Appendix E
Geotechnical Factual Report

Bus Connects Route 2 Swords to City Centre – Ground Investigation

Client:	National Transport Authority (NTA)
Client's Representative:	Jacobs
Report No.:	20-0399A
Date:	December 2021
Status:	Final for Issue

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Approved: ISO 9001 • ISO 14001 • OHSAS 18001

CONTENTS

APPENDICES

Document Control Sheet

Report No.:		20-0399A			
Project Title:		Bus Connects Route 2 Swords to City Centre			
Client:		National Transport Authority (NTA)			
Client's Representative:		Jacobs			
Revision:	A02	**Status:**	Final for Issue	**Issue Date:**	9th December 2021
Prepared by:		**Reviewed by:**		**Approved by:**	
 Stuart Abraham MEng MIEI		 Sean Ross BSc MSc MIEI		 Darren O'Mahony BSc MSc MIEI EurGeol PGeo	

The works were conducted in accordance with:

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

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

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

Laboratory testing was conducted in accordance with:

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

METHODS OF DESCRIBING SOILS AND ROCKS

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

Abbreviations used on exploratory hole logs	
U	Nominal 100mm diameter undisturbed open tube sample (thick walled sampler).
UT	Nominal 100mm diameter undisturbed open tube sample (thin walled sampler).
P	Nominal 100mm diameter undisturbed piston sample.
B	Bulk disturbed sample.
LB	Large bulk disturbed sample.
D	Small disturbed sample.
C	Core sub-sample (displayed in the Field Records column on the logs).
L	Liner sample from dynamic sampled borehole.
W	Water sample.
ES / EW	Soil sample for environmental testing / Water sample for environmental testing.
SPT (s)	Standard penetration test using a split spoon sampler (small disturbed sample obtained).
SPT (c)	Standard penetration test using 60 degree solid cone.
(x,x/x,x,x,x)	Blows per increment during the standard penetration test. The initial two values relate to the seating drive (150mm) and the remaining four to the 75mm increments of the test length.
(Y for Z/ Y for Z)	Incomplete standard penetration test where the full test length was not achieved. The blows 'X' represent the total blows for the given seating or test length 'Z' (mm).
N=X	SPT blow count 'N' given by the summation of the blows 'X' required to drive the full test length (300mm).
HVP / HVR	In situ hand vane test result (HVP) and vane test residual result (HVR). Results presented in kPa.
V VR	Shear vane test (borehole). Shear strength stated in kPa. V: undisturbed vane shear strength VR: remoulded vane shear strength
Soil consistency description	In cohesive soils, where samples are disturbed and there are no suitable laboratory tests, N values may be used to indicate consistency on borehole logs – a median relationship of Nx5=Cu is used (as set out in Stroud & Butler 1975).
dd-mm-yyyy	Date at the end and start of shifts, shown at the relevant borehole depth. Corresponding casing and water depths shown in the adjacent columns.
▽	Water strike: initial depth of strike.
▼	Water strike: depth water rose to.
Abbreviations relating to rock core – reference Clause 36.4.4 of BS 5930: 2015	
TCR (%)	Total Core Recovery: Ratio of rock/soil core recovered (both solid and non-intact) to the total length of core run.
SCR (%)	Solid Core Recovery: Ratio of solid core to the total length of core run. Solid core has a full diameter, uninterrupted by natural discontinuities, but not necessarily a full circumference and is measured along the core axis between natural fractures.
RQD (%)	Rock Quality Designation: Ratio of total length of solid core pieces greater than 100mm to the total length of core run.
FI	Fracture Index: Number of natural discontinuities per metre over an indicated length of core of similar intensity of fracturing.
NI	Non Intact: Used where the rock material was recovered fragmented, for example as fine to coarse gravel size particles.
AZCL	Assessed zone of core loss: The estimated depth range where core was not recovered.
DIF	Drilling induced fracture: A fracture of non-geological origin brought about by the rock coring.
(xxx/xxx/xxx)	Spacing between discontinuities (minimum/average/maximum) measured in millimetres.

Bus Connects Route 2 Swords to City Centre

1 AUTHORITY

On the instructions of Jacobs, ("the Client's Representative"), acting on the behalf of National Transport Authority (NTA) ("the Client"), a ground investigation was undertaken at the above location to provide geotechnical and environmental information to inform the planning stage design and enable the design of Bus Connects Core Bus Corridors.

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

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

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

2 SCOPE

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

3 DESCRIPTION OF SITE

As shown on the site location plan in Appendix A, the works were conducted on two sites on the N1 Swords Road in the Drumcondra region of north Dublin.

The northern site (716789,738253) is located at the junction of the N1 and Colins Avenue. The site consists of an area of disused ground, it is bound to the north by Colins Avenue and on the west by Swords Road. Whitehall GAA club is to the east and hospital and care home facilities to the south. The surrounding area is in residential use. The M50 Port Tunnel runs beneath the site.

The southern site (716090,736734) is located at the junction of the N1 with Millmount Avenue on the banks of the Tolka River. The site consists of a small area of parkland with mature trees, laid in grass. The site is surrounded by land in residential or light commercial use.

4 SITE OPERATIONS

4.1 Summary of site works

Site operations, which were conducted between 22nd September and 28th October 2020, comprised:

- one light cable percussion borehole with rotary follow on
- two machine dug trial pits
- three slit trenches

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

4.2 Boreholes

One borehole (R2-CPRC02) was put down by a combination of light cable percussion boring and rotary follow-on drilling techniques with core recovery in bedrock. 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, with SPTs carried out at standard intervals as required. A further borehole (R2-CPRC01) was attempted twice however it met concrete obstructions at shallow depth and could not be progressed.

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

Standard penetration tests were carried out in accordance with BS EN 22476-3:2005+A1:2011 at standard depth intervals throughout the overburden using the split spoon sampler ($SPT_{(s)}$) or solid cone attachment ($SPT_{(c)}$). The penetrations are stated for those tests for which the full 150mm seating drive or 300mm test drive was not possible. The N-values provided on the borehole logs are uncorrected and no allowance has been made for energy ratio corrections. The SPT hammer energy measurement report is provided in

Appendix J.

Where coring was carried out within bedrock strata, Geobor S Coring was used. The core was extracted in up to 1.5m lengths using a SK6L core barrel, which produced core of nominal 102mm diameter, and was placed in single channel wooden core boxes.

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: 2015: Code of practice for ground investigations*.

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

4.3 Standpipe installations

A groundwater monitoring standpipe was installed in borehole R2-CPRC02

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

4.4 Trial Pits

Two trial pits (R2-TP01 & R2-TP02) were excavated using a 3t tracked excavator fitted with a 600mm wide bucket, to depths of 1.05-2.10m.

Environmental samples were taken at depths of 0.5m & 1.0m in each trial pit.

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

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

4.5 Slit trenches

Three slit trenches (R2-SLT01. R2-SLT01A & R2-SLT02) were excavated by a combination of hand digging and mechanical excavation using a compact 3t tracked excavator fitted with a 300mm wide toothless bucket, to locate and identify buried services at the site.

Drawing of the trenches and the locations of services encountered during excavation are shown along with the slit trench logs in Appendix F, with photographs presented in Appendix G.

4.6 Surveying

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

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

4.7 Groundwater monitoring

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

The monitoring records are presented in Section 6.3.

5 LABORATORY WORK

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

5.1 Geotechnical laboratory testing of soils

Laboratory testing of soils comprised:

- **soil classification:** moisture content measurement, Atterberg Limit tests and particle size distribution analysis.
- **shear strength** (total stress): unconsolidated undrained triaxial tests
- **soil chemistry:** BRE Suite A

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

The test results are presented in Appendix H.

5.2 Geotechnical laboratory testing of rock

Laboratory testing of rock sub-samples comprised:

- point load index
- unconfined compressive strength (UCS) tests

Test	Test carried out in accordance with
Point load index	ISRM Suggested Methods (1985) Suggested method for determining point-load strength. Int. J. Rock Mech. Min. Sci. Geomech. Abstr. 22, pp. 53–60
Uniaxial compression strength tests	ISRM Suggested Methods (1981) Suggested method for determining deformability of rock materials in uniaxial compression, Part 2 and ISRM (2007) Ulusay R, Hudson JA (eds) The complete ISRM suggested methods for rock characterization, testing and monitoring, 2007

The test results are presented in Appendix H.

5.3 Environmental laboratory testing of soils

Environmental testing, as specified by the Client's Representative was conducted on selected environmental soil and water samples by Chemtest at its laboratory in Newmarket, Suffolk.

Testing was carried out on a number of samples according to Engineer's Ireland Suite E and Suite H including testing for a range of determinants:

- Metals
- Speciated total petroleum hydrocarbons (TPH)
- Speciated polycyclic aromatic hydrocarbons (PAH)
- Cyanides
- Asbestos screen
- pH
- Waste acceptance criteria (WAC) testing.

Groundwater testing was carried out on a number of samples according to Engineer's Ireland Suite F and additional testing which included testing for a range of determinants:

- Metals
- Speciated total petroleum hydrocarbons (TPH)
- Speciated polycyclic aromatic hydrocarbons (PAH)
- pH

Results of environmental laboratory testing are presented in Appendix I.

6 GROUND CONDITIONS

6.1 General geology of the area

Published geological mapping indicate the superficial deposits underlying the northern section of the site (716789,738253) comprise Glacial Till derived of limestones deposits at the southern section of the site (716090,736734) comprise Alluvium. These deposits are underlain by dark limestone and shale of the Lucan Formation.

6.2 Ground types encountered during investigation of the site

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

- **Topsoil:** encountered typically in 100mm thickness in borehole R2-CPRC02 and slit trenches R2-SLT01 & R2-SLT01A.
- **Made Ground (fill):** typically reworked sandy gravelly cohesive fill with fragments of concrete and brick extending to a maximum depth of 3.5m.
- **Glacial Till:** sandy gravelly clay, typically stiff, becoming very stiff with increasing depth was encountered at 1.20m on R2-TP02 and at depth ranging 3.50m – 13.05m within R2-CPRC02.
- **Bedrock (Limestone):** Rockhead was encountered at depth 13.05mbgl in R2-CPRC02 extending to its base at 20.00m

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.

Groundwater was encountered during percussion boring through soil as water strikes at 3.3m & 5.0m in borehole R2-CPRC02.

It should be noted that the casing used in supporting the borehole walls during drilling may have sealed out additional groundwater strikes and the possibility of encountering groundwater at other depths during excavation works should not be ruled out.

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

Groundwater was not noted during excavation of any of the trial pits or slit trenches.

Subsequent groundwater monitoring of the standpipe installation recorded water levels as shown in Table 1.

Table 1: Groundwater monitoring

Date	Water level (mbgl)
	R2-CPRC02
19/11/2020	2.93
19/01/2021	2.61
12/02/2021	2.72
23/04/2021	2.88
02/06/2021	2.83
22/06/2021	2.96
16/07/2021	2.81
20/08/2021	2.81
24/09/2021	2.78

Continued monitoring of the installed standpipe will give an indication of the seasonal variation in groundwater level which should be factored into design considerations.

7 REFERENCES

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

IS EN 1997-2: 2007: Eurocode 7 - Geotechnical design - Part 2 Ground investigation and testing. National Standards Authority of Ireland.

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

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

BS EN ISO 14688-2:2018: Geotechnical investigation and testing. Identification and classification of soil. Part 2 Principles for a classification.

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

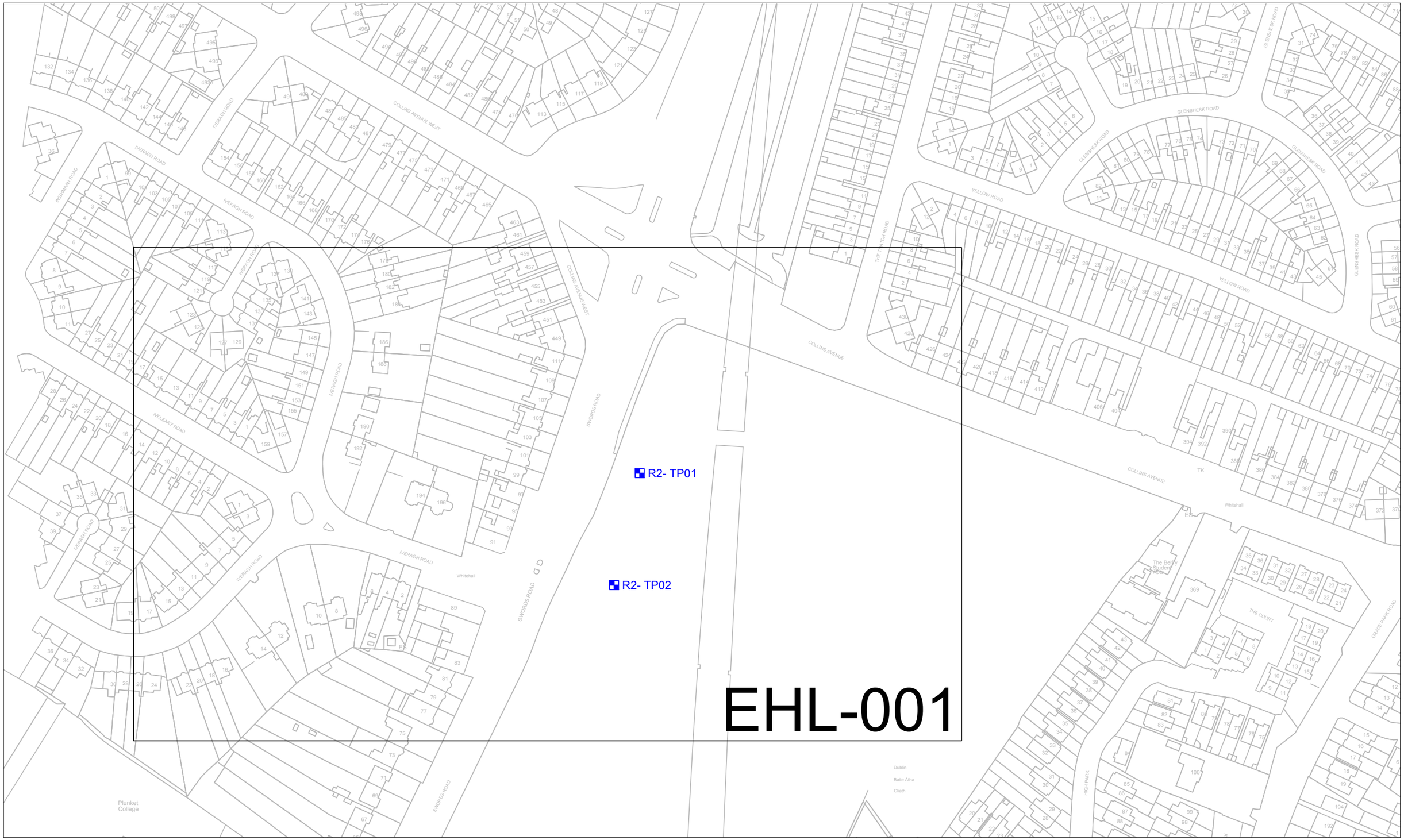
BS EN ISO 14689-1:2018: Geotechnical investigation and testing. Identification and classification of rock. Identification and description.

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

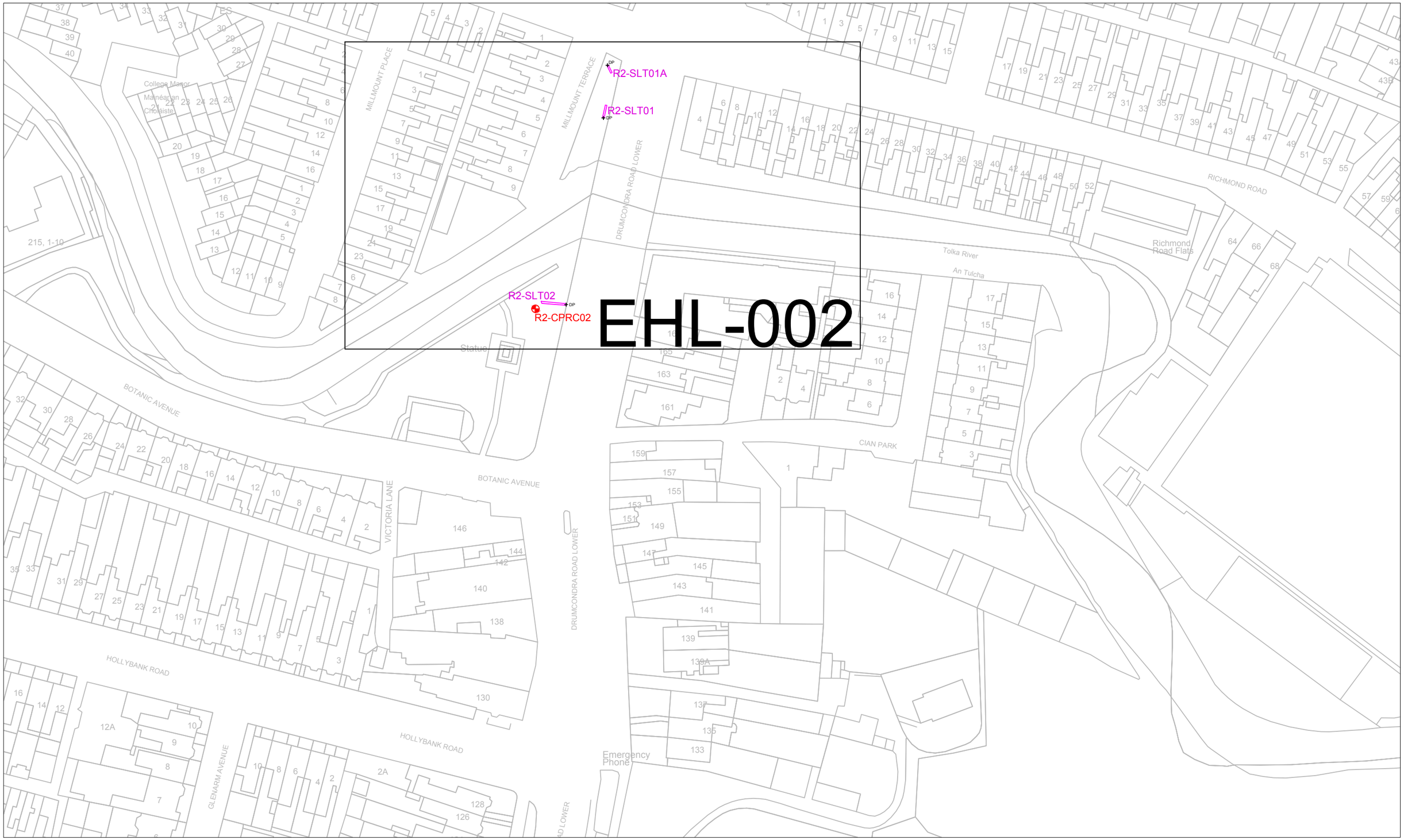
CAUSEWAY GEOTECH

APPENDIX A

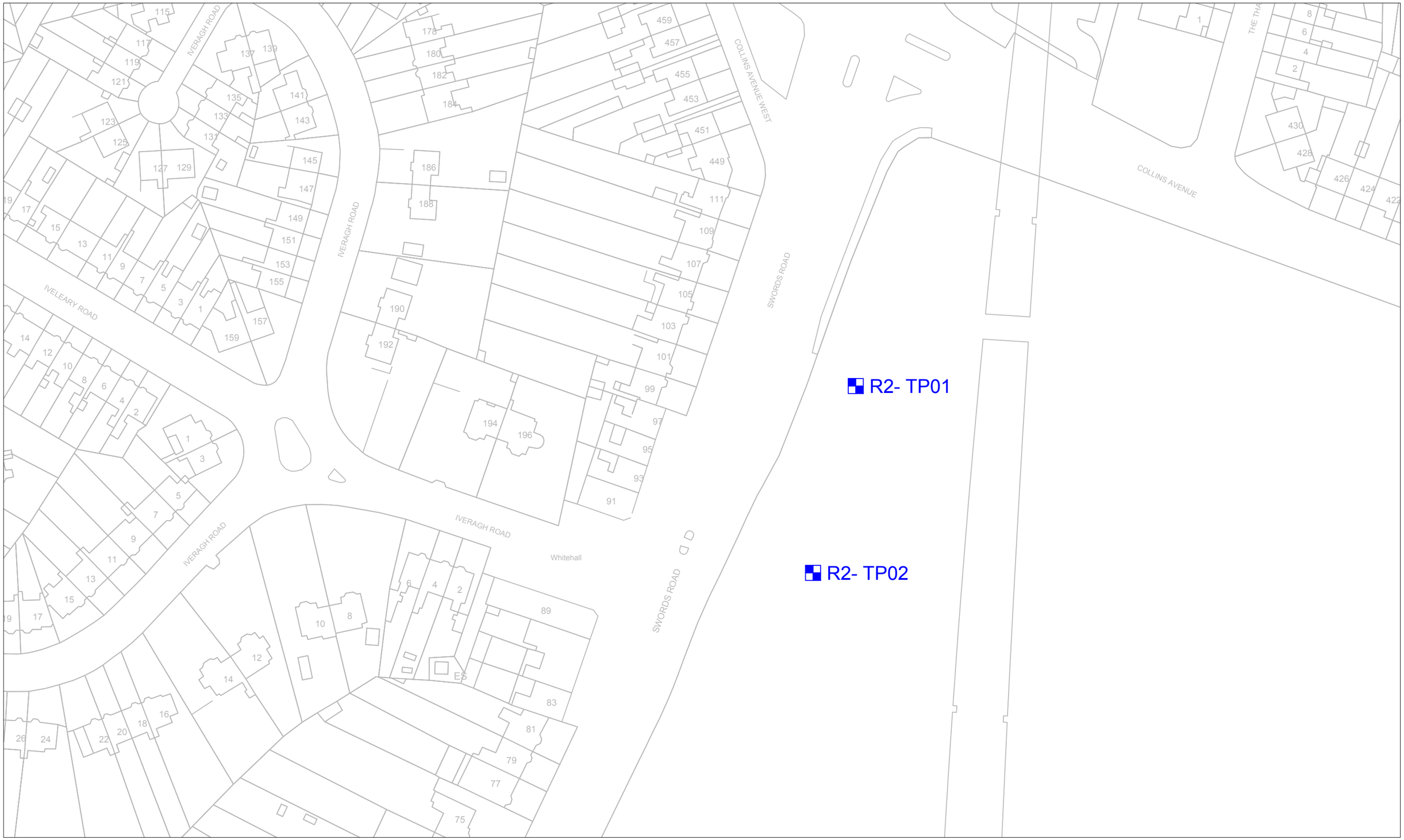
EXPLORATORY HOLE LOCATION PLAN



PROJECT: Bus Connects Route 2 Swords to City Centre		TITLE: Exploratory hole location plan (Overview)			
CLIENT: National Transport Authority (NTA)	KEY: Borehole; Trial Pits; Slit Trench	CAUSEWAY GEOTECH	SCALE: NTS@A3	DATE: 17/11/2020	
ENGINEER: Jacobs			DRWN: BS CHCK: CH	SERIES: 1 of 2	DWG No: 20-0399A-EHL-OW-001



PROJECT: Bus Connects Route 2 Swords to City Centre		TITLE: Exploratory hole location plan (Overview)			
CLIENT: National Transport Authority (NTA)	KEY: Borehole; Trial Pits; Slit Trench	CAUSEWAY GEOTECH	SCALE: NTS@A3	DATE: 17/11/2020	
ENGINEER: Jacobs			DRWN: BS CHCK: CH	SERIES: 2 of 2	DWG No: 20-0399A-EHL-OW-002



PROJECT: Bus Connects Route 2 Swords to City Centre

TITLE: Exploratory hole location plan

CLIENT: National Transport Authority (NTA)

ENGINEER: Jacobs

KEY:
- Borehole
- Trial Pits
- Slit Trench

CAUSEWAY GEOTECH

SCALE: NTS@A3

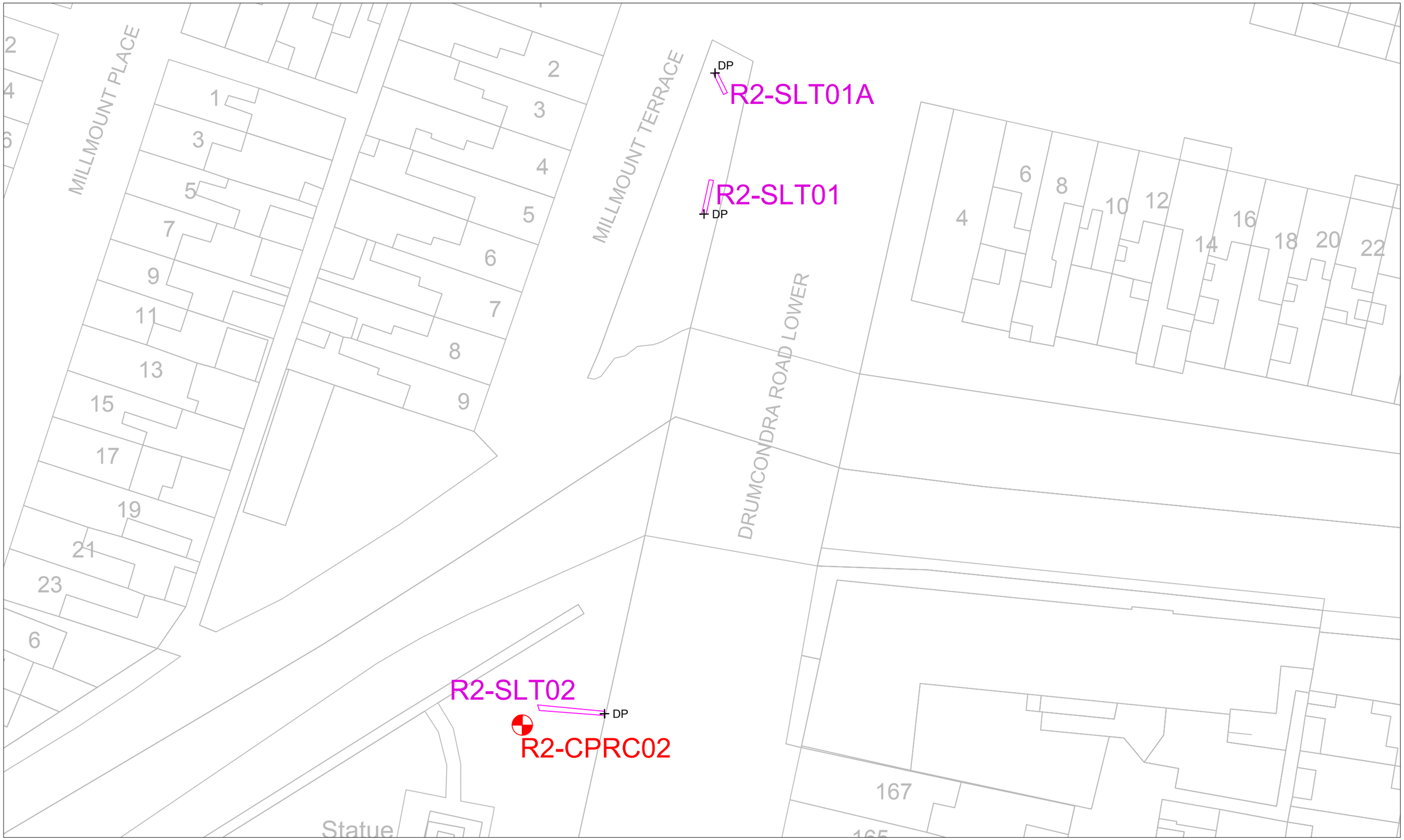
DATE: 17/11/2020

DRWN: BS

CHCK: CH

SERIES: 1 of 2

DWG No: 20-0399A-EHL-001



PROJECT: Bus Connects Route 2 Swords to City Centre		TITLE: Exploratory hole location plan			
CLIENT: National Transport Authority (NTA)	KEY: Borehole; Trial Pits; Slit Trench	CAUSEWAY GEOTECH	SCALE: NTS@A3	DATE: 17/11/2020	
ENGINEER: Jacobs			DRWN: BS; CHCK: CH	SERIES: 2 of 2	DWG No: 20-0399A-EHL-002

CAUSEWAY GEOTECH

APPENDIX B

BOREHOLE LOGS

CAUSEWAY GEOTECH

Project No.	Project Name:	Borehole ID
20-0399A	Bus Connects Route 2 Swords to City Centre	R2-CPRC02
	Client: National Transport Authority (NTA)	
	Client's Rep: Jacobs	

Method	Plant Used	Top (m)	Base (m)	Coordinates
Cable Percussion	Dando 2000	0.00	6.00	
Rotary Drilling	Beretta T44	6.00	6.50	716090.75 E
Rotary Coring	Beretta T44	6.50	20.00	736734.13 N

Final Depth:	20.00 m	Start Date:	26/10/2020	Driller:	BM+GT	Sheet 1 of 3
Elevation:	7.48 mOD	End Date:	28/10/2020	Logger:	GH+NP	Scale: 1:50
						FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description
					7.38	0.10		TOPSOIL
0.50	B1							MADE GROUND: Firm brown to brownish black slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.
0.50	ES2							
1.00	B4							
1.00	ES							
1.00	ES5							
1.20	D3							
1.20 - 1.65	SPT (S)	N=13 (3,4/3,3,3,4) Hammer SN = 0643	1.00	Dry				
2.00	B6							
2.00	D8							
2.00	ES7							
2.00 - 2.45	SPT (S)	N=14 (5,5/4,3,3,4) Hammer SN = 0643	1.50	Dry				
3.00	B9							
3.00	D11							
3.00	ES							
3.00	ES10							
3.00 - 3.45	SPT (S)	N=9 (2,3/2,2,2,3) Hammer SN = 0643 Strike at 3.30m	3.00	Dry	3.98	3.50		Firm brown slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.
4.00	B12				3.48	4.00		Very stiff brown slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.
4.00	D13							
4.00	ES14							
4.00 - 4.45	SPT (S)	N=30 (10,12/10,8,6,6) Hammer SN = 0643	4.00	Dry				
5.00	B16							
5.00	ES17							
5.00 - 5.45	U19	Ublow=50 100% Strike at 5.00m	4.50	Dry				
5.50	D15							
6.00	B18				1.48	6.00		Very stiff grey sandy gravelly CLAY. (Driller's description)
6.00 - 6.45	SPT (S)	N=47 (6,7/9,9,12,17) Hammer SN = 0643	4.50	Dry				
6.50	C15	100 NI			0.98	6.50		Very stiff greyish brown becoming grey slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to coarse of mixed lithologies including sandstone and limestone.
8.00			6.50			(4.00)		
8.00	C15							
8.00 - 8.29	SPT(S) N=50 (14,20/50 for 140mm) Hammer SN = 0209	97						

TCR | SCR | RQD | FI

Water | Backfill

Water Strikes			
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
3.30		20	3.20
5.00			

Casing Details	
To (m)	Diam (mm)
6.50	200

Water Added	
From (m)	To (m)

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

Remarks

Hand dug inspection pit excavated to 1.20m.

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth.	17/12/2020

AGS

CAUSEWAY GEOTECH

Project No.	Project Name:	Borehole ID
20-0399A	Bus Connects Route 2 Swords to City Centre	R2-CPRC02
	Client: National Transport Authority (NTA)	
	Client's Rep: Jacobs	

Method	Plant Used	Top (m)	Base (m)
Cable Percussion	Dando 2000	0.00	6.00
Rotary Drilling	Beretta T44	6.00	6.50
Rotary Coring	Beretta T44	6.50	20.00

Coordinates: 716090.75 E, 736734.13 N

Final Depth:	20.00 m	Start Date:	26/10/2020	Driller:	BM+GT	Sheet 2 of 3
Elevation:	7.48 mOD	End Date:	28/10/2020	Logger:	GH+NP	Scale: 1:50
						FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
9.50						6.50							
9.50	C15										Very stiff greyish brown becoming grey slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to coarse of mixed lithologies including sandstone and limestone.		
9.50 - 9.67	SPT(S) N=50 (42 for 140mm/50 for 30mm) Hammer SN = 209	100											
								-3.02	10.50				
11.00						6.50					Very stiff grey slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to coarse of various lithologies including sandstone and limestone.		
11.00	C												
11.00 - 11.27	SPT(S) N=50 (14,20/50 for 120mm) Hammer SN = 0209	100			NI				(2.00)				
12.50						6.50		-5.02	12.50				
12.50	C15										Very stiff grey sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to coarse of limestone.		
12.50 - 12.85	SPT(S) N=50 (18,20/50 for 200mm) Hammer SN = 0209	100	63	8	NI				(0.55)				
								-5.57	13.05		Medium strong thinly bedded dark grey LIMESTONE with widely spaced beds of weak dark grey MUDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing with dark grey clay deposits. Discontinuities; 1. 5 to 15 degree bedding fractures, closely spaced (15/70/240), planar and slightly undulating, smooth with grey clay deposits on fracture surfaces. 2. At 13.25m to 13.75m, 13.50m to 14.25m and 14.65m to 14.80m: 70 to 90 degree joints, undulating, smooth with grey clay deposits on joint surfaces.		
14.00					14	6.50			(1.85)				
14.00 - 14.20	SPT(S) N=50 (25 for 40mm/50 for 160mm) Hammer SN = 0209	100	100	43									
14.90	C							-7.42	14.90		Medium strong (locally weak) medium bedded dark grey LIMESTONE with widely spaced beds of weak dark grey MUDSTONE. Partially weathered: slightly reduced strength, slightly closer fracture spacing with dark grey clay deposits. Discontinuities: 1. 5 to 15 degree bedding fractures, closely spaced (15/135/775), planar and slightly undulating, smooth with patchy grey clay deposits on fracture surfaces. 2. At 16.20m to 16.40m: 80 to 90 degree joint, undulating, smooth with grey clay deposits on joint surface. *15.55m to 15.90m: 85 to 90 degree incipient joint, undulating.*		
15.40	C												
15.50		100	100	75									
16.55 - 16.80	C				6				(5.10)				
17.00													
17.10	C	100	100	75									
18.20	C												
18.50													
		TCR	SCR	RQD	FI								

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
3.30		20	3.20
5.00			

Casing Details

To (m)	Diam (mm)
6.50	200

Water Added

From (m)	To (m)

Chiselling Details

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

Remarks

Hand dug inspection pit excavated to 1.20m.

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth.	17/12/2020

AGS

CAUSEWAY GEOTECH

Project No.	Project Name:	Borehole ID
20-0399A	Bus Connects Route 2 Swords to City Centre	R2-CPRC02
	Client: National Transport Authority (NTA)	
	Client's Rep: Jacobs	

Method	Plant Used	Top (m)	Base (m)
Cable Percussion	Dando 2000	0.00	6.00
Rotary Drilling	Beretta T44	6.00	6.50
Rotary Coring	Beretta T44	6.50	20.00

Coordinates: 716090.75 E, 736734.13 N

Final Depth: 20.00 m | Start Date: 26/10/2020 | Driller: BM+GT

Elevation: 7.48 mOD | End Date: 28/10/2020 | Logger: GH+NP

Sheet 3 of 3 | Scale: 1:50 | FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
19.10 - 19.85	C	100	100	74							Medium strong (locally weak) medium bedded dark grey LIMESTONE with widely spaced beds of weak dark grey MUDSTONE. Partially weathered: slightly reduced strength, slightly closer fracture spacing with dark grey clay deposits. Discontinuities: 1. 5 to 15 degree bedding fractures, closely spaced (15/135/775), planar and slightly undulating, smooth with patchy grey clay deposits on fracture surfaces. 2. At 16.20m to 16.40m: 80 to 90 degree joint, undulating, smooth with grey clay deposits on joint surface.		
20.00								-12.52	20.00		End of Borehole at 20.00m		

TCR	SCR	RQD	FI

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
3.30		20	3.20
5.00			

Casing Details

To (m)	Diam (mm)
6.50	200

Water Added

From (m)	To (m)

Chiselling Details

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

Remarks

Hand dug inspection pit excavated to 1.20m.

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth.	17/12/2020

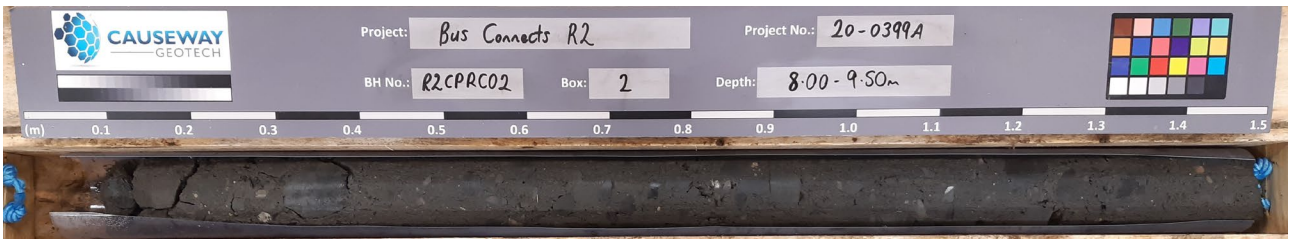
AGS

CAUSEWAY GEOTECH

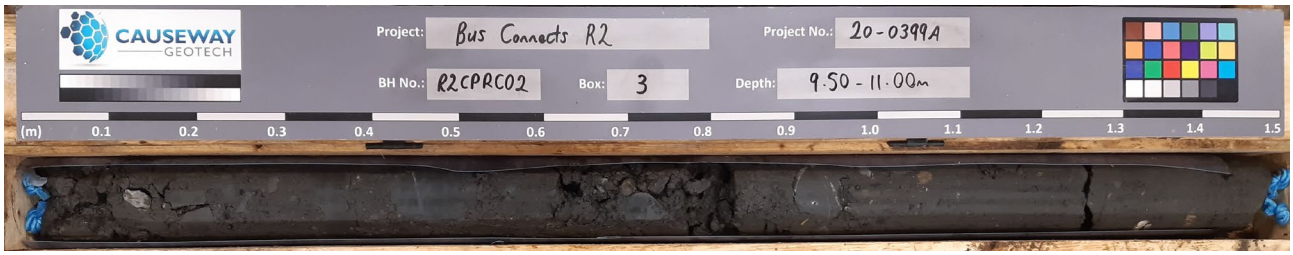
APPENDIX C

CORE PHOTOGRAPHS

R2-CPRC02 Box 1 6.50-8.00m

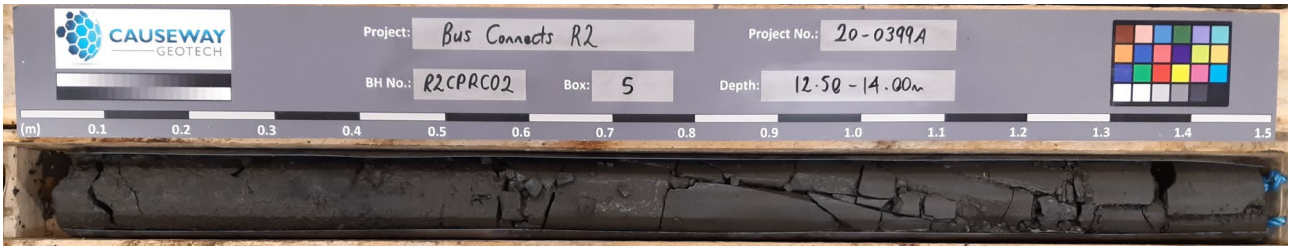


R2-CPRC02 Box 2 8.00-9.50m

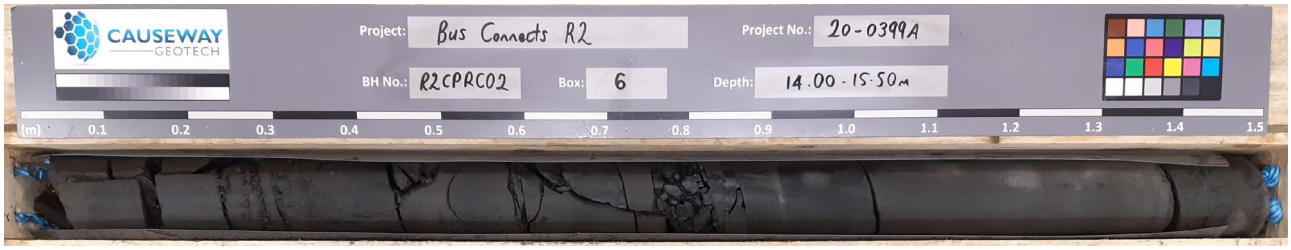


R2-CPRC02 Box 3 9.50-11.00m

R2-CPRC02 Box 4 11.00-12.50m

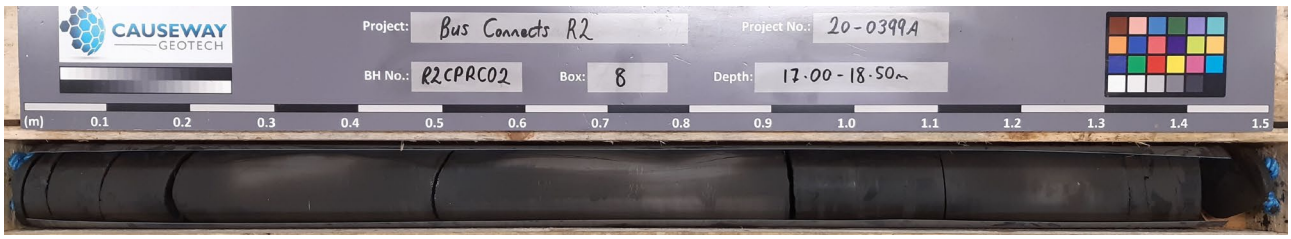


R2-CPRC02 Box 5 12.50-14.00m

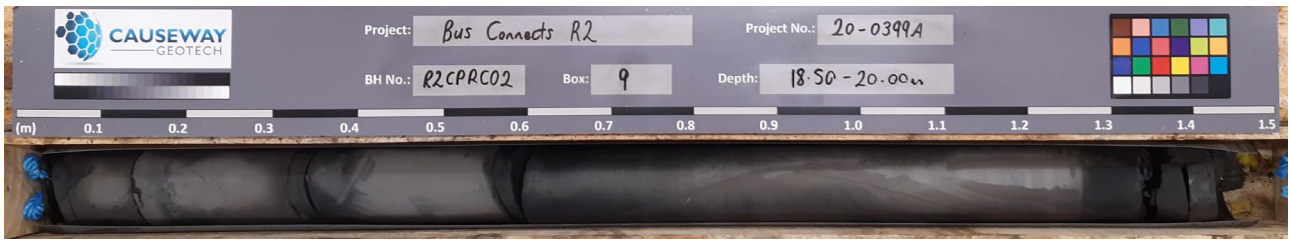


R2-CPRC02 Box 6 14.00-15.50m

R2-CPRC02 Box 7 15.50-17.00m



R2-CPRC02 Box 8 17.00-18.50m



R2-CPRC02 Box 9 18.50-20.00m

CAUSEWAY GEOTECH

APPENDIX D

TRIAL PIT LOGS

CAUSEWAY GEOTECH

Project No. 20-0399A	**Project Name:** Bus Connects Route 2 Swords to City Centre		**Trial Pit ID** R2-TP01
Coordinates 716787.57 E 738253.75 N	**Client:** National Transport Authority (NTA)		
Method: Trial Pitting	**Client's Representative:** Jacobs		Sheet 1 of 1 Scale: 1:25
Plant: 3T Tracked Excavator	**Elevation** 43.99 mOD	**Date:** 22/09/2020	**Logger:** RS	FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
0.50	ES					MADE GROUND: Stiff brown slightly sandy gravelly CLAY with coarse gravel sized pieces of wood. Sand is fine to coarse. Gravel is subangular fine to coarse of mixed lithologies.	
0.50	ES1						
0.50		HVP=112, HVR=26					
0.50		HVP=124, HVR=55					
0.50		HVP=130, HVR=14	43.19	0.80			
0.50		HVP=157, HVR=15				MADE GROUND: Dark grey very sandy silty subangular fine to coarse GRAVEL of limestone with low cobble content. Sand is fine to coarse. (Diesel odour present)	
1.00	B3						
1.00	ES		42.94	1.05		End of trial pit at 1.05m	
1.00	ES2						

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

Water Strikes	
Struck at (m)	Remarks

Depth: 1.05
Width: 0.60
Length: 2.50

Remarks: No groundwater encountered.

Stability: Stable

Termination Reason: Terminated on concrete.

Last Updated 17/12/2020

AGS

CAUSEWAY GEOTECH

Project No. 20-0399A	**Project Name:** Bus Connects Route 2 Swords to City Centre		**Trial Pit ID** R2-TP02
Coordinates 716775.70 E 738201.89 N	**Client:** National Transport Authority (NTA)		
Method: Trial Pitting	**Client's Representative:** Jacobs		Sheet 1 of 1 Scale: 1:25
Plant: 3T Tracked Excavator	**Elevation** 43.51 mOD	**Date:** 22/09/2020	**Logger:** RS	FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
0.50	B2					MADE GROUND: Very stiff brown slightly sandy slightly gravelly CLAY with cobble sized pieces of red brick. Sand is fine to coarse. Gravel is subangular fine to coarse of mixed lithologies.	
0.50	ES						
0.50	ES1						
0.50		HVP=201, HVR=26					
0.50		HVP=201, HVR=32					
0.50		HVP=201, HVR=46					
			42.60	0.90			
1.00	B4					MADE GROUND: Brownish grey very sandy very silty fine to coarse GRAVEL of mixed lithologies with cobble sized pieces of concrete and brick. Sand is fine to coarse.	
1.00	ES3						
			42.30	1.20			
						Very stiff dark grey slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to medium of mixed lithologies predominantly limestone.	
2.00	B5						
			41.40	2.10		End of trial pit at 2.10m	

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

Water Strikes	
Struck at (m)	Remarks

Depth: 2.10
Width: 0.60
Length: 2.00

Remarks: No groundwater encountered.

Stability: Stable

Termination Reason: Terminated on refusal.

Last Updated 17/12/2020

AGS

CAUSEWAY GEOTECH

APPENDIX E

TRIAL PIT PHOTOGRAPHS


CAUSEWAY
GEOTECH
Project Name
Bus Connects
Project Number
20-0399A
Date
22/09/2020
Exploration Number
TP01
0.2
0.3
0.4
0.5

R2-TP01

R2-TP01

R2-TP01

R2-TP01

R2-TP01

R2-TP02


CAUSEWAY
GEOTECH
Project Name
Bus Connects
Project Number
20-0399A
Date
22/09/2020
Exploration Number
R2 TP02

R2-TP02

R2-TP02

R2-TP02

CAUSEWAY GEOTECH

APPENDIX F

SLIT TRENCH LOGS & SKETCHES

CAUSEWAY GEOTECH

Project No.	Project Name:	Trial Pit ID
20-0399A	Bus Connects Route 2 Swords to City Centre	R2-SLT01
Coordinates 716110.92 E 736790.80 N	**Client:** National Transport Authority (NTA)	
Method: Slit Trenching	**Client's Representative:** Jacobs	Sheet 1 of 1 Scale: 1:25
Plant: 3T Tracked Excavator	**Elevation** 7.63 mOD / **Date:** 15/10/2020 / **Logger:** GH	FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
			7.52	0.10		TOPSOIL	
0.50 0.50	B3 ES1					MADE GROUND: Firm greyish brown slightly sandy gravelly CLAY with medium cobble and low boulder content, fragments of glass, plastic, concrete and red brick. Sand is fine to coarse. Gravel is subangular fine to coarse of mixed lithologies. Cobbles and boulders are angular of mixed lithologies.	
1.00 1.00	B4 ES2						
			5.52	2.10		MADE GROUND: Firm brown slightly sandy slightly gravelly CLAY with medium cobble content. Sand is fine to coarse. Gravel is subangular fine to coarse of mixed lithologies. Cobbles are rounded of mixed lithologies.	
			4.92	2.70		MADE GROUND: Firm mottled brown and black slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Grave is subangular fine to coarse of mixed lithologies. Cobbles are angular of mixed lithologies.	
			4.53	3.10		End of trial pit at 3.10m	

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

Water Strikes	
Struck at (m)	Remarks

Depth: 3.10
Width: 0.55
Length: 3.75

Remarks:
No groundwater encountered.

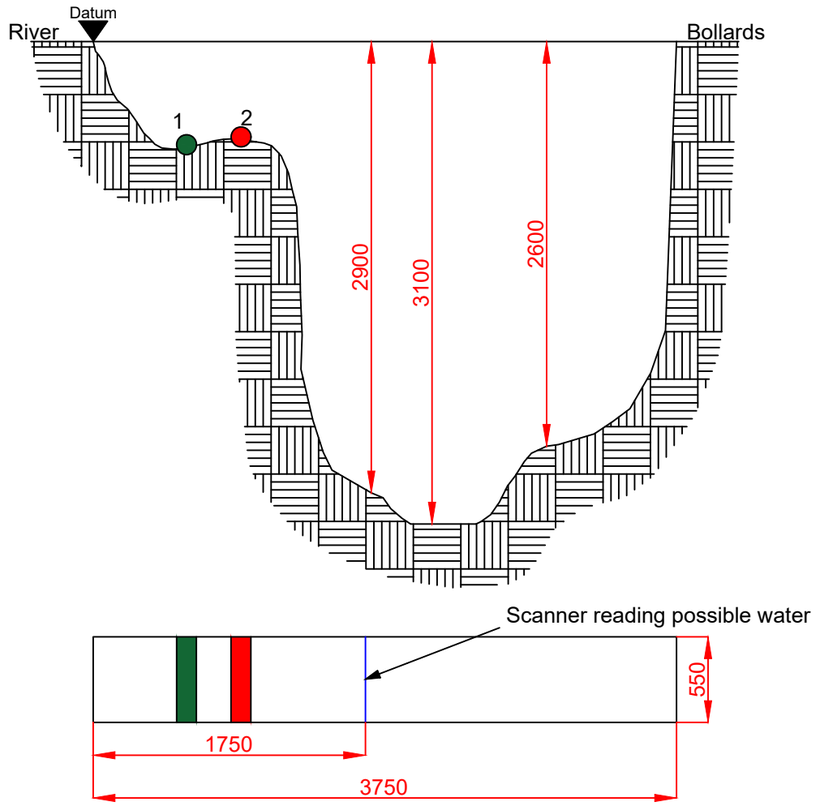
Stability:	Termination Reason:	Last Updated
Stable	Terminated at scheduled depth.	17/12/2020

AGS

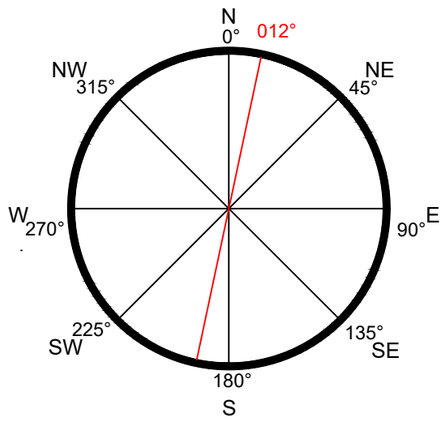
JOB NUMBER: 20-0399A	JOB NAME: Bus Connects	LOCATION: R2 - ST01

CLIENT:	CLIENTS REPRESENTATIVE:	CREW: GH	PLANT & EQUIPMENT 3 Tonne Excavator & Hand Tools

TRENCH: (SECTION & PLAN)



TRENCH - ORIENTATION



TRENCH ORIENTATED : 012° FROM NORTH

COORDINATES: DATUM WALL

EASTING: - 716111.148

NORTHING: - 7367790.780

ELEVATION: - 7.573

No:	Type of Service:	Diameter (in mm)	Depth to Top of Service (m)	Distance to Centre of Service (m)	Details/Comments
01	Unknown	127	0.60	0.60	127mm Green Duct Unknown
02	Unknown	127	0.50	0.95	127mm Red Duct Unknown
03					
04					
05					
06					
07					
08					
09					
10					
11					
12					
13					
14					
15					

TRENCH LENGTH (m) : 3.75

TRENCH DEPTH (m) : 3.10

TRENCH WIDTH (m) : 0.55

STABILITY: Stable

GROUNDWATER: None

SCALE: NTS@A3

DRAWN: BS

CHECKED: CH

DATE EXCAVATED: 15-10-2020

CAUSEWAY GEOTECH

Project No. 20-0399A	**Project Name:** Bus Connects Route 2 Swords to City Centre		**Trial Pit ID** R2-SLT01A
Coordinates 716112.14 E 736806.44 N	**Client:** National Transport Authority (NTA)		
Method: Slit Trenching	**Client's Representative:** Jacobs		Sheet 1 of 1 Scale: 1:25
Plant: 3T Tracked Excavator	**Elevation** 7.16 mOD	**Date:** 15/10/2020	**Logger:** GH	FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
			6.96	0.20		TOPSOIL	
			6.86	0.30		MADE GROUND: Grey slightly sandy angular fine to coarse GRAVEL of limestone. Sand is fine to coarse. Cloth layer underneath.	
0.50	B3					MADE GROUND: Firm greyish brown slightly sandy slightly gravelly SILT with medium cobble content, pieces of plastic, red brick and glass. Sand is fine to coarse. Gravel is subangular fine to coarse of mixed lithologies. Cobbles are angular of mixed lithologies.	
0.50	ES1						
1.00	B4						
1.00	ES2						
			5.66	1.50		End of trial pit at 1.50m	

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

Water Strikes	
Struck at (m)	Remarks

Depth: 1.50
Width: 0.55
Length: 2.70

Remarks: No groundwater encountered.

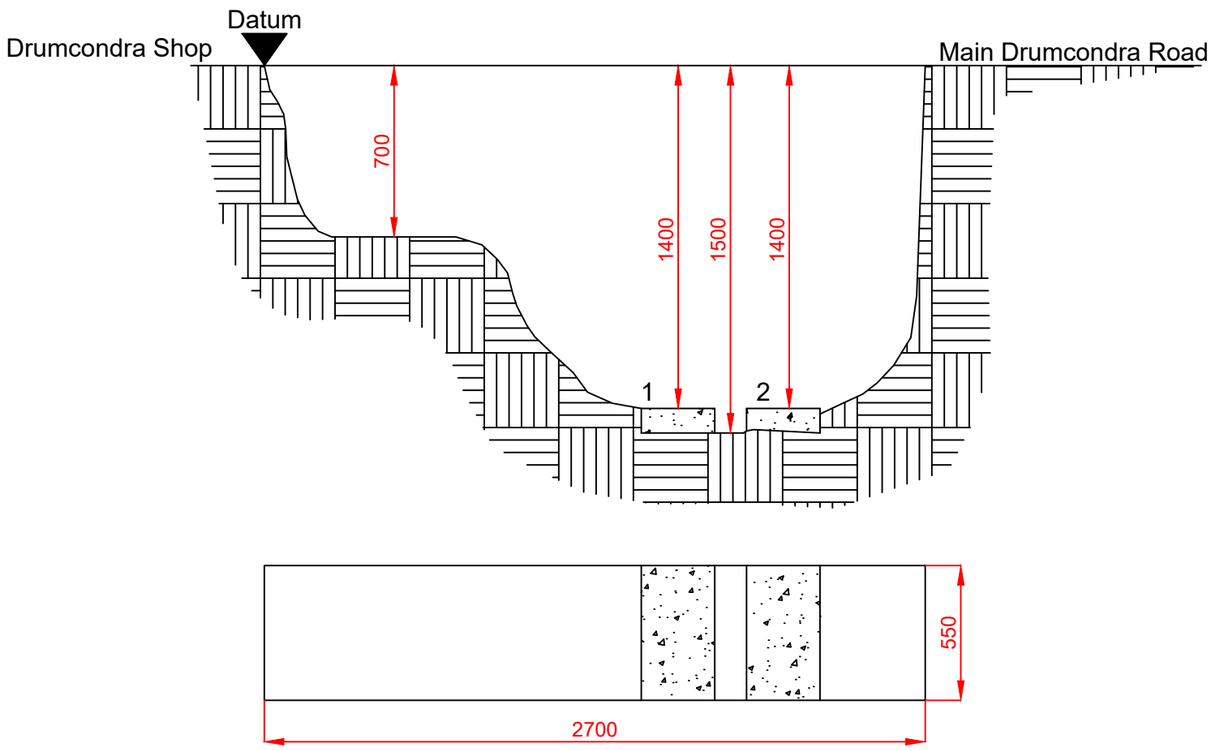
Stability:	Termination Reason:	Last Updated
Stable	ESB services exposed.	17/12/2020

AGS

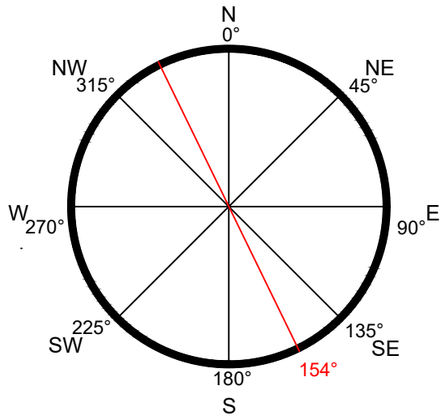
JOB NUMBER: 20-0399A	JOB NAME: Bus Connects	LOCATION: R2 - ST01A

CLIENT:	CLIENTS REPRESENTATIVE:	CREW: GH	PLANT & EQUIPMENT 3 Tonne Excavator & Hand Tools

TRENCH: (SECTION & PLAN)



TRENCH - ORIENTATION



TRENCH ORIENTATED : 154° FROM NORTH

COORDINATES: DATUM WALL

EASTING: - 716112.138

NORTHING: - 736806.439

ELEVATION: - 7.160

No:	Type of Service:	Diameter (in mm)	Depth to Top of Service (m)	Distance to Centre of Service (m)	Details/Comments
01	ESB	300	1.40	1.54 - 1.84	300mm Concrete ESB Slab
02	ESB	300	1.40	1.97 - 2.27	300mm Concrete ESB Slab
03					
04					
05					
06					
07					
08					
09					
10					
11					
12					
13					
14					
15					

TRENCH LENGTH (m) : 2.70

TRENCH DEPTH (m) : 1.50

TRENCH WIDTH (m) : 0.55

STABILITY: Stable

GROUNDWATER: None

SCALE: NTS@A3

DRAWN: BS

CHECKED: CH

DATE EXCAVATED: 15-10-2020

CAUSEWAY GEOTECH	**Project No.** 20-0399A	**Project Name:** Bus Connects Route 2 Swords to City Centre	**Trial Pit ID** R2-SLT02
	Coordinates 716099.87 E 736735.41 N	**Client:** National Transport Authority (NTA)	
Method: Slit Trenching		**Client's Representative:** Jacobs	Sheet 1 of 1 Scale: 1:25
Plant: 3T Tracked Excavator	**Elevation** 7.42 mOD	**Date:** 29/09/2020	**Logger:** RS FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
0.50	ES1					MADE GROUND: Stiff greyish brown slightly sandy gravelly CLAY with cobble sized pieces of concrete and red brick. Sand is fine to coarse. Gravel is subrounded fine to coarse of mixed lithologies.	
1.00	ES2						
			5.26	2.15		End of trial pit at 2.15m	

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

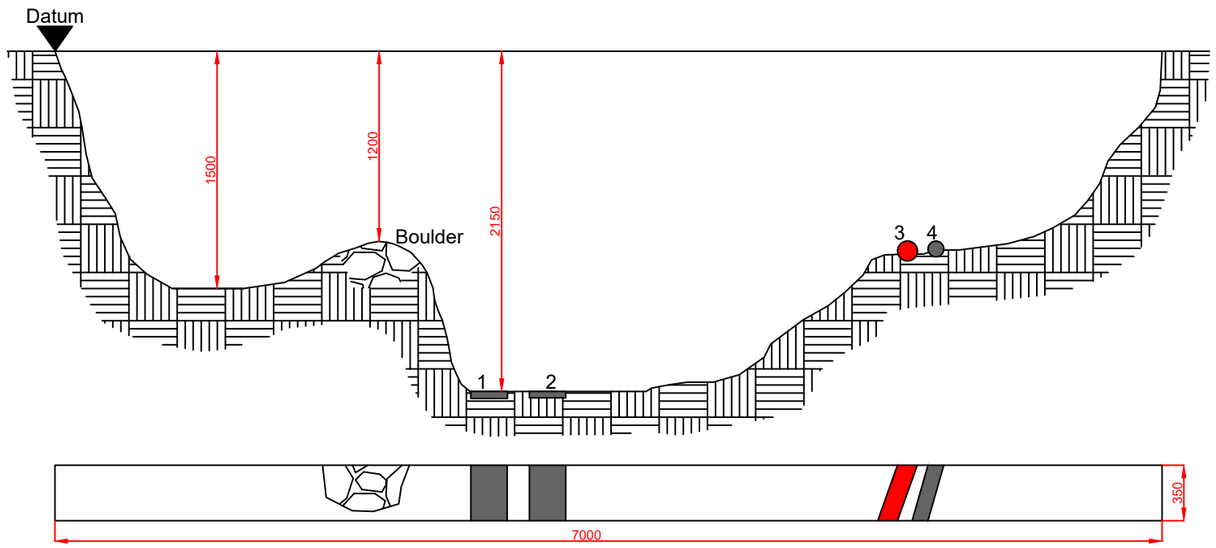
Water Strikes			
Struck at (m)	Remarks		
		Depth: 2.15	**Remarks:** No groundwater encountered.
		Width: 0.35	
		Length: 7.00	

Stability:	**Termination Reason:**	**Last Updated**	AGS
Stable	ESB services exposed.	17/12/2020	

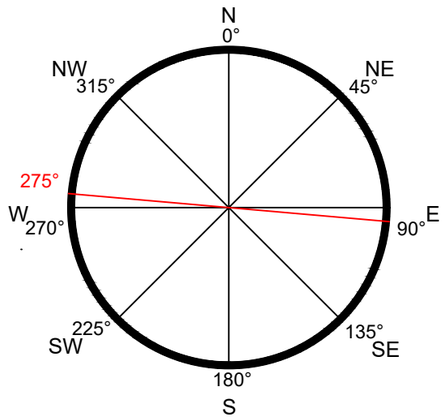
JOB NUMBER: 20-0399A	JOB NAME: Bus Connects	LOCATION: R02-SLT02

CLIENT:	CLIENTS REPRESENTATIVE:	CREW: RS	PLANT & EQUIPMENT 3 Tonne Excavator & Hand Tools

TRENCH: (SECTION & PLAN)



TRENCH - ORIENTATION



TRENCH ORIENTATED : 275° FROM NORTH

COORDINATES: DATUM WALL

EASTING: - 716099.867

NORTHING: - 736735.425

ELEVATION: - 7.412

No:	Type of Service:	Diameter (in mm)	Depth to Top of Service (m)	Distance to Centre of Service (m)	Details/Comments
01	ESB	230	2.15	2.63 - 2.86	230mm ESB Slab
02	ESB	230	2.15	3.00 - 3.23	230mm ESB Slab
03	Unknown	125	1.20	5.39	125mm Red PVC Duct Unknown
04	Unknown	100	1.20	5.57	100mm Grey PVC Duct Unknown
05					
06					
07					
08					
09					
10					
11					
12					
13					
14					
15					

TRENCH LENGTH (m) : 7.00

TRENCH DEPTH (m) : 2.15

TRENCH WIDTH (m) : 0.35

STABILITY: Stable

GROUNDWATER: None

SCALE: NTS@A3

DRAWN: BS

CHECKED: CH

DATE EXCAVATED: 29/09/2020

CAUSEWAY GEOTECH

APPENDIX G

SLIT TRENCH PHOTOGRAPHS

R2-SLT01

R2-SLT01

R2-SLT01

R2-SLT01

R2-SLT01A

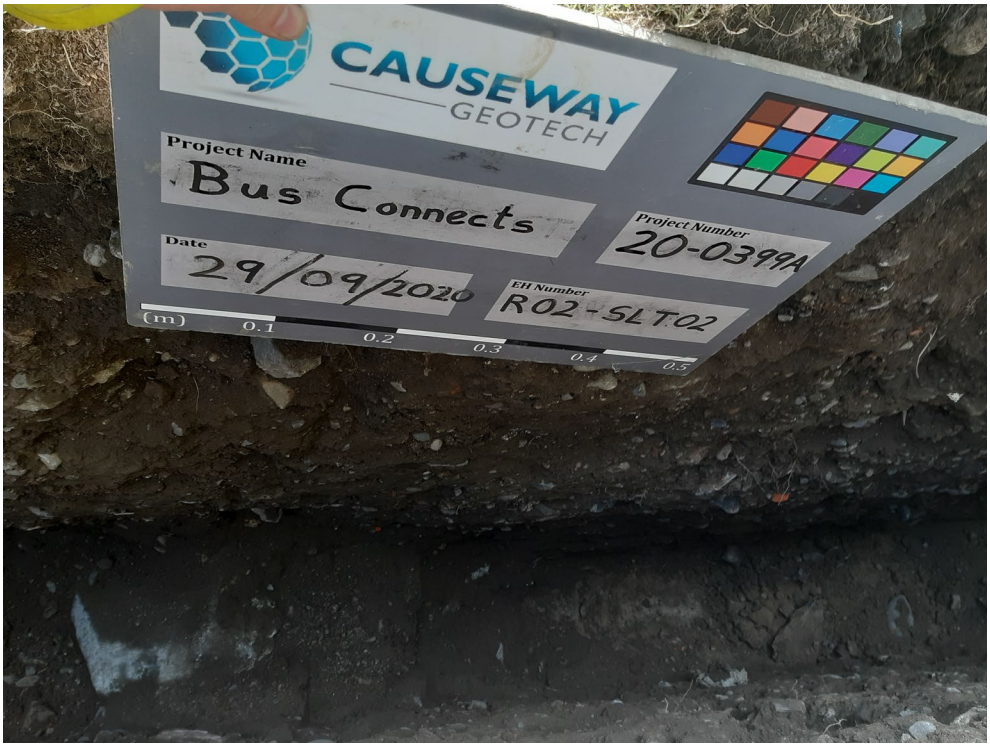
R2-SLT01A

R2-SLT01A

R2-SLT02

R2-SLT02

R2-SLT02



R2-SLT02

R2-SLT02

R2-SLT02

CAUSEWAY GEOTECH

APPENDIX H

GEOTECHNICAL LABORATORY TEST RESULTS

CAUSEWAY GEOTECH

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Unit 3 Balbriggan Business Park, Balbriggan
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ROI: +353 (0)1 526 7465
Registered in Ireland.
Company Number: 633786

www.causewaygeotech.com

SOIL AND ROCK SAMPLE ANALYSIS
LABORATORY TEST REPORT

23 November 2020

Project Name:	Bus Connects - Route 2 - Swords to City Centre
Project No.:	20-0399A
Client:	National Transport Authority (NTA)
Engineer:	AECOM

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

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

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

Stephen Watson

Laboratory Manager

Signed for and on behalf of Causeway Geotech Ltd

Project Name: Bus Connects - Route 2 - Swords to City Centre

Report Reference: Schedule 1

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

Tests marked with* in this report are not United Kingdom Accreditation Service (UKAS) accredited and are not included in Causeway Geotech Limited's scope of UKAS Accreditation Schedule of Tests. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

Material tested	Type of test/Properties measured/Range of measurement	Standard specifications	No. of results included in the report
SOIL	Moisture Content of Soil	BS 1377-2: 1990: Cl 3.2	7
SOIL	Liquid and Plastic Limits of soil-1 point cone penetrometer method	BS 1377-2: 1990: Cl 4.4, 5.3 & 5.4	6
SOIL	Particle size distribution - wet sieving	BS 1377-2: 1990: Cl 9.2	6
SOIL	Particle size distribution - sedimentation hydrometer method	BS 1377-2: 1990: Cl 9.5	5
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: Cl 9	2
ROCK	Point load index	ISRM Commission on Testing Methods. Suggested Method for Determining Point Load Strength 1985	4
ROCK	Uniaxial Compressive Strength (UCS)*	ISRM Suggested Methods -Rock Characterization Testing and Monitoring, Ed. E T Brown - 1981	2

SUB-CONTRACTED TESTS

In agreement with Client, the following tests were conducted by an approved sub-contractor. All sub-contracting laboratories used are UKAS accredited.

Material tested	Type of test/Properties measured/Range of measurement	Standard specifications	No. of results included in the report
SOIL – Subcontracted to Eurofins Chemtest Ltd *(UKAS 2183)*	BRE Test – Suite A		3

Summary of Classification Test Results

Project No.	Project Name
20-0399A	Bus Connects Route 2 - Swords to City Centre

Hole No.	Sample				Soil Description	Density bulk	Density dry	*w*	Passing 425µm	LL	PL	PI	Particle density	Casagrande Classification
	Ref	Top	Base	Type		Mg/m3		%	%	%	%	%	Mg/m3	
R2-CPRC02	13	4.00		D	Grey sandy gravelly silty CLAY.			10.0	63	28 -1pt	13	15		CL
R2-CPRC02	15	5.50		D	Grey sandy gravelly silty CLAY.			9.4	76	32 -1pt	15	17		CL
R2-CPRC02	15	6.50		C	Grey sandy gravelly silty CLAY.			8.2	50	24 -1pt	15	9		CL
R2-CPRC02	15	9.50		C	Grey sandy gravelly silty CLAY.			5.8	43	24 -1pt	16	8		CL
R2-CPRC02	15	12.50		C	Grey sandy gravelly silty CLAY.			7.1	52	24 -1pt	15	9		CL
R2-TP01	3	1.00		B	Brown gravelly slightly clayey fine to coarse SAND.			11.0						
R2-TP02	4	1.00		B	Brown gravelly silty fine to coarse SAND.			13.0	50	42 -1pt	25	17		CI

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

LAB 01R Version 4

Key

Density test	Liquid Limit	Particle density
Linear measurement unless :	4pt cone unless :	sp - small pyknometer
wd - water displacement	cas - Casagrande method	gj - gas jar
wi - immersion in water	1pt - single point test	

Date Printed

23/11/2020

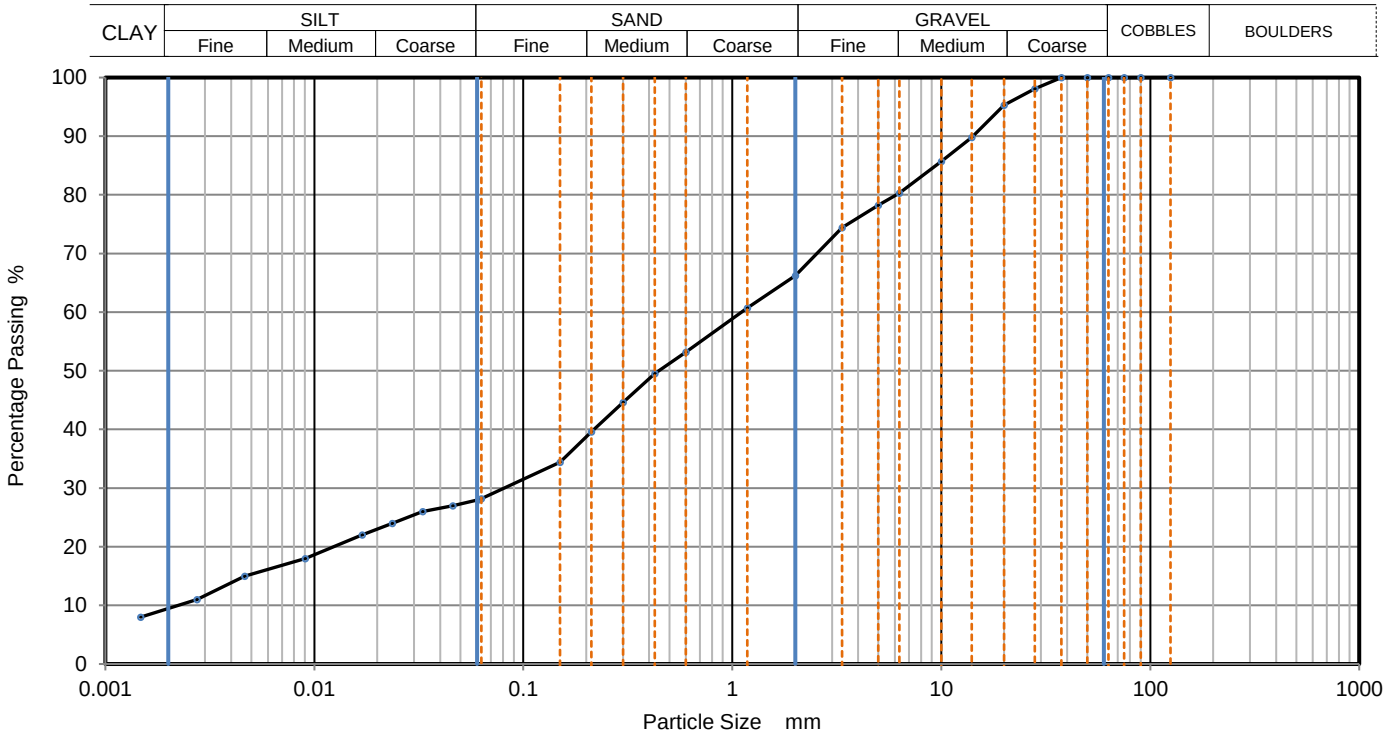
Approved By

Stephen.Watson

UKAS TESTING

10122

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**20-0399A**
				Borehole/Pit No.	R2-CPRC02
Site Name	Bus Connects Route 2 - Swords to City Centre			Sample No.	6
Soil Description	Grey sandy gravelly silty CLAY.			Depth, m	2.00
Specimen Reference	3	Specimen Depth	2 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2020110331



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06126	28
90	100	0.04590	27
75	100	0.03294	26
63	100	0.02362	24
50	100	0.01694	22
37.5	100	0.00904	18
28	98	0.00464	15
20	95	0.00274	11
14	90	0.00148	8
10	86		
6.3	80		
5	78		
3.35	74		
2	66		
1.18	61		
0.6	53	Particle density	(assumed)
0.425	50	2.65	Mg/m3
0.3	45		
0.212	40		
0.15	34		
0.063	28		

Dry Mass of sample, g	2384

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	33.8
Sand	38.0
Silt	18.8
Clay	9.4

Grading Analysis		
D100	mm	
D60	mm	1.1
D30	mm	0.0809
D10	mm	0.00224
Uniformity Coefficient		490
Curvature Coefficient		2.6

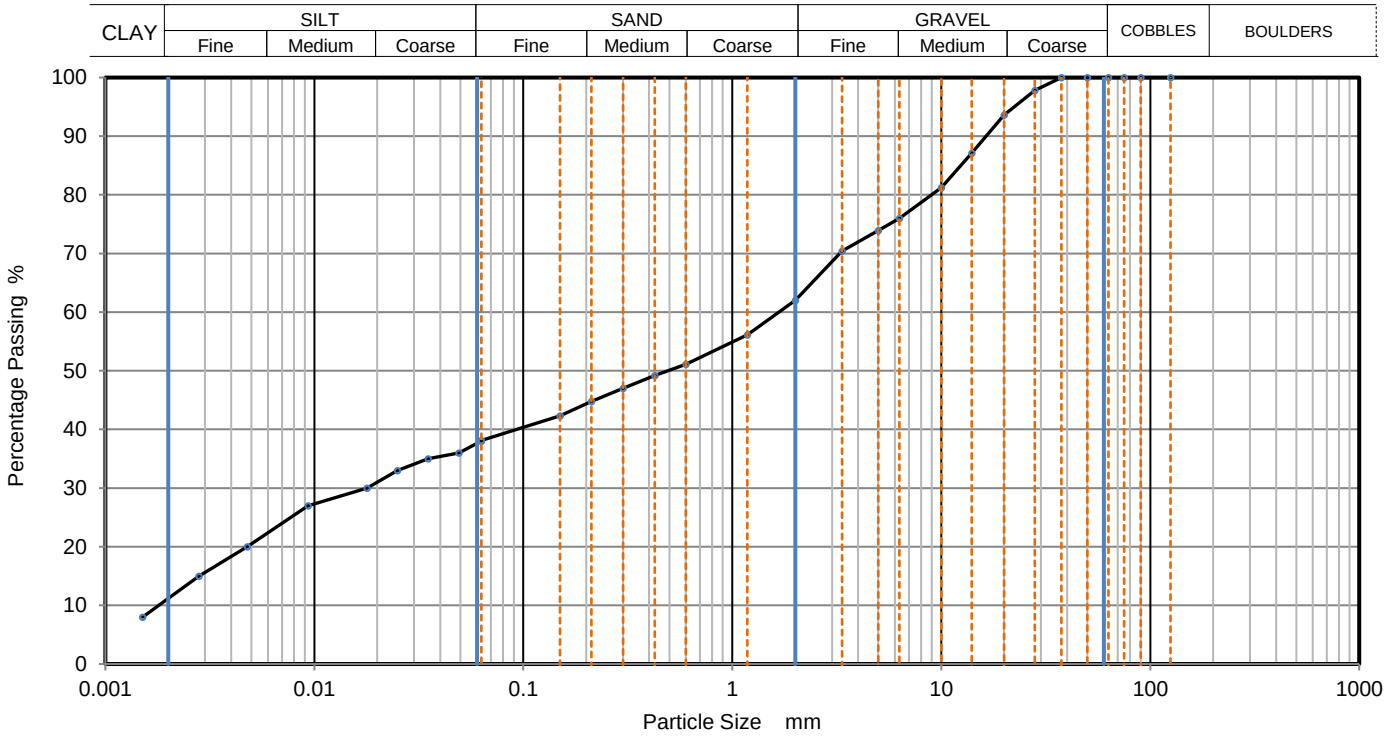
Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen.Watson

UKAS TESTING 10122

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**20-0399A**
				Borehole/Pit No.	R2-CPRC02
Site Name	Bus Connects Route 2 - Swords to City Centre			Sample No.	12
Soil Description	Grey sandy gravelly silty CLAY.			Depth, m	4.00
Specimen Reference	3	Specimen Depth	4 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2020110332



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	38
90	100	0.04921	36
75	100	0.03502	35
63	100	0.02492	33
50	100	0.01784	30
37.5	100	0.00933	27
28	98	0.00477	20
20	94	0.00280	15
14	87	0.00151	8
10	81		
6.3	76		
5	74		
3.35	70		
2	62		
1.18	56		
0.6	51	Particle density	(assumed)
0.425	49	2.65	Mg/m3
0.3	47		
0.212	45		
0.15	42		
0.063	38		

Dry Mass of sample, g: 2329

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	38.0
Sand	23.9
Silt	26.8
Clay	11.3

Grading Analysis		
D100	mm	
D60	mm	1.67
D30	mm	0.0182
D10	mm	0.00177
Uniformity Coefficient		940
Curvature Coefficient		0.11

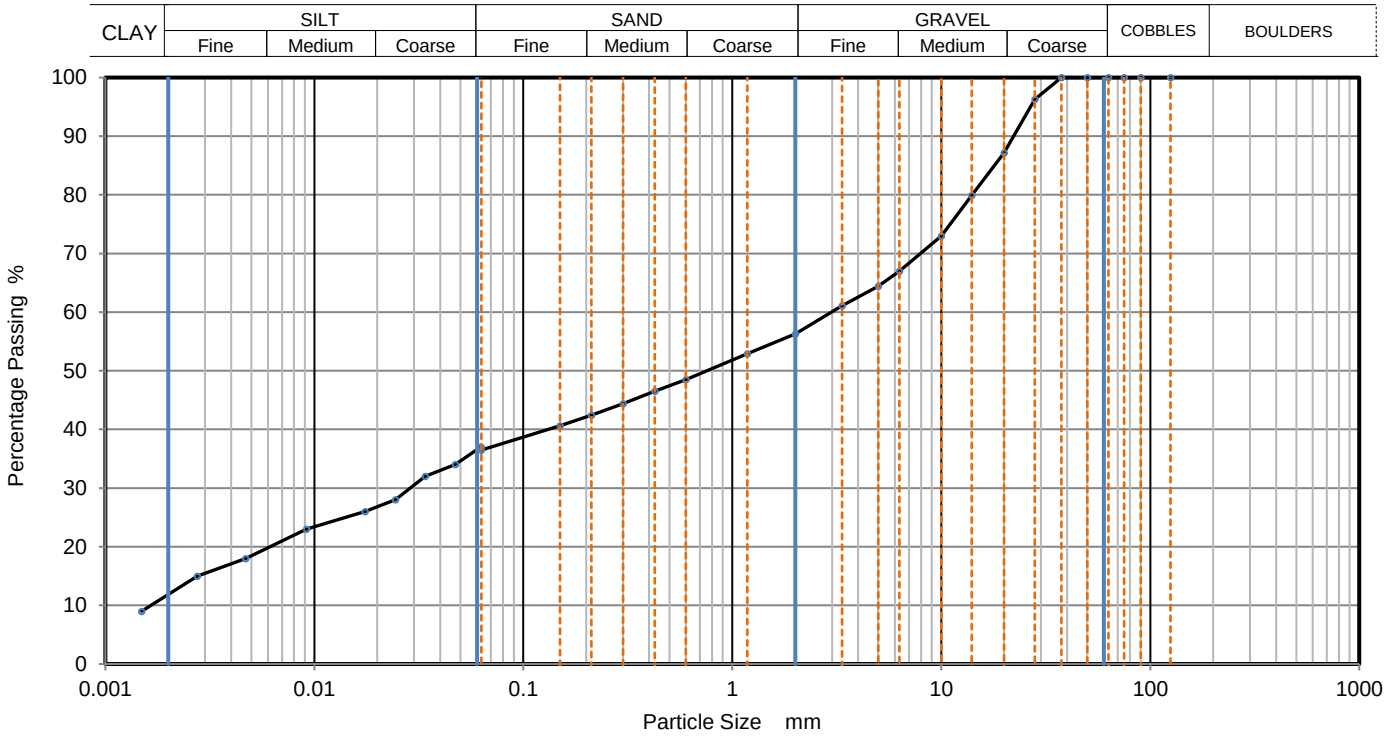
Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen.Watson

UKAS TESTING 10122

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**20-0399A**
				Borehole/Pit No.	R2-CPRC02
Site Name	Bus Connects Route 2 - Swords to City Centre			Sample No.	15
Soil Description	Grey sandy gravelly silty CLAY.			Depth, m	6.50
Specimen Reference	7	Specimen Depth	6.5 m	Sample Type	C
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2020110336



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06264	37
90	100	0.04725	34
75	100	0.03388	32
63	100	0.02444	28
50	100	0.01751	26
37.5	100	0.00916	23
28	96	0.00469	18
20	87	0.00275	15
14	80	0.00149	9
10	73		
6.3	67		
5	64		
3.35	61		
2	56		
1.18	53		
0.6	49	Particle density	(assumed)
0.425	47	2.65	Mg/m3
0.3	44		
0.212	42		
0.15	41		
0.063	37		

Dry Mass of sample, g	2478

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	43.7
Sand	19.8
Silt	24.8
Clay	11.7

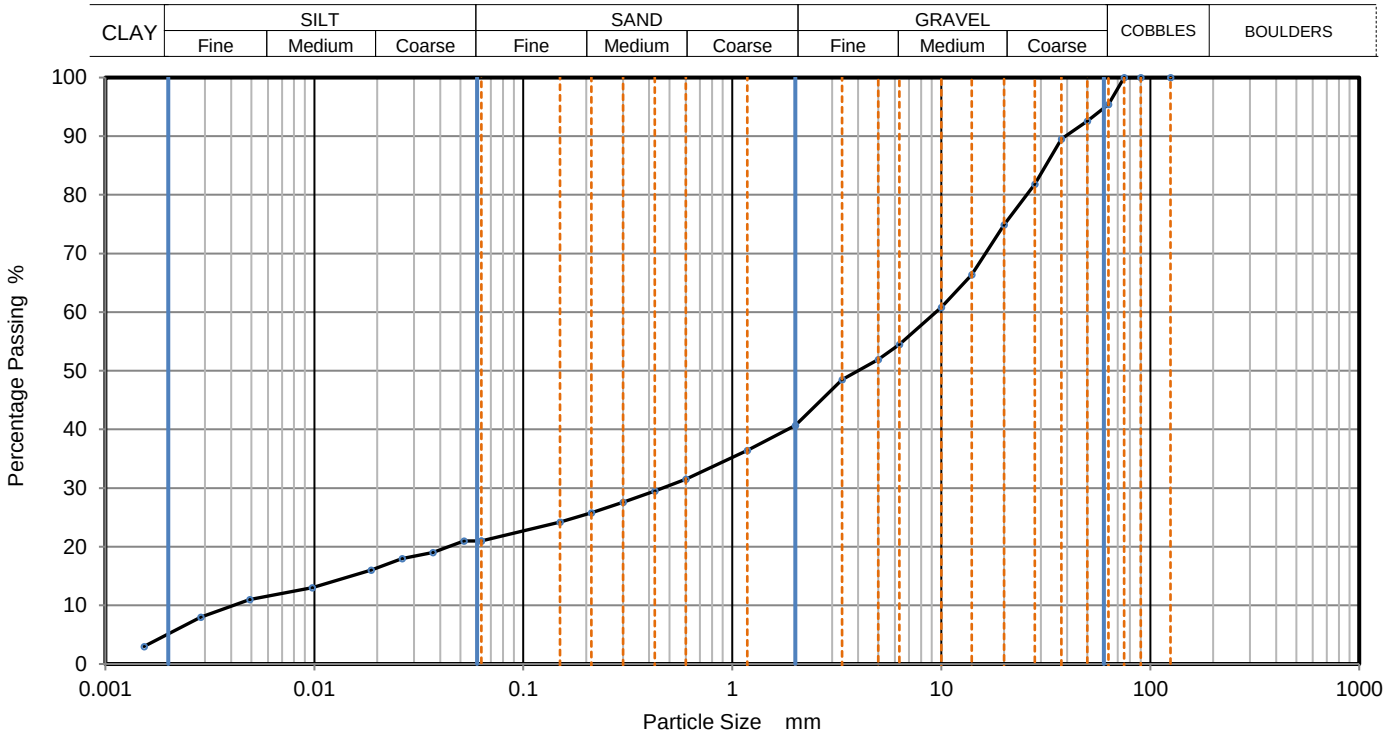
Grading Analysis		
D100	mm	
D60	mm	2.99
D30	mm	0.0293
D10	mm	0.00171
Uniformity Coefficient		1700
Curvature Coefficient		0.17

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen.Watson

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION				Job Ref	20-0399A
					Borehole/Pit No.	R2-SLT01
Site Name	Bus Connects Route 2 - Swords to City Centre				Sample No.	4
Soil Description	Grey sandy gravelly silty CLAY.				Depth, m	1.00
Specimen Reference	3	Specimen Depth	1	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5				KeyLAB ID	Caus2020110341



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	21
90	100	0.05201	21
75	100	0.03699	19
63	95	0.02630	18
50	93	0.01870	16
37.5	90	0.00977	13
28	82	0.00491	11
20	75	0.00287	8
14	66	0.00153	3
10	61		
6.3	55		
5	52		
3.35	49		
2	41		
1.18	36		
0.6	32	Particle density	(assumed)
0.425	30	2.65	Mg/m3
0.3	28		
0.212	26		
0.15	24		
0.063	21		

Dry Mass of sample, g	7415

Sample Proportions	% dry mass
Cobbles	4.6
Gravel	54.7
Sand	19.7
Silt	15.7
Clay	5.3

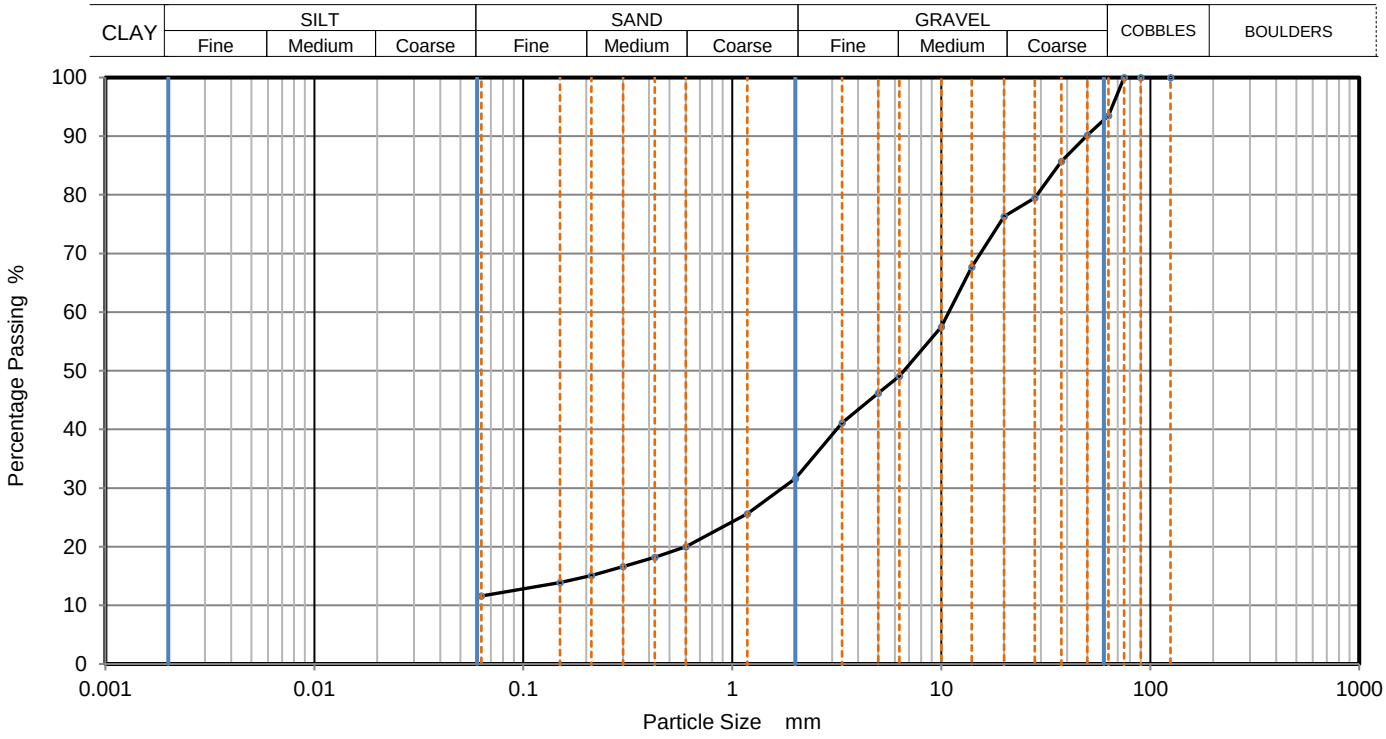
Grading Analysis		
D100	mm	
D60	mm	9.4
D30	mm	0.464
D10	mm	0.00395
Uniformity Coefficient		2400
Curvature Coefficient		5.8

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen.Watson

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	20-0399A
				Borehole/Pit No.	R2-TP01
Site Name	Bus Connects Route 2 - Swords to City Centre			Sample No.	3
Soil Description	Brown gravelly slightly clayey fine to coarse SAND.			Depth, m	1.00
Specimen Reference	5	Specimen Depth	1 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	Caus2020110342



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	94		
50	90		
37.5	86		
28	80		
20	76		
14	68		
10	58		
6.3	49		
5	46		
3.35	41		
2	32		
1.18	26		
0.6	20		
0.425	18		
0.3	17		
0.212	15		
0.15	14		
0.063	12		

Dry Mass of sample, g	7960

Sample Proportions	% dry mass
Cobbles	6.5
Gravel	61.9
Sand	20.0
Fines <0.063mm	12.0

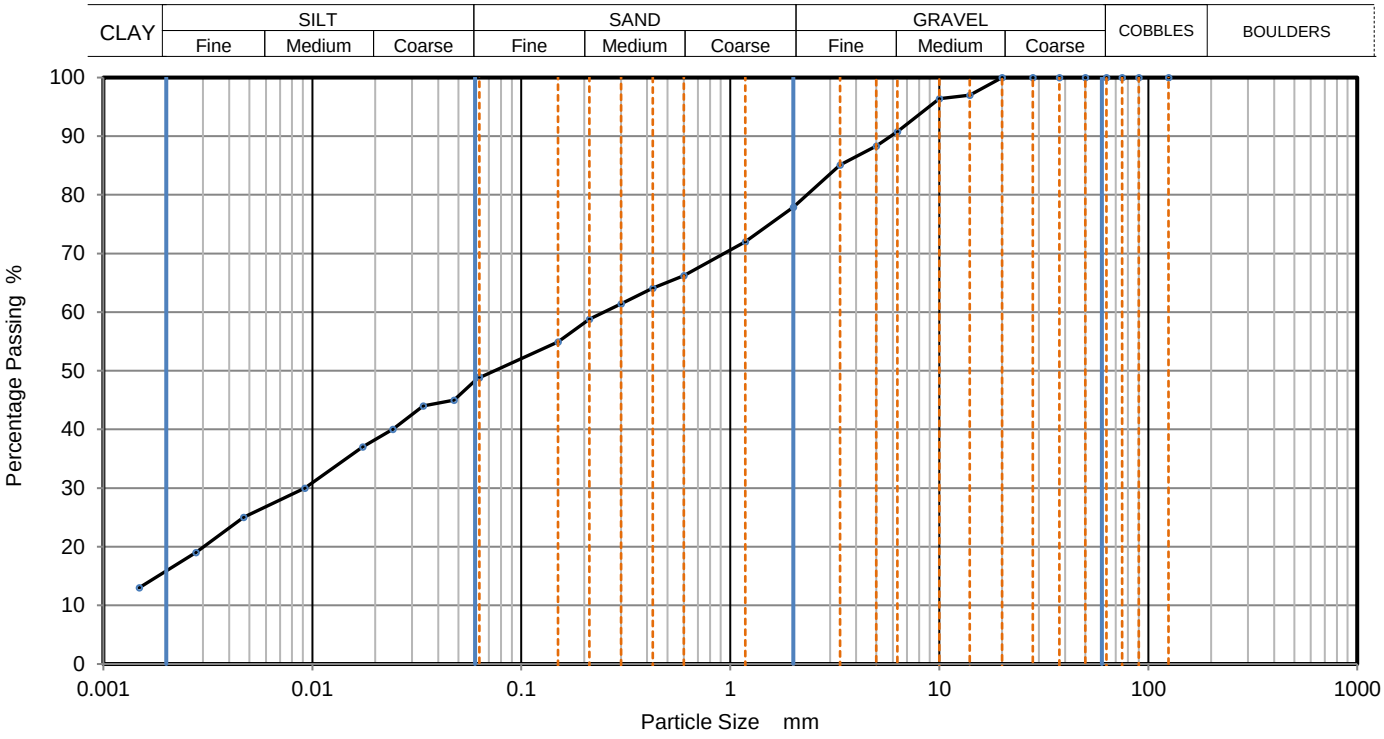
Grading Analysis		
D100	mm	
D60	mm	10.9
D30	mm	1.73
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen.Watson

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**20-0399A**
				Borehole/Pit No.	R2-TP02
Site Name	Bus Connects Route 2 - Swords to City Centre			Sample No.	5
Soil Description	Brown sandy gravelly silty CLAY.			Depth, m	2.00
Specimen Reference	3	Specimen Depth	2 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2020110344



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	49
90	100	0.04758	45
75	100	0.03388	44
63	100	0.02428	40
50	100	0.01740	37
37.5	100	0.00921	30
28	100	0.00469	25
20	100	0.00277	19
14	97	0.00148	13
10	96		
6.3	91		
5	88		
3.35	85		
2	78		
1.18	72		
0.6	66	Particle density	(assumed)
0.425	64	2.65	Mg/m3
0.3	61		
0.212	59		
0.15	55		
0.063	49		

Dry Mass of sample, g	508

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	22.1
Sand	29.1
Silt	32.9
Clay	15.9

Grading Analysis		
D100	mm	
D60	mm	0.249
D30	mm	0.00886
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

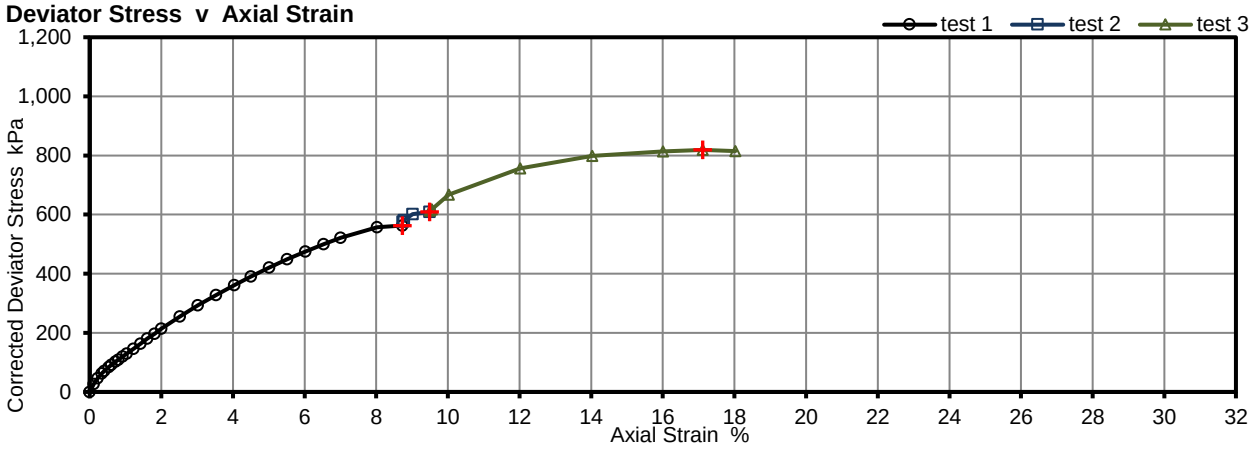
Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen.Watson

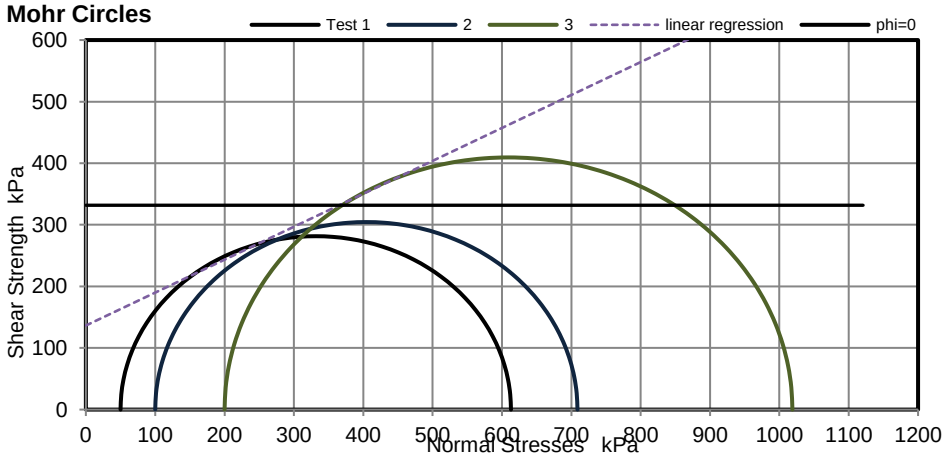
CAUSEWAY GEOTECH	**Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - Multistage test**				Job Ref	20-0399A	
					Borehole/Pit No.	R2-CPRC02	
Site Name	Bus Connects Route 2 - Swords to City Centre				Sample No.	19	
Soil Description	Grey sandy gravelly silty CLAY.				Depth	5.00	
Specimen Reference	6	Specimen Depth	5.05	m	Sample Type	U	
Specimen Description	Hard grey sandy gravelly silty CLAY.				KeyLAB ID	Caus2020110334	
Test Method	BS1377:Part 7:1990, clause 9, multistage test on a single spe				Date of test	10/11/2020	

Length		mm	210.0		
Diameter		mm	104.2		
Bulk Density		Mg/m3	2.20		
Moisture Content		%	10.1		
Dry Density		Mg/m3	2.00		
Rate of Strain		%/min	1.00		
Stage Number			1	2	3
Cell Pressure		kPa	50	100	200
End of stage	Axial Strain	%	8.7	9.5	17.1
	Deviator Stress, (σ1 - σ3) corrected for area and membrane	kPa	563.0	608.9	818.8
	Shear strength, cu	kPa	281.5	304.4	409.4
	Mode of failure		Compound		

Deviator Stress v Axial Strain



Mohr Circles



ϕu = 0

Average cu 332 kPa

Linear Regression

ϕu 28.1 °

cu 136 kPa

Mohr circles and their interpretation is not covered by BS1377-7: 1990. These are provided for information only.

Remarks

Approved	Printed
Stephen.Watson	23/11/2020 16:46

LAB 16R Version 4

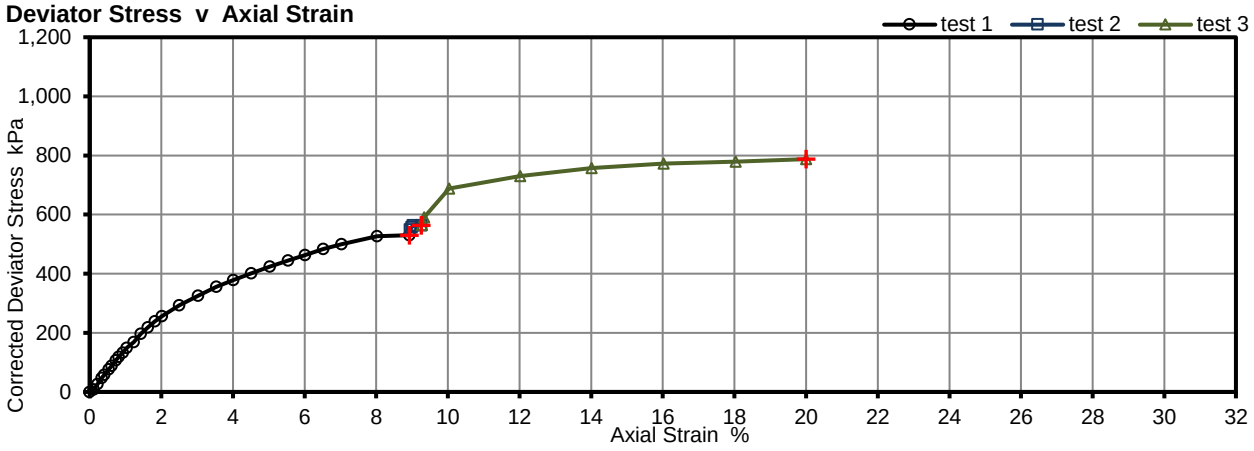
UKAS TESTING

10122

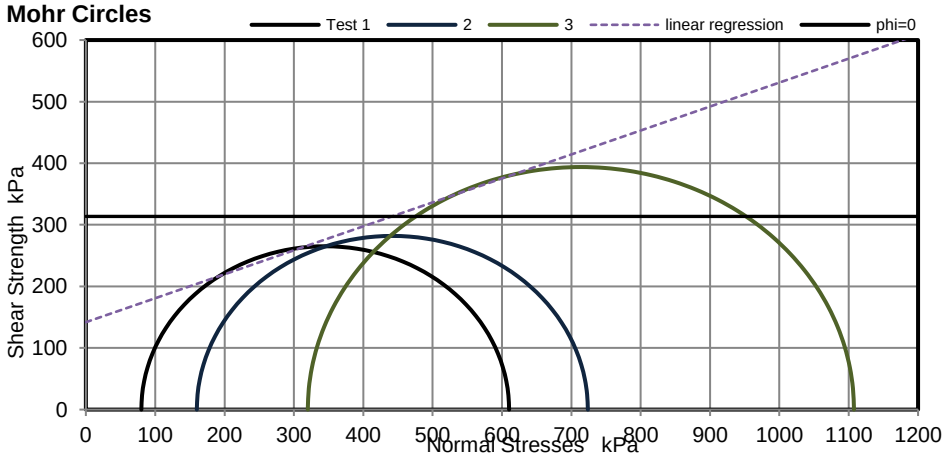
CAUSEWAY GEOTECH	**Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - Multistage test**			Job Ref	20-0399A
				Borehole/Pit No.	R2-CPRC02
Site Name	Bus Connects Route 2 - Swords to City Centre			Sample No.	15
Soil Description	Grey sandy gravelly silty CLAY.			Depth	8.00
Specimen Reference	3	Specimen Depth	8.05 m	Sample Type	C
Specimen Description	Hard grey sandy gravelly silty CLAY.			KeyLAB ID	Caus2020110337
Test Method	BS1377:Part 7:1990, clause 9, multistage test on a single spe			Date of test	10/11/2020

Length		mm	209.0		
Diameter		mm	104.5		
Bulk Density		Mg/m3	2.37		
Moisture Content		%	7.3		
Dry Density		Mg/m3	2.21		
Rate of Strain		%/min	1.00		
Stage Number			1	2	3
Cell Pressure		kPa	80	160	320
End of stage	Axial Strain	%	8.9	9.3	20.0
	Deviator Stress, (σ1 - σ3) corrected for area and membrane	kPa	530.3	563.9	787.6
	Shear strength, cu	kPa	265.2	281.9	393.8
	Mode of failure				

Deviator Stress v Axial Strain



Mohr Circles



ϕu = 0
Average cu 314 kPa

Linear Regression
ϕu 21.3 °
cu 142 kPa

Mohr circles and their interpretation is not covered by BS1377-7: 1990. These are provided for information only.

Remarks

No failure defined. Testing terminated at 20% axial strain.

Approved: Stephen.Watson

Printed: 23/11/2020 16:46

LAB 16R Version 4

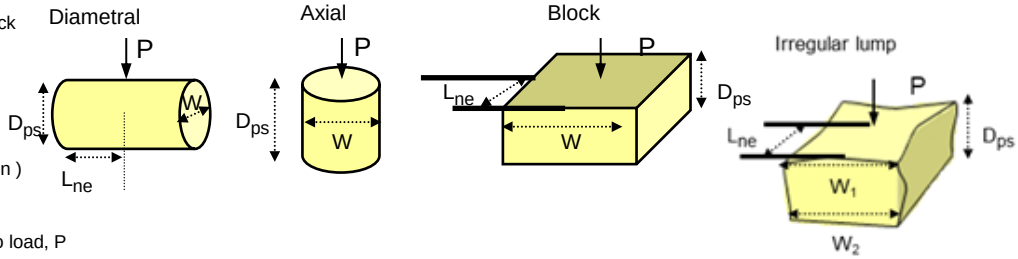
UKAS TESTING 10122

Point Load Strength Index Tests
Summary of Results

Project No.	Project Name
20-0399A	Bus Connects Route 2 - Swords to City Centre

Borehole No.	Sample			Specimen		Rock Type	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P	Equivalent diameter, De	Point Load Strength Index		Remarks (including water content if measured)
	Depth	Ref.	Type	Ref.	Depth		Type (D, A, I, B)	Direction (L, P or U)		Lne	W	Dps	Dps'			Is	Is(50)	
	m				m					mm	mm	mm	mm	kN	mm	MPa	MPa	
R2-CPRC02	14.90		C	1	14.90	LIMESTONE	D	U	YES	61.3	101.3	101.3	97.0	10.3	99.1	1.0	1.4	
R2-CPRC02	15.40		C	2	15.40	LIMESTONE	A	U	NO		101.3	40.0	37.0	12.6	69.1	2.6	3.1	
R2-CPRC02	17.10		C	3	17.10	LIMESTONE	A	U	NO		101.3	86.0	81.0	18.6	102.2	1.8	2.5	
R2-CPRC02	18.20		C	4	18.20	LIMESTONE	D	U	YES	96.1	101.4	101.4	96.0	21.3	98.7	2.2	3.0	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
L - parallel to planes of weakness
P - perpendicular to planes of weakness
U - unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P



Test performed in accordance with ISRM Suggested Methods : 2007, unless noted otherwise

Detailed legend for test and dimensions, based on ISRM, is shown above.

Size factor, F = (De/50)0.45 for all tests.

LAB 17R Version 4

Date Printed: 23/11/2020

Approved By: Stephen.Watson

UKAS TESTING 10122

UNIAXIAL COMPRESSION TEST ON ROCK - SUMMARY OF RESULTS

Project No.	Project Name
20-0399A	Bus Connects Route 2 - Swords to City Centre

Hole No.	Sample				Rock Type	Specimen Dimensions[2]			Bulk Density[2]	Water Content[1]	Uniaxial Compression[3]			Remarks
	Ref	Top	Base	Type		Dia. mm	Length mm	H/D	Mg/m^3	%	Condition	Mode of failure	UCS MPa	
R2-CPRC02		16.55	16.80	C	LIMESTONE	101.2	255.3	2.5	2.70	0.3	as received	S	21.7	
R2-CPRC02		19.10	19.85	C	LIMESTONE	101.3	255.6	2.5	2.70	0.2	as received	F	18.5	

Notes

1 ISRM p87 test 1, water content at 105 ± 3 °C, specimen as tested for UCS

2 ISRM p86 clause (vii), Caliper method used for determination of bulk volume and derivation of bulk density

3 ISRM p153 part 1, determination of Uniaxial Compressive Strength (UCS) of Rock Materials

above notes apply unless annotated otherwise in the remarks

Mode of failure :

S - Single shear MS - multiple shear

AC - Axial cleavage F - Fragmented

Test Specification	Date Printed	Approved By	Table
International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007	23/11/2020	Stephen.Watson	1 sheet 1

eurofins | Chemtest
Eurofins Chemtest Ltd
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

UKAS TESTING
2183

Final Report

Report No.:	20-30599-1
Initial Date of Issue:	17-Nov-2020
Client	Causeway Geotech Ltd
Client Address:	8 Drumahiskey Road Balnamore Ballymoney County Antrim BT53 7QL
Contact(s):	Carin Cornwall Colm Hurley Darren O'Mahony Gabriella Horan Joe Gervin John Cameron Lucy Newland Martin Gardiner Matthew Gilbert Neil Haggan Paul Dunlop Sean Ross Stephen Franey Stephen McCracken Stephen Watson Stuart Abraham Thomas McAllis
Project	20-0399A Bus Connects Route 2 Swords to City Centre

Quotation No.:		**Date Received:**	11-Nov-2020
Order No.:		**Date Instructed:**	11-Nov-2020
No. of Samples:	3		
Turnaround (Wkdays):	5	**Results Due:**	17-Nov-2020
Date Approved:	17-Nov-2020		

Approved By:

Details: Glynn Harvey, Technical Manager

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

Results - Soil

Project: 20-0399A Bus Connects Route 2 Swords to City Centre

Client: Causeway Geotech Ltd			**Chemtest Job No.:**		20-30599	20-30599	20-30599
Quotation No.:			**Chemtest Sample ID.:**		1095060	1095061	1095062
Order No.:			Client Sample Ref.:		16	18	
			Sample Location:		R2-CPRC02	R2-CPRC02	R2-CPRC02
			Sample Type:		SOIL	SOIL	SOIL
			Top Depth (m):		5.00	6.00	11.00
			Date Sampled:		09-Nov-2020	09-Nov-2020	09-Nov-2020
Determinand	**Accred.**	**SOP**	**Units**	**LOD**			
Moisture	N	2030	%	0.020	12	11	8.8
pH (2.5:1)	N	2010		4.0	8.6	8.5	8.3
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	0.031	< 0.010	0.048

Test Methods

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

Report Information

Key

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

Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

Uncertainty of measurement for the determinands tested are available upon request

None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis

All Asbestos testing is performed at the indicated laboratory

Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied

B - Sample age exceeds stability time (sampling to extraction)

C - Sample not received in appropriate containers

D - Broken Container

E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 45 days from the date of receipt

All water samples will be retained for 14 days from the date of receipt

Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:

customerservices@chemtest.com

LABORATORY RESTRICTION REPORT

Project Reference	20-0399A	To	Sean Ross
Project Name	Bus Connects Route 9 - Swords to City Centre	Position	Project Manager
TR reference	20-0399A / G01	From	Joseph Nicholl
		Position	Laboratory Quality 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			
R2CP RC02	19	5.00	U	Oedometer	Unable to obtain specimen for test - coarse gravel content too high	CANCEL
R2CP RC02	15	11.00	U	UU Triaxial Oedometer	Unable to obtain specimen for test - coarse gravel content too high	CANCEL

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

Laboratory Signature	Project Manager Signature
Joseph Nicholl	Sean Ross
Date	Date
13 November 2020	

CAUSEWAY GEOTECH

APPENDIX I

ENVIRONMENTAL LABORATORY TEST RESULTS

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

Final Report

Report No.:	20-25513-1
Initial Date of Issue:	02-Oct-2020
Client	Causeway Geotech Ltd
Client Address:	8 Drumahiskey Road Balnamore Ballymoney County Antrim BT53 7QL
Contact(s):	Carin Cornwall Colm Hurley Darren O'Mahony Gabriella Horan Joe Gervin John Cameron Lucy Newland Martin Gardiner Matthew Gilbert Neil Haggan Paul Dunlop Sean Ross Stephen Franey Stephen McCracken Stephen Watson Stuart Abraham Thomas McAllis
Project	20-0399a Bus Connects
Quotation No.:	Q20-21063
Order No.:	
No. of Samples:	3
Turnaround (Wkdays):	5
Date Approved:	02-Oct-2020
Approved By:	
Details:	Glynn Harvey, Technical Manager

Date Received:	23-Sep-2020
Date Instructed:	28-Sep-2020
Results Due:	02-Oct-2020

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

Results - Soil

Project: 20-0399a Bus Connects

Client: Causeway Geotech Ltd			**Chemtest Job No.:**		20-25513	20-25513	20-25513
Quotation No.: Q20-21063			**Chemtest Sample ID.:**		1068885	1068886	1068888
			Sample Location:		R2-TP01	R2-TP01	R2-TP02
			Sample Type:		SOIL	SOIL	SOIL
			Top Depth (m):		0.5	1	0.5
			Date Sampled:		22-Sep-2020	22-Sep-2020	22-Sep-2020
			Asbestos Lab:		COVENTRY	COVENTRY	COVENTRY
Determinand	**Accred.**	**SOP**	**Units**	**LOD**			
ACM Type	U	2192		N/A	-	-	-
Asbestos Identification	U	2192		N/A	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected
ACM Detection Stage	U	2192		N/A	-	-	-
Moisture	N	2030	%	0.020	9.4	10	9.4
pH	M	2010		4.0	9.2	8.7	8.2
Boron (Hot Water Soluble)	M	2120	mg/kg	0.40	0.75	0.79	< 0.40
Sulphate (2:1 Water Soluble) as SO4	M	2120	g/l	0.010	0.39	0.15	0.59
Cyanide (Total)	M	2300	mg/kg	0.50	< 0.50	< 0.50	< 0.50
Arsenic	M	2450	mg/kg	1.0	19	19	19
Cadmium	M	2450	mg/kg	0.10	0.66	1.7	1.7
Chromium	M	2450	mg/kg	1.0	11	14	13
Copper	M	2450	mg/kg	0.50	21	26	24
Mercury	M	2450	mg/kg	0.10	0.11	0.10	< 0.10
Nickel	M	2450	mg/kg	0.50	21	39	39
Lead	M	2450	mg/kg	0.50	60	44	22
Zinc	M	2450	mg/kg	0.50	77	63	56
Organic Matter	M	2625	%	0.40	1.4	1.9	1.1
Total TPH >C6-C40	M	2670	mg/kg	10	260	< 10	< 10
Naphthalene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Acenaphthylene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Acenaphthene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Fluorene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Phenanthrene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Anthracene	M	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Fluoranthene	M	2700	mg/kg	0.10	2.2	< 0.10	< 0.10
Pyrene	M	2700	mg/kg	0.10	3.4	< 0.10	< 0.10
Benzo[a]anthracene	M	2700	mg/kg	0.10	1.4	< 0.10	< 0.10
Chrysene	M	2700	mg/kg	0.10	1.6	< 0.10	< 0.10
Benzo[b]fluoranthene	M	2700	mg/kg	0.10	1.7	< 0.10	< 0.10
Benzo[k]fluoranthene	M	2700	mg/kg	0.10	0.52	< 0.10	< 0.10
Benzo[a]pyrene	M	2700	mg/kg	0.10	1.4	< 0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	M	2700	mg/kg	0.10	0.82	< 0.10	< 0.10
Dibenz(a,h)Anthracene	M	2700	mg/kg	0.10	0.15	< 0.10	< 0.10
Benzo[g,h,i]perylene	M	2700	mg/kg	0.10	1.2	< 0.10	< 0.10
Coronene	N	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Total Of 17 PAH's	N	2700	mg/kg	2.0	14	< 2.0	< 2.0
Total Phenols	M	2920	mg/kg	0.30	< 0.30	< 0.30	< 0.30

Results - Single Stage WAC

Project: 20-0399a Bus Connects

					Landfill Waste Acceptance Criteria Limits		
Chemtest Job No:	20-25513						
Chemtest Sample ID:	1068886						
Sample Ref:							
Sample ID:							
Sample Location:	R2-TP01						
Top Depth(m):	1						
Bottom Depth(m):							
Sampling Date:	22-Sep-2020						
Determinand	**SOP**	**Accred.**	**Units**		**Inert Waste Landfill**	**Stable, Non-reactive hazardous waste in non-hazardous Landfill**	**Hazardous Waste Landfill**
Total Organic Carbon	2625	M	%	1.1	3	5	6
Loss on Ignition					--	--	10
Total BTEX	2760	M	mg/kg	< 0.010	6	--	--
Total PCBs (7 Congeners)	2815	M	mg/kg	< 0.10	1	--	--
TPH Total WAC (Mineral Oil)	2670	M	mg/kg	< 10	500	--	--
Total (Of 17) PAH's	2700	N	mg/kg	< 2.0	100	--	--
pH					--	>6	--
Acid Neutralisation Capacity					--	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 at L/S 10 l/kg**		
Arsenic	1450	U	< 0.0010	< 0.050	0.5	2	25
Barium	1450	U	0.020	< 0.50	20	100	300
Cadmium	1450	U	< 0.00010	< 0.010	0.04	1	5
Chromium	1450	U	< 0.0010	< 0.050	0.5	10	70
Copper	1450	U	0.0017	< 0.050	2	50	100
Mercury	1450	U	< 0.00050	< 0.0050	0.01	0.2	2
Molybdenum	1450	U	0.0066	0.066	0.5	10	30
Nickel	1450	U	0.0014	< 0.050	0.4	10	40
Lead	1450	U	< 0.0010	< 0.010	0.5	10	50
Antimony	1450	U	< 0.0010	< 0.010	0.06	0.7	5
Selenium	1450	U	< 0.0010	< 0.010	0.1	0.5	7
Zinc	1450	U	< 0.0010	< 0.50	4	50	200
Chloride	1220	U	1.7	17	800	15000	25000
Fluoride	1220	U	0.36	3.6	10	150	500
Sulphate	1220	U	27	270	1000	20000	50000
Total Dissolved Solids	1020	N	170	1700	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	U	7.0	70	500	800	1000

Solid Information	
Dry mass of test portion/kg	0.090
Moisture (%)	10

Waste Acceptance Criteria

Landfill WAC analysis (specifically leaching test results) must not be used for hazardous waste classification purposes. This analysis is only applicable for hazardous waste landfill acceptance and does not give any indication as to whether a waste may be hazardous or non-hazardous.

Results - Single Stage WAC

Project: 20-0399a Bus Connects

					Landfill Waste Acceptance Criteria Limits		
Chemtest Job No:	20-25513						
Chemtest Sample ID:	1068888						
Sample Ref:							
Sample ID:							
Sample Location:	R2-TP02						
Top Depth(m):	0.5						
Bottom Depth(m):							
Sampling Date:	22-Sep-2020						
Determinand	**SOP**	**Accred.**	**Units**		**Inert Waste Landfill**	**Stable, Non-reactive hazardous waste in non-hazardous Landfill**	**Hazardous Waste Landfill**
Total Organic Carbon	2625	M	%	0.64	3	5	6
Loss on Ignition					--	--	10
Total BTEX	2760	M	mg/kg	< 0.010	6	--	--
Total PCBs (7 Congeners)	2815	M	mg/kg	< 0.10	1	--	--
TPH Total WAC (Mineral Oil)	2670	M	mg/kg	< 10	500	--	--
Total (Of 17) PAH's	2700	N	mg/kg	< 2.0	100	--	--
pH					--	>6	--
Acid Neutralisation Capacity					--	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 at L/S 10 l/kg**		
Arsenic	1450	U	< 0.0010	< 0.050	0.5	2	25
Barium	1450	U	0.021	< 0.50	20	100	300
Cadmium	1450	U	< 0.00010	< 0.010	0.04	1	5
Chromium	1450	U	< 0.0010	< 0.050	0.5	10	70
Copper	1450	U	0.0011	< 0.050	2	50	100
Mercury	1450	U	< 0.00050	< 0.0050	0.01	0.2	2
Molybdenum	1450	U	0.011	0.11	0.5	10	30
Nickel	1450	U	< 0.0010	< 0.050	0.4	10	40
Lead	1450	U	< 0.0010	< 0.010	0.5	10	50
Antimony	1450	U	< 0.0010	< 0.010	0.06	0.7	5
Selenium	1450	U	0.0057	0.057	0.1	0.5	7
Zinc	1450	U	0.0078	< 0.50	4	50	200
Chloride	1220	U	< 1.0	< 10	800	15000	25000
Fluoride	1220	U	0.23	2.3	10	150	500
Sulphate	1220	U	100	1000	1000	20000	50000
Total Dissolved Solids	1020	N	230	2300	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	U	4.1	< 50	500	800	1000

Solid Information	
Dry mass of test portion/kg	0.090
Moisture (%)	9.4

Waste Acceptance Criteria

Landfill WAC analysis (specifically leaching test results) must not be used for hazardous waste classification purposes. This analysis is only applicable for hazardous waste landfill acceptance and does not give any indication as to whether a waste may be hazardous or non-hazardous.

Test Methods

SOP	Title	Parameters included	Method summary
1020	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Conductivity Meter
1220	Anions, Alkalinity & Ammonium in Waters	Fluoride; Chloride; Nitrite; Nitrate; Total; Oxidisable Nitrogen (TON); Sulfate; Phosphate; Alkalinity; Ammonium	Automated colorimetric analysis using 'Aquakem 600' Discrete Analyser.
1450	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).
1610	Total/Dissolved Organic Carbon in Waters	Organic Carbon	TOC Analyser using Catalytic Oxidation
1920	Phenols in Waters by HPLC	Phenolic compounds including: Phenol, Cresols, Xylenols, Trimethylphenols Note: Chlorophenols are excluded.	Determination by High Performance Liquid Chromatography (HPLC) using electrochemical detection.
2010	pH Value of Soils	pH	pH Meter
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2040	Soil Description(Requirement of MCERTS)	Soil description	As received soil is described based upon BS5930
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2300	Cyanides & Thiocyanate in Soils	Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Allkaline extraction followed by colorimetric determination using Automated Flow Injection Analyser.
2450	Acid Soluble Metals in Soils	Metals, including: Arsenic; Barium; Beryllium; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Vanadium; Zinc	Acid digestion followed by determination of metals in extract by ICP-MS.
2625	Total Organic Carbon in Soils	Total organic Carbon (TOC)	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2670	Total Petroleum Hydrocarbons (TPH) in Soils by GC-FID	TPH (C6–C40); optional carbon banding, e.g. 3-band – GRO, DRO & LRO*TPH C8–C40	Dichloromethane extraction / GC-FID
2700	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-FID	Acenaphthene; Acenaphthylene; Anthracene; Benzo[a]Anthracene; Benzo[a]Pyrene; Benzo[b]Fluoranthene; Benzo[ghi]Perylene; Benzo[k]Fluoranthene; Chrysene; Dibenz[ah]Anthracene; Fluoranthene; Fluorene; Indeno[123cd]Pyrene; Naphthalene; Phenanthrene; Pyrene	Dichloromethane extraction / GC-FID (GC-FID detection is non-selective and can be subject to interference from co-eluting compounds)
2760	Volatile Organic Compounds (VOCs) in Soils by Headspace GC-MS	Volatile organic compounds, including BTEX and halogenated Aliphatic/Aromatics.(cf. USEPA Method 8260)*please refer to UKAS schedule	Automated headspace gas chromatographic (GC) analysis of a soil sample, as received, with mass spectrometric (MS) detection of volatile organic compounds.
2815	Polychlorinated Biphenyls (PCB) ICES7Congeners in Soils by GC-MS	ICES7 PCB congeners	Acetone/Hexane extraction / GC-MS
2920	Phenols in Soils by HPLC	Phenolic compounds including Resorcinol, Phenol, Methylphenols, Dimethylphenols, 1-Naphthol and TrimethylphenolsNote: chlorophenols are excluded.	60:40 methanol/water mixture extraction, followed by HPLC determination using electrochemical detection.
640	Characterisation of Waste (Leaching C10)	Waste material including soil, sludges and granular waste	ComplianceTest for Leaching of Granular Waste Material and Sludge

Report Information

Key

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

Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

Uncertainty of measurement for the determinands tested are available upon request

None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis

All Asbestos testing is performed at the indicated laboratory

Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied

B - Sample age exceeds stability time (sampling to extraction)

C - Sample not received in appropriate containers

D - Broken Container

E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 45 days from the date of receipt

All water samples will be retained for 14 days from the date of receipt

Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:

customerservices@chemtest.com

eurofins | Chemtest
Eurofins Chemtest Ltd
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

Final Report

Report No.:	20-29441-1
Initial Date of Issue:	09-Nov-2020
Client	Causeway Geotech Ltd
Client Address:	8 Drumahiskey Road Balnamore Ballymoney County Antrim BT53 7QL
Contact(s):	Carin Cornwall Colm Hurley Darren O'Mahony Gabriella Horan Joe Gervin John Cameron Lucy Newland Martin Gardiner Matthew Gilbert Neil Haggan Paul Dunlop Sean Ross Stephen Franey Stephen McCracken Stephen Watson Stuart Abraham Thomas McAllis
Project	20-0399A Bus Connects Route 2

Quotation No.:	Q20-21063	**Date Received:**	30-Oct-2020
Order No.:		**Date Instructed:**	03-Nov-2020
No. of Samples:	2		
Turnaround (Wkdays):	5	**Results Due:**	09-Nov-2020
Date Approved:	09-Nov-2020		

Approved By:

Details: Glynn Harvey, Technical Manager

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

Results - Soil

Project: 20-0399A Bus Connects Route 2

Client: Causeway Geotech Ltd		**Chemtest Job No.:**			20-29441	20-29441
Quotation No.: Q20-21063		**Chemtest Sample ID.:**			1089266	1089268
			Sample Location:		R2CPRC02	R2CPRC02
			Sample Type:		SOIL	SOIL
			Top Depth (m):		1.00	3.00
			Date Sampled:		26-Oct-2020	26-Oct-2020
			Asbestos Lab:		LIVERPOOL	LIVERPOOL
Determinand	**Accred.**	**SOP**	**Units**	**LOD**		
ACM Type	U	2192		N/A	-	-
Asbestos Identification	U	2192		N/A	No Asbestos Detected	No Asbestos Detected
ACM Detection Stage	U	2192		N/A	-	-
Moisture	N	2030	%	0.020	5.5	9.6
pH	M	2010		4.0	8.7	8.6
Boron (Hot Water Soluble)	M	2120	mg/kg	0.40	0.67	0.66
Sulphate (2:1 Water Soluble) as SO4	M	2120	g/l	0.010	0.021	0.18
Cyanide (Total)	M	2300	mg/kg	0.50	< 0.50	0.50
Arsenic	M	2450	mg/kg	1.0	23	25
Cadmium	M	2450	mg/kg	0.10	1.1	1.0
Chromium	M	2450	mg/kg	1.0	18	11
Copper	M	2450	mg/kg	0.50	50	35
Mercury	M	2450	mg/kg	0.10	0.46	1.1
Nickel	M	2450	mg/kg	0.50	34	27
Lead	M	2450	mg/kg	0.50	440	180
Zinc	M	2450	mg/kg	0.50	120	80
Organic Matter	M	2625	%	0.40	3.3	4.0
Total TPH >C6-C40	M	2670	mg/kg	10	60	< 10
Naphthalene	M	2700	mg/kg	0.10	< 0.10	< 0.10
Acenaphthylene	M	2700	mg/kg	0.10	< 0.10	< 0.10
Acenaphthene	M	2700	mg/kg	0.10	< 0.10	< 0.10
Fluorene	M	2700	mg/kg	0.10	< 0.10	< 0.10
Phenanthrene	M	2700	mg/kg	0.10	1.0	< 0.10
Anthracene	M	2700	mg/kg	0.10	0.39	< 0.10
Fluoranthene	M	2700	mg/kg	0.10	3.2	0.60
Pyrene	M	2700	mg/kg	0.10	3.6	0.64
Benzo[a]anthracene	M	2700	mg/kg	0.10	2.0	< 0.10
Chrysene	M	2700	mg/kg	0.10	1.9	< 0.10
Benzo[b]fluoranthene	M	2700	mg/kg	0.10	4.0	< 0.10
Benzo[k]fluoranthene	M	2700	mg/kg	0.10	1.4	< 0.10
Benzo[a]pyrene	M	2700	mg/kg	0.10	3.3	< 0.10
Indeno(1,2,3-c,d)Pyrene	M	2700	mg/kg	0.10	2.3	< 0.10
Dibenz(a,h)Anthracene	M	2700	mg/kg	0.10	1.1	< 0.10
Benzo[g,h,i]perylene	M	2700	mg/kg	0.10	2.6	< 0.10
Coronene	N	2700	mg/kg	0.10	< 0.10	< 0.10
Total Of 17 PAH's	N	2700	mg/kg	2.0	27	< 2.0
Total Phenols	M	2920	mg/kg	0.30	< 0.30	< 0.30

Results - Single Stage WAC

Project: 20-0399A Bus Connects Route 2

					Landfill Waste Acceptance Criteria Limits		
Chemtest Job No:	20-29441						
Chemtest Sample ID:	1089266						
Sample Ref:							
Sample ID:							
Sample Location:	R2CPRC02						
Top Depth(m):	1.00						
Bottom Depth(m):							
Sampling Date:	26-Oct-2020						
Determinand	**SOP**	**Accred.**	**Units**		**Inert Waste Landfill**	**Stable, Non-reactive hazardous waste in non-hazardous Landfill**	**Hazardous Waste Landfill**
Total Organic Carbon	2625	M	%	1.9	3	5	6
Loss on Ignition					--	--	10
Total BTEX	2760	M	mg/kg	< 0.010	6	--	--
Total PCBs (7 Congeners)	2815	M	mg/kg	< 0.10	1	--	--
TPH Total WAC (Mineral Oil)	2670	M	mg/kg	60	500	--	--
Total (Of 17) PAH's	2700	N	mg/kg	27	100	--	--
pH					--	>6	--
Acid Neutralisation Capacity					--	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 at L/S 10 l/kg**		
Arsenic	1450	U	0.0034	< 0.050	0.5	2	25
Barium	1450	U	0.012	< 0.50	20	100	300
Cadmium	1450	U	< 0.00010	< 0.010	0.04	1	5
Chromium	1450	U	< 0.0010	< 0.050	0.5	10	70
Copper	1450	U	0.0044	< 0.050	2	50	100
Mercury	1450	U	< 0.00050	< 0.0050	0.01	0.2	2
Molybdenum	1450	U	0.0081	0.081	0.5	10	30
Nickel	1450	U	< 0.0010	< 0.050	0.4	10	40
Lead	1450	U	0.0018	0.018	0.5	10	50
Antimony	1450	U	0.0013	0.013	0.06	0.7	5
Selenium	1450	U	0.0025	0.025	0.1	0.5	7
Zinc	1450	U	0.0034	< 0.50	4	50	200
Chloride	1220	U	< 1.0	< 10	800	15000	25000
Fluoride	1220	U	0.33	3.3	10	150	500
Sulphate	1220	U	7.3	73	1000	20000	50000
Total Dissolved Solids	1020	N	72	720	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	U	24	240	500	800	1000

Solid Information	
Dry mass of test portion/kg	0.090
Moisture (%)	5.5

Waste Acceptance Criteria

Landfill WAC analysis (specifically leaching test results) must not be used for hazardous waste classification purposes. This analysis is only applicable for hazardous waste landfill acceptance and does not give any indication as to whether a waste may be hazardous or non-hazardous.

Test Methods

SOP	Title	Parameters included	Method summary
1020	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Conductivity Meter
1220	Anions, Alkalinity & Ammonium in Waters	Fluoride; Chloride; Nitrite; Nitrate; Total; Oxidisable Nitrogen (TON); Sulfate; Phosphate; Alkalinity; Ammonium	Automated colorimetric analysis using 'Aquakem 600' Discrete Analyser.
1450	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).
1610	Total/Dissolved Organic Carbon in Waters	Organic Carbon	TOC Analyser using Catalytic Oxidation
1920	Phenols in Waters by HPLC	Phenolic compounds including: Phenol, Cresols, Xylenols, Trimethylphenols Note: Chlorophenols are excluded.	Determination by High Performance Liquid Chromatography (HPLC) using electrochemical detection.
2010	pH Value of Soils	pH	pH Meter
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2040	Soil Description(Requirement of MCERTS)	Soil description	As received soil is described based upon BS5930
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2300	Cyanides & Thiocyanate in Soils	Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Allkaline extraction followed by colorimetric determination using Automated Flow Injection Analyser.
2450	Acid Soluble Metals in Soils	Metals, including: Arsenic; Barium; Beryllium; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Vanadium; Zinc	Acid digestion followed by determination of metals in extract by ICP-MS.
2625	Total Organic Carbon in Soils	Total organic Carbon (TOC)	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2670	Total Petroleum Hydrocarbons (TPH) in Soils by GC-FID	TPH (C6–C40); optional carbon banding, e.g. 3-band – GRO, DRO & LRO*TPH C8–C40	Dichloromethane extraction / GC-FID
2700	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-FID	Acenaphthene; Acenaphthylene; Anthracene; Benzo[a]Anthracene; Benzo[a]Pyrene; Benzo[b]Fluoranthene; Benzo[ghi]Perylene; Benzo[k]Fluoranthene; Chrysene; Dibenz[ah]Anthracene; Fluoranthene; Fluorene; Indeno[123cd]Pyrene; Naphthalene; Phenanthrene; Pyrene	Dichloromethane extraction / GC-FID (GC-FID detection is non-selective and can be subject to interference from co-eluting compounds)
2760	Volatile Organic Compounds (VOCs) in Soils by Headspace GC-MS	Volatile organic compounds, including BTEX and halogenated Aliphatic/Aromatics.(cf. USEPA Method 8260)*please refer to UKAS schedule	Automated headspace gas chromatographic (GC) analysis of a soil sample, as received, with mass spectrometric (MS) detection of volatile organic compounds.
2815	Polychlorinated Biphenyls (PCB) ICES7Congeners in Soils by GC-MS	ICES7 PCB congeners	Acetone/Hexane extraction / GC-MS
2920	Phenols in Soils by HPLC	Phenolic compounds including Resorcinol, Phenol, Methylphenols, Dimethylphenols, 1-Naphthol and TrimethylphenolsNote: chlorophenols are excluded.	60:40 methanol/water mixture extraction, followed by HPLC determination using electrochemical detection.
640	Characterisation of Waste (Leaching C10)	Waste material including soil, sludges and granular waste	ComplianceTest for Leaching of Granular Waste Material and Sludge

Report Information

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I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"

Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

Uncertainty of measurement for the determinands tested are available upon request

None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis

All Asbestos testing is performed at the indicated laboratory

Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied

B - Sample age exceeds stability time (sampling to extraction)

C - Sample not received in appropriate containers

D - Broken Container

E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 45 days from the date of receipt

All water samples will be retained for 14 days from the date of receipt

Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:

customerservices@chemtest.com

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

Final Report

Report No.:	20-31961-1
Initial Date of Issue:	30-Nov-2020
Client	Causeway Geotech Ltd
Client Address:	8 Drumahiskey Road Balnamore Ballymoney County Antrim BT53 7QL
Contact(s):	Carin Cornwall Colm Hurley Darren O'Mahony Gabriella Horan Joe Gervin John Cameron Lucy Newland Martin Gardiner Matthew Gilbert Neil Haggan Paul Dunlop Sean Ross Stephen Franey Stephen McCracken Stephen Watson Stuart Abraham Thomas McAllis
Project	20-0399A Bus Connects Route 2
Quotation No.:	Q20-21063
Date Received:	24-Nov-2020
Order No.:	
Date Instructed:	26-Nov-2020
No. of Samples:	1
Turnaround (Wkdays):	5
Results Due:	02-Dec-2020
Date Approved:	30-Nov-2020
Approved By:	

Details:	Glynn Harvey, Technical Manager

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

Results - Water

Project: 20-0399A Bus Connects Route 2

Client: Causeway Geotech Ltd			**Chemtest Job No.:**		20-31961
Quotation No.: Q20-21063			**Chemtest Sample ID.:**		1101778
			Sample Location:		R2-CPRC02
			Sample Type:		WATER
			Date Sampled:		19-Nov-2020
Determinand	**Accred.**	**SOP**	**Units**	**LOD**	
pH	U	1010		N/A	7.7
Electrical Conductivity	U	1020	µS/cm	1.0	840
Ammonia (Free) as N	U	1220	mg/l	0.050	0.19
Nitrite as N	U	1220	mg/l	0.010	< 0.010
Nitrate as N	U	1220	mg/l	0.50	< 0.50
Phosphorus (Total)	N	1220	mg/l	0.020	< 0.020
Phosphate as P	U	1220	mg/l	0.050	< 0.050
Nitrogen (Total)	N	1340	mg/l	5.0	6.6
Calcium	U	1415	mg/l	5.0	62
Magnesium	U	1415	mg/l	0.50	22
Sodium	U	1415	mg/l	0.50	91
Total Hardness as CaCO3	U	1270	mg/l	15	250
Arsenic (Dissolved)	U	1450	µg/l	1.0	1.0
Boron (Dissolved)	U	1450	µg/l	20	120
Barium (Dissolved)	U	1450	µg/l	5.0	85
Cadmium (Dissolved)	U	1450	µg/l	0.080	< 0.080
Copper (Dissolved)	U	1450	µg/l	1.0	< 1.0
Iron (Dissolved)	N	1450	µg/l	20	120
Mercury (Dissolved)	U	1450	µg/l	0.50	2.0
Manganese (Dissolved)	U	1450	µg/l	1.0	53
Molybdenum (Dissolved)	U	1450	µg/l	1.0	13
Nickel (Dissolved)	U	1450	µg/l	1.0	6.1
Lead (Dissolved)	U	1450	µg/l	1.0	< 1.0
Antimony (Dissolved)	U	1450	µg/l	1.0	2.8
Selenium (Dissolved)	U	1450	µg/l	1.0	3.0
Zinc (Dissolved)	U	1450	µg/l	1.0	9.6
Chromium (Trivalent)	N	1490	µg/l	20	[B] < 20
Chromium (Hexavalent)	U	1490	µg/l	20	[B] < 20
Total Organic Carbon	U	1610	mg/l	2.0	< 2.0
Mineral Oil	N	1670	µg/l	10	< 10
Total TPH >C6-C40	U	1670	µg/l	10	< 10
Naphthalene	U	1800	µg/l	0.10	< 0.10
Acenaphthylene	U	1800	µg/l	0.10	< 0.10
Acenaphthene	U	1800	µg/l	0.10	< 0.10
Fluorene	U	1800	µg/l	0.10	< 0.10
Phenanthrene	U	1800	µg/l	0.10	< 0.10
Anthracene	U	1800	µg/l	0.10	< 0.10
Fluoranthene	U	1800	µg/l	0.10	< 0.10
Pyrene	U	1800	µg/l	0.10	< 0.10
Benzo[a]anthracene	U	1800	µg/l	0.10	< 0.10
Chrysene	U	1800	µg/l	0.10	< 0.10

Results - Water

Project: 20-0399A Bus Connects Route 2

Client: Causeway Geotech Ltd			**Chemtest Job No.:**		20-31961
Quotation No.: Q20-21063			**Chemtest Sample ID.:**		1101778
			Sample Location:		R2-CPRC02
			Sample Type:		WATER
			Date Sampled:		19-Nov-2020
Determinand	**Accred.**	**SOP**	**Units**	**LOD**	
Benzo[b]fluoranthene	U	1800	µg/l	0.10	< 0.10
Benzo[k]fluoranthene	U	1800	µg/l	0.10	< 0.10
Benzo[a]pyrene	U	1800	µg/l	0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	U	1800	µg/l	0.10	< 0.10
Dibenz(a,h)Anthracene	U	1800	µg/l	0.10	< 0.10
Benzo[g,h,i]perylene	U	1800	µg/l	0.10	< 0.10
Total Of 16 PAH's	U	1800	µg/l	2.0	< 2.0

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.

Sample:	Sample Ref:	Sample ID:	Sample Location:	Sampled Date:	Deviation Code(s):	Containers Received:
1101778			R2-CPRC02	19-Nov-2020	B	Coloured Winchester 1000ml
1101778			R2-CPRC02	19-Nov-2020	B	EPA Vial 40ml
1101778			R2-CPRC02	19-Nov-2020	B	Plastic Bottle 1000ml

Test Methods

SOP	Title	Parameters included	Method summary
1010	pH Value of Waters	pH	pH Meter
1020	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Conductivity Meter
1220	Anions, Alkalinity & Ammonium in Waters	Fluoride; Chloride; Nitrite; Nitrate; Total; Oxidisable Nitrogen (TON); Sulfate; Phosphate; Alkalinity; Ammonium	Automated colorimetric analysis using 'Aquakem 600' Discrete Analyser.
1270	Total Hardness of Waters	Total hardness	Calculation applied to calcium and magnesium results, expressed as mg l-1 CaCO3 equivalent.
1340	Total Nitrogen in Waters	Total Nitrogen and organic Nitrogen	Persulphate digestion followed by colorimetry.
1415	Cations in Waters by ICP-MS	Sodium; Potassium; Calcium; Magnesium	Direct determination by inductively coupled plasma - mass spectrometry (ICP-MS).
1450	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).
1490	Hexavalent Chromium in Waters	Chromium [VI]	Automated colorimetric analysis by 'Aquakem 600' Discrete Analyser using 1,5-diphenylcarbazide.
1610	Total/Dissolved Organic Carbon in Waters	Organic Carbon	TOC Analyser using Catalytic Oxidation
1670	Total Petroleum Hydrocarbons (TPH) in Waters by GC-FID	TPH (C6–C40); optional carbon banding, e.g. 3-band – GRO, DRO & LRO	Pentane extraction / GC FID detection
1800	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Waters by GC-MS	Acenaphthene; Acenaphthylene; Anthracene; Benzo[a]Anthracene; Benzo[a]Pyrene; Benzo[b]Fluoranthene; Benzo[ghi]Perylene; Benzo[k]Fluoranthene; Chrysene; Dibenz[ah]Anthracene; Fluoranthene; Fluorene; Indeno[123cd]Pyrene; Naphthalene; Phenanthrene; Pyrene	Pentane extraction / GCMS detection

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customerservices@chemtest.com

CAUSEWAY GEOTECH

APPENDIX J

SPT HAMMER ENERGY MEASUREMENT REPORT

Southern Testing
Environmental & Geotechnical

SPT Hammer Energy Test Report

in accordance with BSEN ISO 22476-3:2005

Southern Testing
Keeble House
Stuart Way
East Grinstead
West Sussex
RH19 4QA

SPT Hammer Ref: .0208
Test Date: 22/02/2020
Report Date: 03/03/2020
File Name: .0208.spt
Test Operator: NPB

Instrumented Rod Data

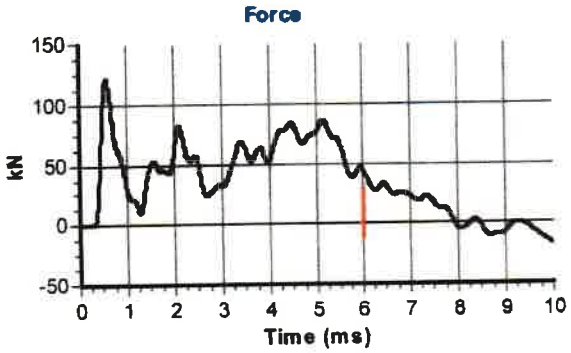
Diameter d_r (mm): 54
Wall Thickness t_r (mm): 6.0
Assumed Modulus E_a (GPa): 200
Accelerometer No.1: 6458
Accelerometer No.2: 9607

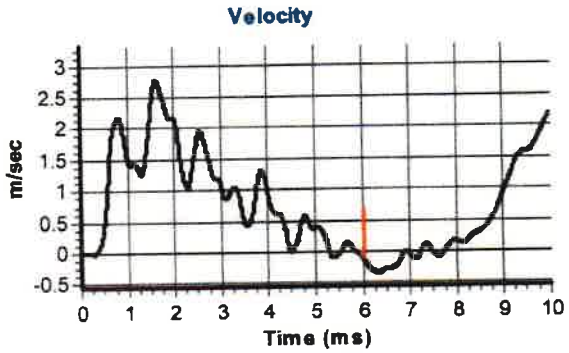
SPT Hammer Information

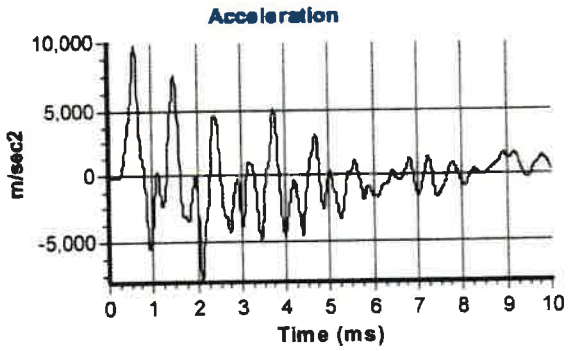
Hammer Mass m (kg): 63.5
Falling Height h (mm): 760
SPT String Length L (m): 10.0

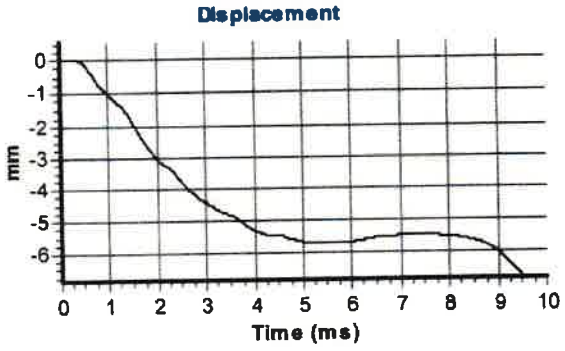
Comments / Location

BALLEYMONEY









Calculations

Area of Rod A (mm2): 905
Theoretical Energy E_{theor} (J): 473
Measured Energy E_{meas} (J): 331

Energy Ratio E_r (%): 70

Signed: Neil Burrows
Title: Field Operations Manager

The recommended calibration interval is 12 months

Southern Testing
Environmental & Geotechnical

SPT Hammer Energy Test Report

in accordance with BSEN ISO 22476-3:2005

Southern Testing
Keeble House
Stuart Way
East Grinstead
West Sussex
RH19 4QA

SPT Hammer Ref: .0643
Test Date: 22/02/2020
Report Date: 03/03/2020
File Name: .0643.spt
Test Operator: NPB

Instrumented Rod Data

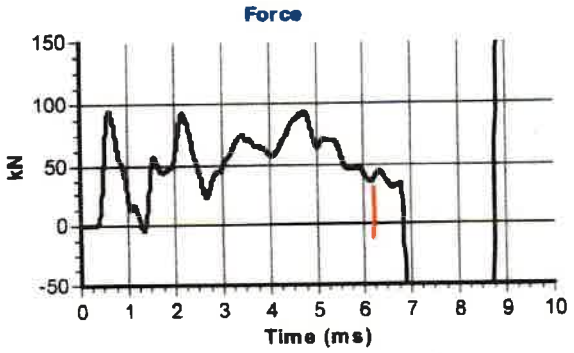
Diameter d_r (mm): 54
Wall Thickness t_r (mm): 6.0
Assumed Modulus E_a (GPa): 200
Accelerometer No.1: 6458
Accelerometer No.2: 9607

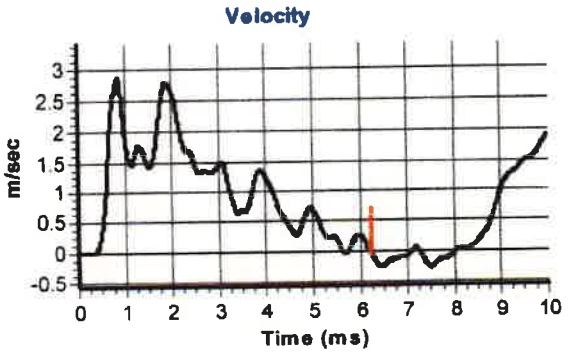
SPT Hammer Information

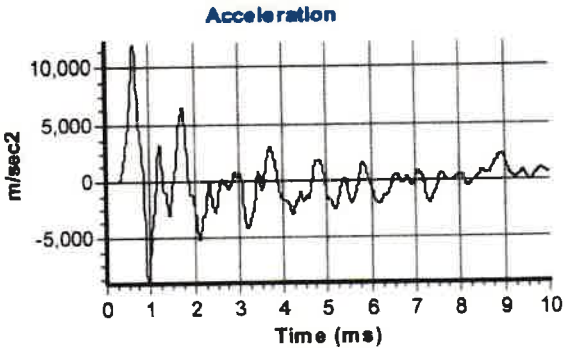
Hammer Mass m (kg): 63.5
Falling Height h (mm): 760
SPT String Length L (m): 10.0

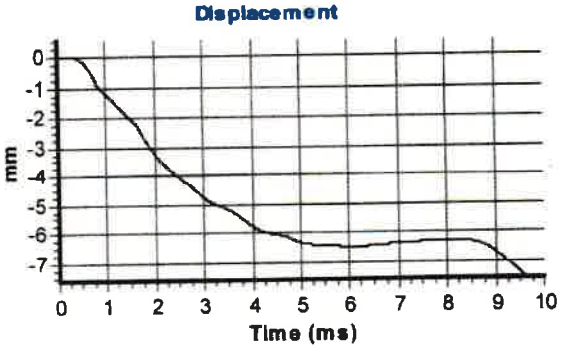
Comments / Location

BALLEYMONEY









Calculations

Area of Rod A (mm2): 905
Theoretical Energy E_{theor} (J): 473
Measured Energy E_{meas} (J): 400

Energy Ratio E_r (%): 85

Signed: Neil Burrows
Title: Field Operations Manager

The recommended calibration interval is 12 months