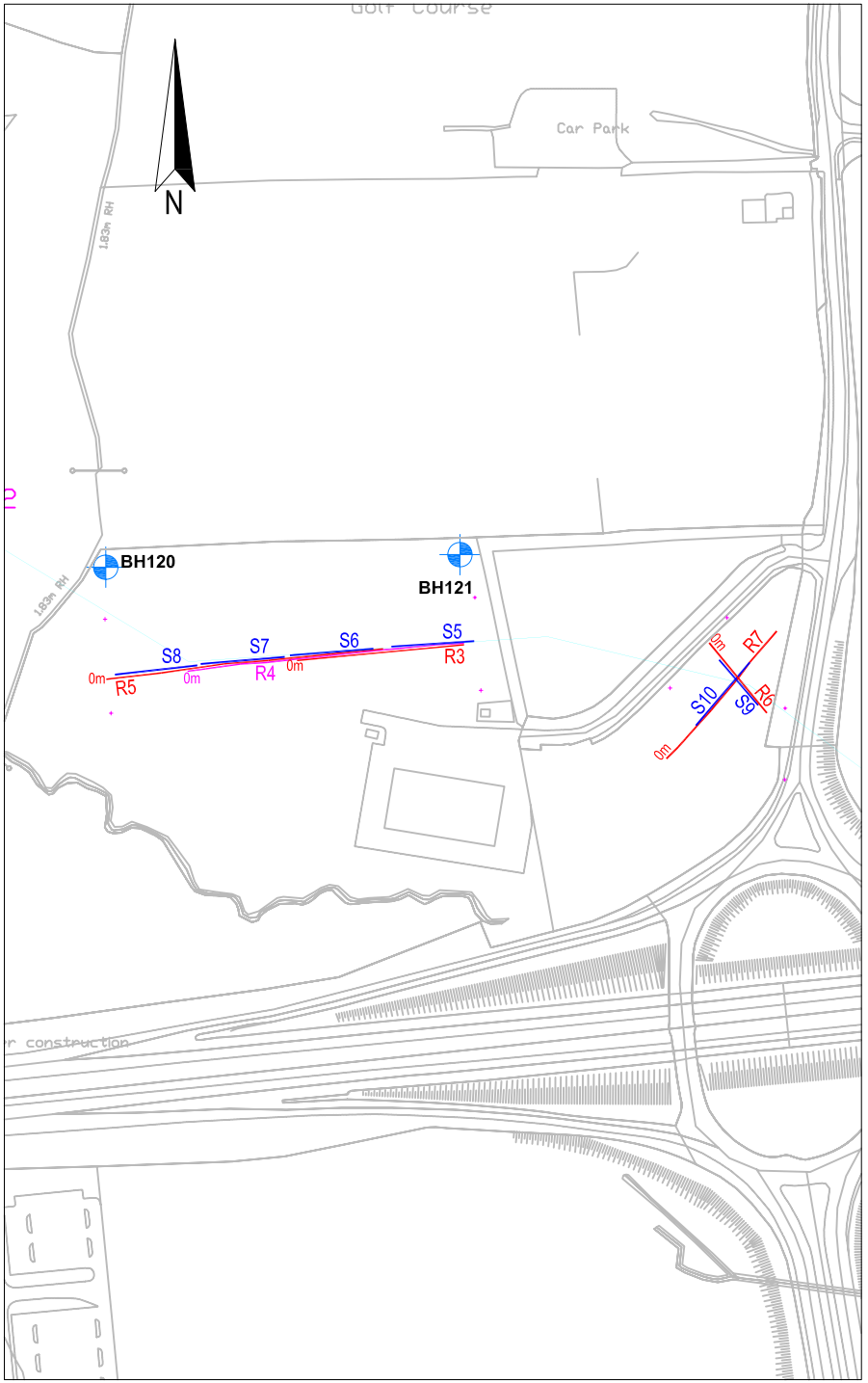
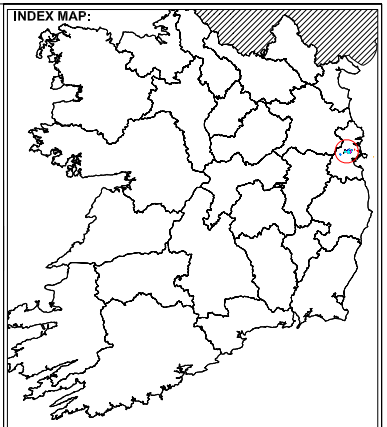


FIGURE 2: GEO-2 & GEO-3 LOCATION



INDEX MAP:



LEGEND:

- ERT Profile
- Seismic Refraction Profile
- Proposed Pipeline

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PROJECT:	GREATER DUBLIN REGIONAL DRAINAGE GEOPHYSICAL SURVEY
CLIENT.:	CAUSEWAY GEOTECH LTD.
DRAWING NO:	AGL15015_01 GEOPHYSICAL LOCATION
SCALE:	1:4000 @ A3
DATE:	13.02.15

Version:	Date:	Drawn By:	Checked:
1	13.02.15	SOR	TL

FIGURE 1: GEO-1 LOCATION

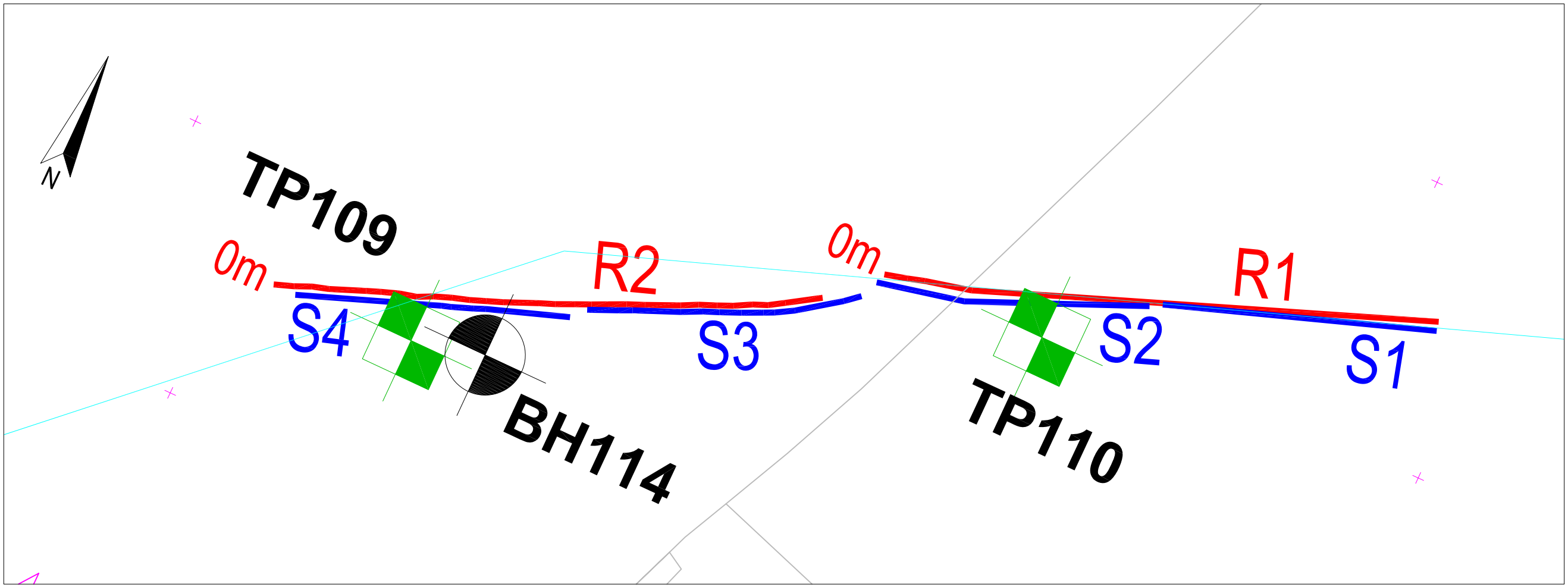
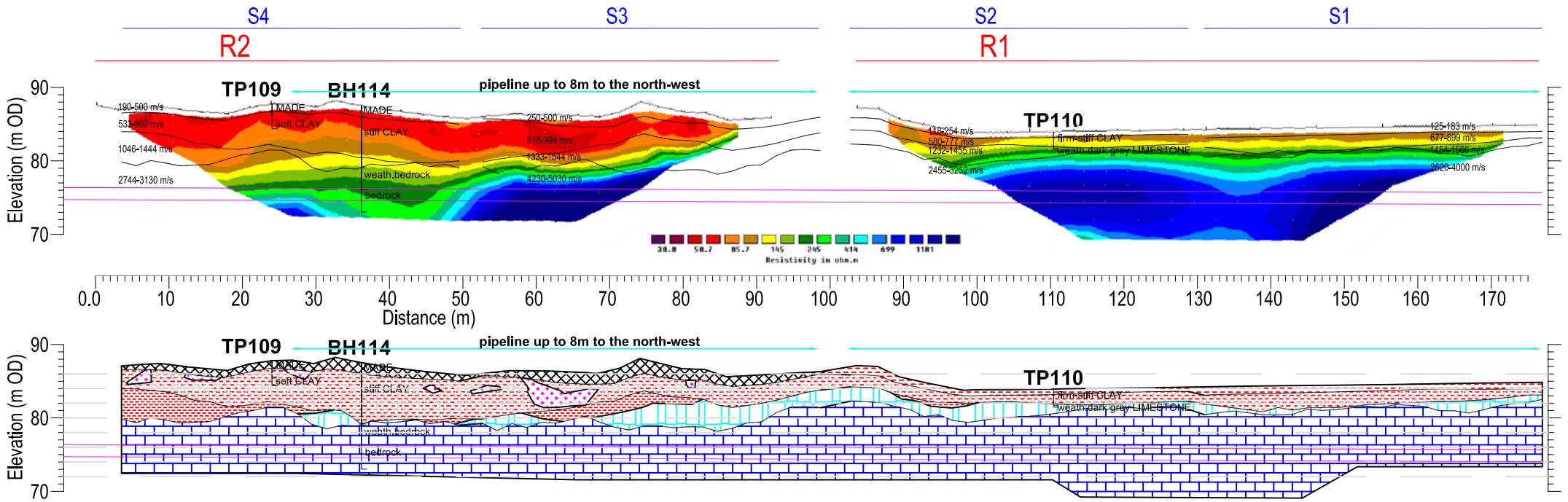
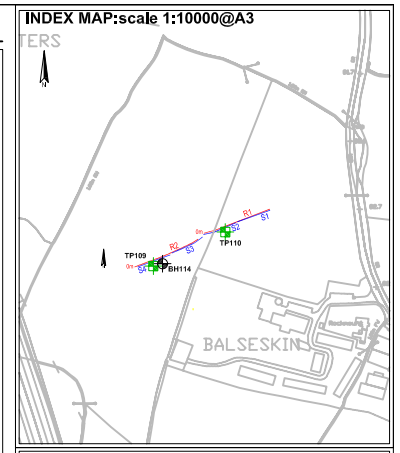


FIGURE 2: GEO-1 INTERPRETED SECTION



Note that the elevations for this section need to be checked against the project datum

INDEX MAP:scale 1:10000@A3



LEGEND:

- Made Ground
- Firm-Stiff SILT/CLAY
- Stiff-very Stiff SILT/CLAY
- Soft-Firm Sandy Gravelly CLAY
- Firm-Stiff Sandy Gravelly CLAY
- Stiff-very Stiff Sandy Gravelly CLAY
- Highly-Moderately Weathered Muddy LIMESTONE & SHALE
- Slightly Weathered-Fresh Muddy LIMESTONE & SHALE
- Proposed Pipeline Location
- Proposed Invert Level

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PROJECT:	GREATER DUBLIN REGIONAL DRAINAGE GEOPHYSICAL SURVEY
CLIENT.:	CAUSEWAY GEOTECH LTD.
DRAWING NO:	AGL15015_02 GEO-1 RESULTS
SCALE:	1:750 @ A3
DATE:	13.02.15

Version:	Date:	Drawn By:	Checked:
1	13.02.15	SOR	TL

FIGURE 1: GEO-2 LOCATION

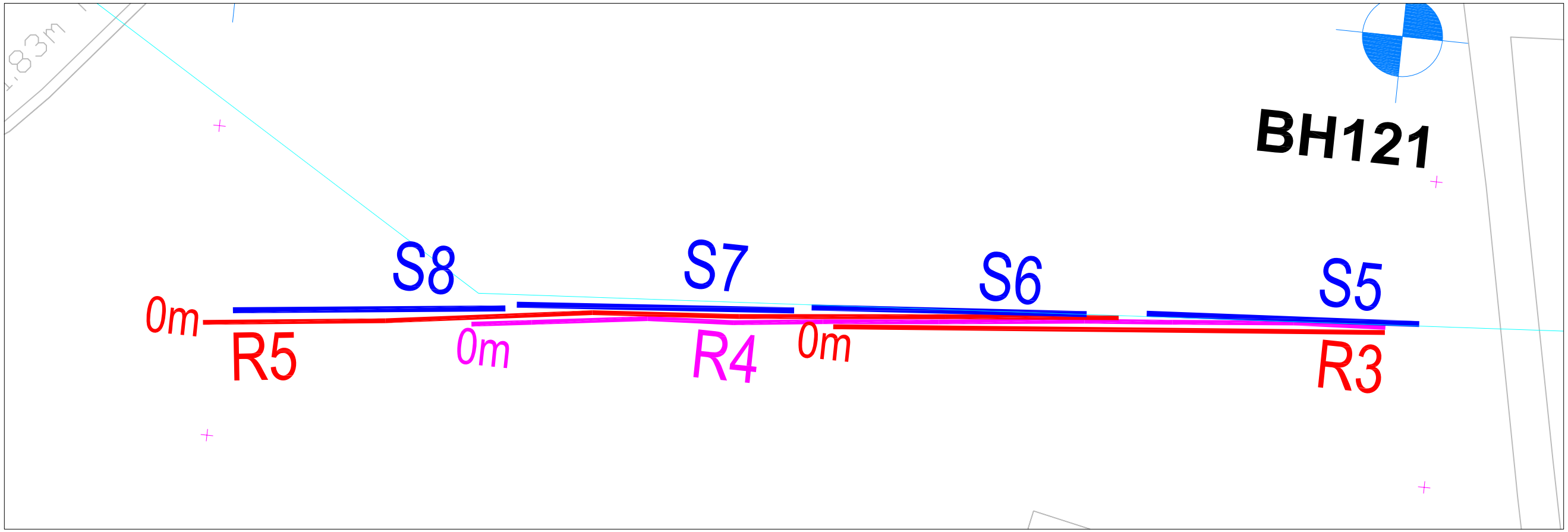
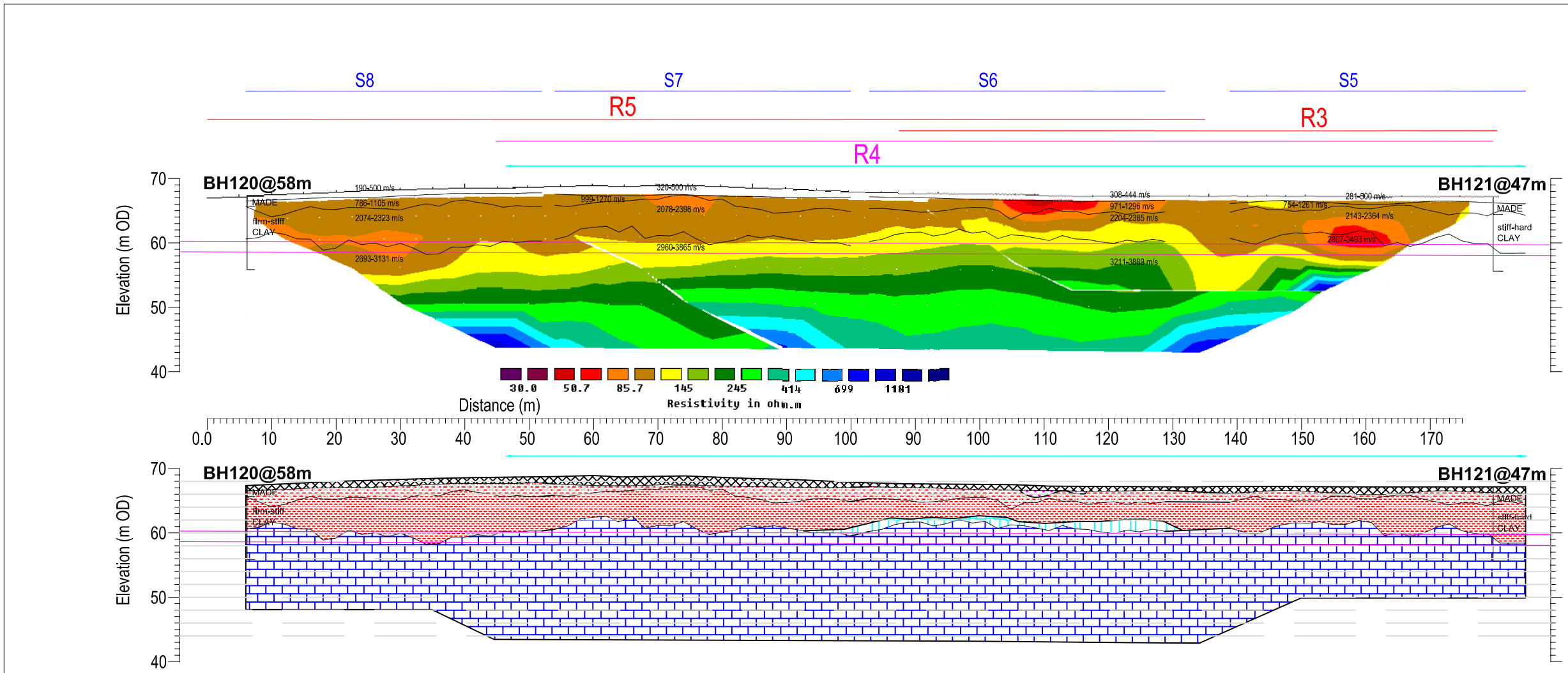
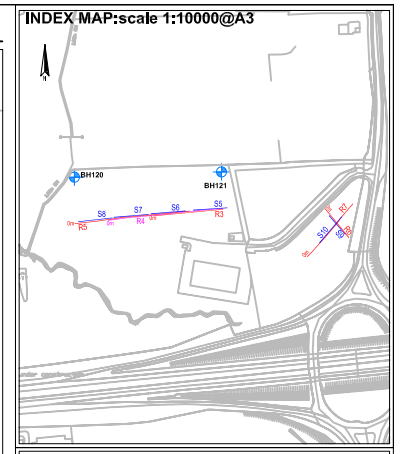


FIGURE 2: GEO-2 INTERPRETED SECTION



Note that the elevations for this section need to be checked against the project datum

INDEX MAP:scale 1:10000@A3



LEGEND:

- Made Ground
- Firm-Stiff SILT/CLAY
- Stiff-very Stiff SILT/CLAY
- Soft-Firm Sandy Gravelly CLAY
- Firm-Stiff Sandy Gravelly CLAY
- Stiff-very Stiff Sandy Gravelly CLAY
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- Proposed Pipeline Location
- Proposed Invert Level

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PROJECT:	GREATER DUBLIN REGIONAL DRAINAGE GEOPHYSICAL SURVEY
CLIENT.:	CAUSEWAY GEOTECH LTD.
DRAWING NO:	AGL15015_03 GEO-2 RESULTS
SCALE:	1:750 @ A3
DATE:	13.02.15

Version:	Date:	Drawn By:	Checked:
1	13.02.15	SOR	TL

FIGURE 1: GEO-3 LOCATION

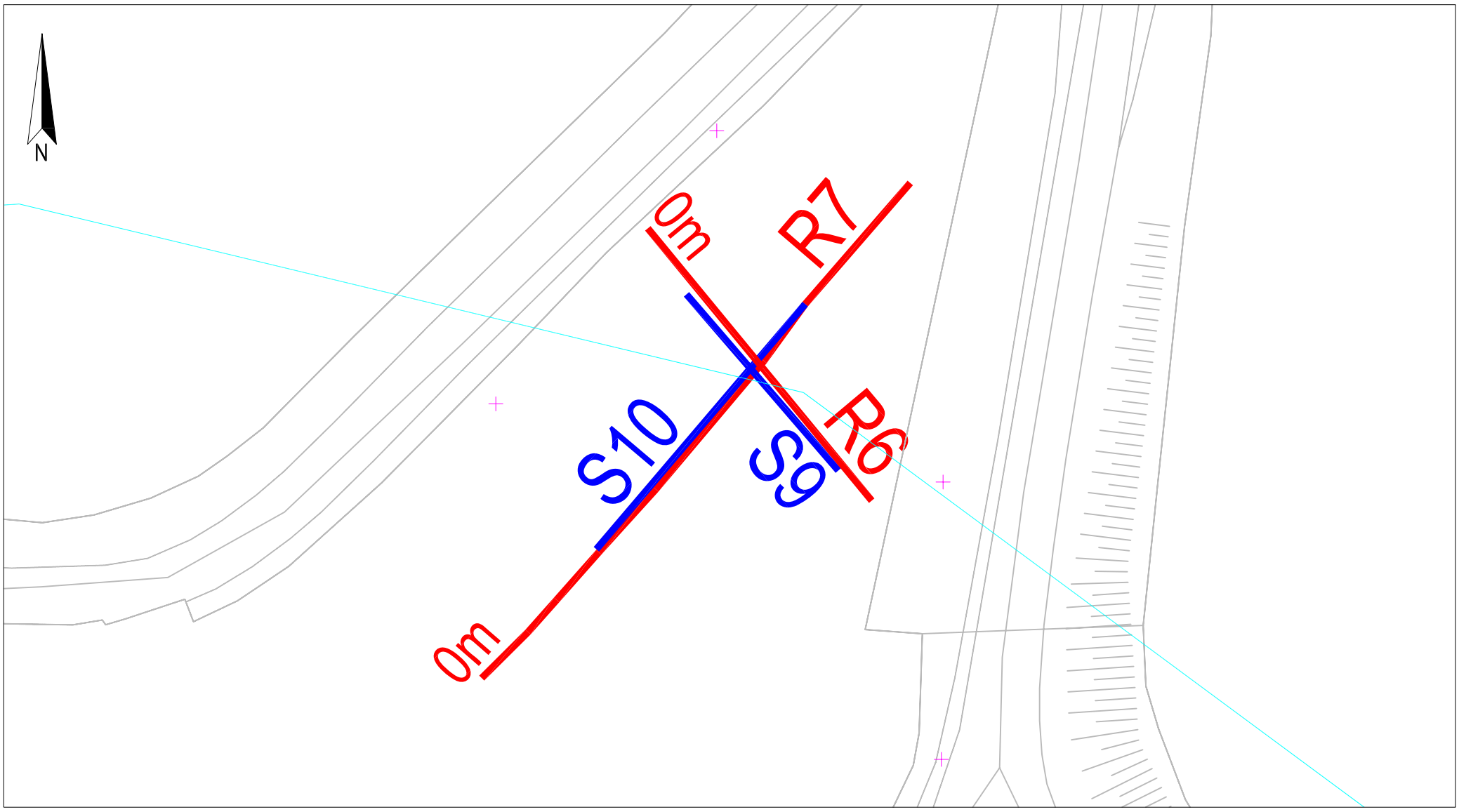
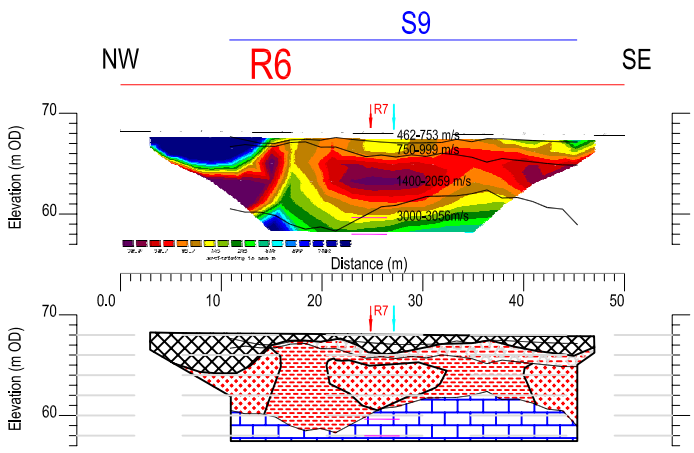
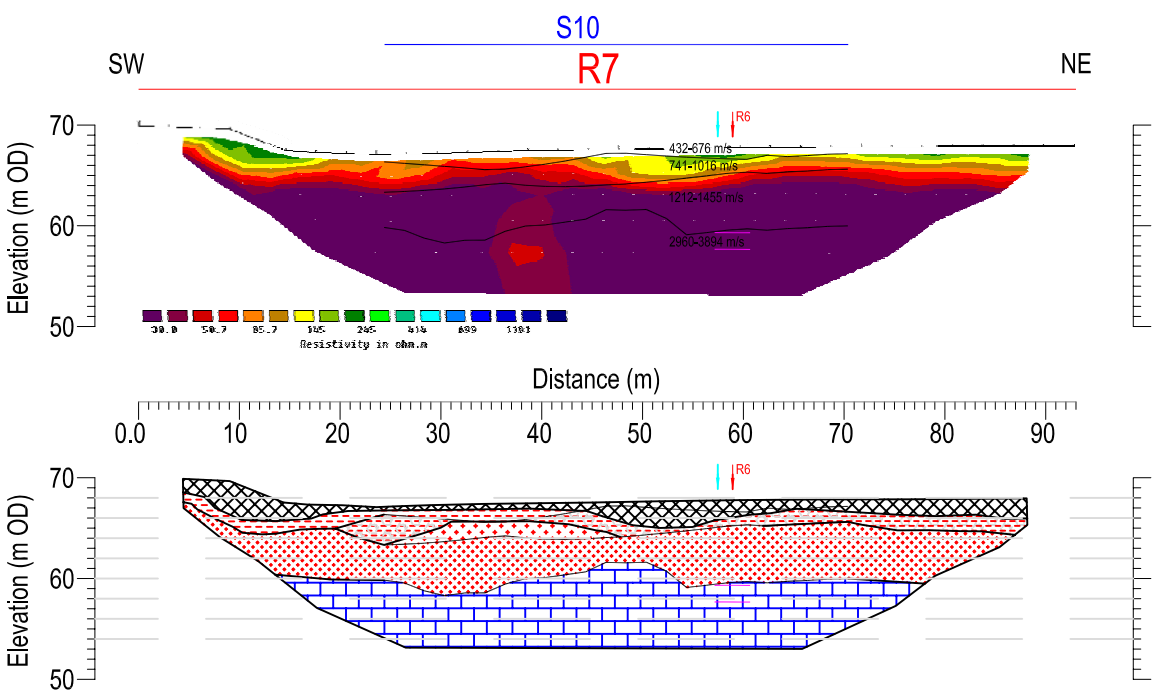


FIGURE 2: GEO-3 INTERPRETED SECTIONS





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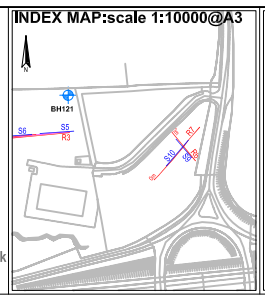
INDEX MAP:scale 1:10000@A3



LEGEND:

- Made Ground
- Firm-Stiff SILT/CLAY
- Stiff-very Stiff SILT/CLAY
- Soft-Firm Sandy Gravelly CLAY
- Firm-Stiff Sandy Gravelly CLAY
- Stiff-very Stiff Sandy Gravelly CLAY
- Highly-Moderately Weathered Muddy LIMESTONE & SHALE
- Slightly Weathered-Fresh Muddy LIMESTONE & SHALE
- Proposed Pipeline Location
- Proposed Invert Level

PROJECT:	GREATER DUBLIN REGIONAL DRAINAGE GEOPHYSICAL SURVEY
CLIENT.:	CAUSEWAY GEOTECH LTD.
DRAWING NO:	AGL15015_04 GEO-3 RESULTS
SCALE:	1:750 @ A3
DATE:	13.02.15

Version:	Date:	Drawn By:	Checked:
1	13.02.15	SOR	TL

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