



Appendix A14.2
Ground Investigation
Report



CAUSEWAY
— GEOTECH

Bus Connects Route 9 Tallaght/Clondalkin to City Centre – Ground Investigation

Client: National Transport Authority (NTA)

Client's Representative: AECOM/Mott MacDonald

Report No.: 20-0399D

Date: December 2020

Status: Final for Issue

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Document Control Sheet




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Document Control Sheet

Report No.:		20-0399D			
Project Title:		Bus Connects Route 9 Tallaght/Clondalkin to City Centre			
Client:		National Transport Authority (NTA)			
Client's Representative:		AECOM/Mott MacDonald			
Revision:	A01	Status:	Final for Issue	Issue Date:	14 th November 2020
Prepared by:		Reviewed by:		Approved by:	
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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 $N \times 5 = C_u$ 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 9 Tallaght/Clondalkin to City Centre

1 AUTHORITY

On the instructions of AECOM/Mott MacDonald, (“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, soil and rock core sampling, environmental sampling, groundwater monitoring, in-situ and laboratory testing, and the preparation of a factual report on the findings.

3 DESCRIPTION OF SITE

As shown on the site location plan in Appendix A, the works were conducted along the proposed route from Tallaght in South Dublin to the Walkinstown Roundabout, with most locations undertaken along the Greenhills Road in grass areas, housing estates or industrial areas.

4 SITE OPERATIONS

4.1 Summary of site works

Site operations, which were conducted between 29th September and 29th October 2020, comprised:

- eighteen light cable percussion boreholes
- four boreholes by rotary follow-on methods
- one borehole by dynamic (windowless) sampling methods
- a standpipe installation in eight boreholes
- eleven machine dug trial pits
- indirect CBR tests at ten locations.

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

4.2 Boreholes

A total of nineteen boreholes were put down in a minimum diameter of 150mm through soils and rock strata to their completion depths by a combination of methods, including light percussion boring using a Dando Terrier rig, light cable percussion boring using a Dando 2000 rig, and rotary drilling by a truck mounted Beretta T44 rotary drilling rig.

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

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

4.2.1 Light cable percussion boreholes

Fourteen boreholes (R9CP01-R9CP13) were put down to completion in minimum 200mm diameter using a Dando 2000 light cable percussion boring rig. All boreholes were terminated either at their scheduled completion depths, or else on encountering virtual refusal. R9CP13A was terminated due to encountering an old tank and removed to a new position at R9CP13.

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 obstruction

Disturbed (bulk and small bag) samples were taken within the encountered strata. Undisturbed (U100) samples were taken where appropriate and as directed within fine soils. Environmental samples were taken at standard intervals, as directed by the Client's Representative.

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

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

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

Appendix B presents the borehole logs.

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

Four boreholes (R9CPGS01-R9CPGS04) were put down by a combination of light cable percussion boring and rotary follow-on drilling techniques using a truck mounted Beretta T44 rotary drilling rig with core recovery in overburden and bedrock.

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.

In the cable percussion section of the boreholes, disturbed (bulk and small bag) samples were taken within the encountered strata. Undisturbed (U100) samples were taken where appropriate and as directed within fine soils. Environmental samples were taken at standard intervals, as directed by the Client's Representative.

Any water strikes encountered during boring were recorded along with any changes in their levels as the borehole proceeded. Where water was added to assist with boring, a note has been added to the log to account for same.

Where the cable percussion borehole had not been advanced onto bedrock, rotary percussive methods were employed to advance the borehole to bedrock after which rotary coring was employed to recover core samples of the bedrock. Symmetrix cased full-hole drilling was used, with SPTs carried out at standard intervals as required.

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 I.

Where coring was carried out, 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.

4.2.3 Dynamic sampled boreholes

One borehole (R9WS01) was put down to completion by light percussion boring techniques using a Dando Terrier dynamic sampling rig.

A hand dug inspection pit was carried out between ground level and 1.20m depth to ensure the borehole was put down clear of services or subsurface obstructions.

The borehole was taken to a depth of 1.27m where it was terminated on encountering a service which was not picked up during the initial location clearance.

Disturbed (bulk) samples were taken within the encountered strata. Environmental samples were taken at standard intervals, as directed by the Client's Representative.

Appendix B presents the borehole logs.

4.3 Standpipe installations

A groundwater monitoring standpipe was installed in R9CP02, R9CP04, R9CP05, R9CP06, R9CP08, R9CP11, R9CPGS01 and R9CPGS04.

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

Eleven trial pits (R9TP01–R9TP11) were excavated using a 3t tracked excavator of JCB3CX fitted with a 600mm wide bucket, to a maximum depth of 4.20m.

Environmental samples were taken at standard intervals, as directed by the Client's Representative.

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

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

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

4.5 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 (Irl)) at each location are recorded on the individual exploratory hole logs. The exploratory hole plan presented in Appendix A shows these as-built positions.

4.6 Archaeological monitoring

Archaeological monitoring was conducted by Shanarc Archaeology during the excavation of R9TP01, R9TP02, R9TP04-R9TP07, R9TP10, R9TP11 and during excavation of inspection pits for R9CP03, R9CP04 and R9CP07-R9CP13a.

The findings of the monitoring are presented as a report in Appendix J.

4.7 Groundwater monitoring

Following completion of site works, groundwater monitoring was conducted on one round. 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, lab shear vane
- **compaction related:** Moisture Condition Value, California bearing ratio tests
- **soil chemistry:** pH, water soluble sulphate content, acid soluble sulphate content and total sulphur

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

The test results are presented in Appendix G.

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.

Soil testing was carried out on a number of samples according to Engineer’s Ireland Suite E and Rialta Suite of testing which included 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 H.

6 GROUND CONDITIONS

6.1 General geology of the area

Published geological mapping indicate the superficial deposits underlying the site comprise Glacial Till and fluvioglacial sands and gravels. These deposits are underlain by limestones and shales 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:

- **Paved surface:** R9CP07, R9CP09, R9CP12 and R9CP13 encountered 100-200 of bitmac surfacing while R9CP11 and R9CP13A encountered 100-200mm of concrete surfacing.
- **Made Ground (gravel surfacing):** R9CP06, R9CP08, R9CP10, R9TP03 and R9TP09 encountered gravel surfacing ranging in thickness from 100-200mm.
- **Topsoil:** encountered across the site in all grass area adjacent to Greenhills road ranging in thickness from 100-600mm.
- **Made Ground (sub-base):** approximately 200-300mm of aggregate fill beneath the paved surface,

topsoil or gravel surfacing at R9CP02, R9CP07, R9CP09, R9CP11, R9CP12, R9CP13, R9TP03 and R9TP09.

- **Made Ground (fill):** reworked sandy gravelly clay/silt or sandy clayey gravel or gravelly silty sand fill encountered at all locations except R9CP04, R9CP07, R9CP09, R9CP11, R9CP12, R9CPGS01 and R9TP02 to a maximum depth of 6.50m in R9CPGS02. Varying amounts of red brick, wood, plastic, cloth, glass, rubber, carpet, ceramics and concrete were encountered across the site concentrated R9CP05, R9TP05 and R9TP06.
- **Fluvioglacial deposits:** typically medium dense to dense sands and gravels interspersed with layers of sandy gravelly clay or silt encountered predominantly at all locations north of the M50 where the Greenhills Road roughly follows the path of an old glacial river channel.
- **Glacial Till:** sandy gravelly clay, frequently with low cobble content, typically firm or stiff in upper horizons, becoming very stiff with increasing depth.
- **Bedrock (Limestone/Mudstone):** Rockhead was encountered at depths ranging from 10m in R9CPGS03 to 12.95m in R9CPGS02 in the vicinity of where the Greenhills Road crosses the M50.

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, rotary drilling and trial pit excavation as groundwater strikes as shown in Table 1 below.

Table 1: Groundwater strikes encountered during the ground investigation

GI Ref	Water Level (mbgl)	Comments
R9CP01	5.00	Slow seepage at 5.00m
R9CP08	4.10	Rose to 4.00m after 20 mins
R9CP13	2.00	Seepage
R9CPGS01	9.00	
R9CPGS02	9.00	
R9CPGS03	9.00	
R9CPGS04	9.00	
R9TP05	1.60	Rapid water strike at 1.60m

Groundwater was not noted during drilling at some of the borehole locations. However, it should be noted that the casing used in supporting the borehole walls during drilling may have sealed out any additional groundwater strikes and the possibility of encountering groundwater at other depths during excavation works should not be ruled out.

It should 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 other trial pits.

Subsequent groundwater monitoring of the standpipe installations recorded water levels as shown in Table 2.

Table 2: Groundwater monitoring

Date	Water level (mbgl)							
	R9CP02	R9CP04	R9CP05	R9CP06	R9CP08	R9CP11	R9CPGS01	R9CPGS04
19/11/20	1.16	Bung stuck	Dry	Dry	4.1	3.28	8.00	8.92

Seasonal variation in groundwater levels should also be factored into design considerations and continued monitoring of the installed standpipes will give an indication of the seasonal variation.

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.

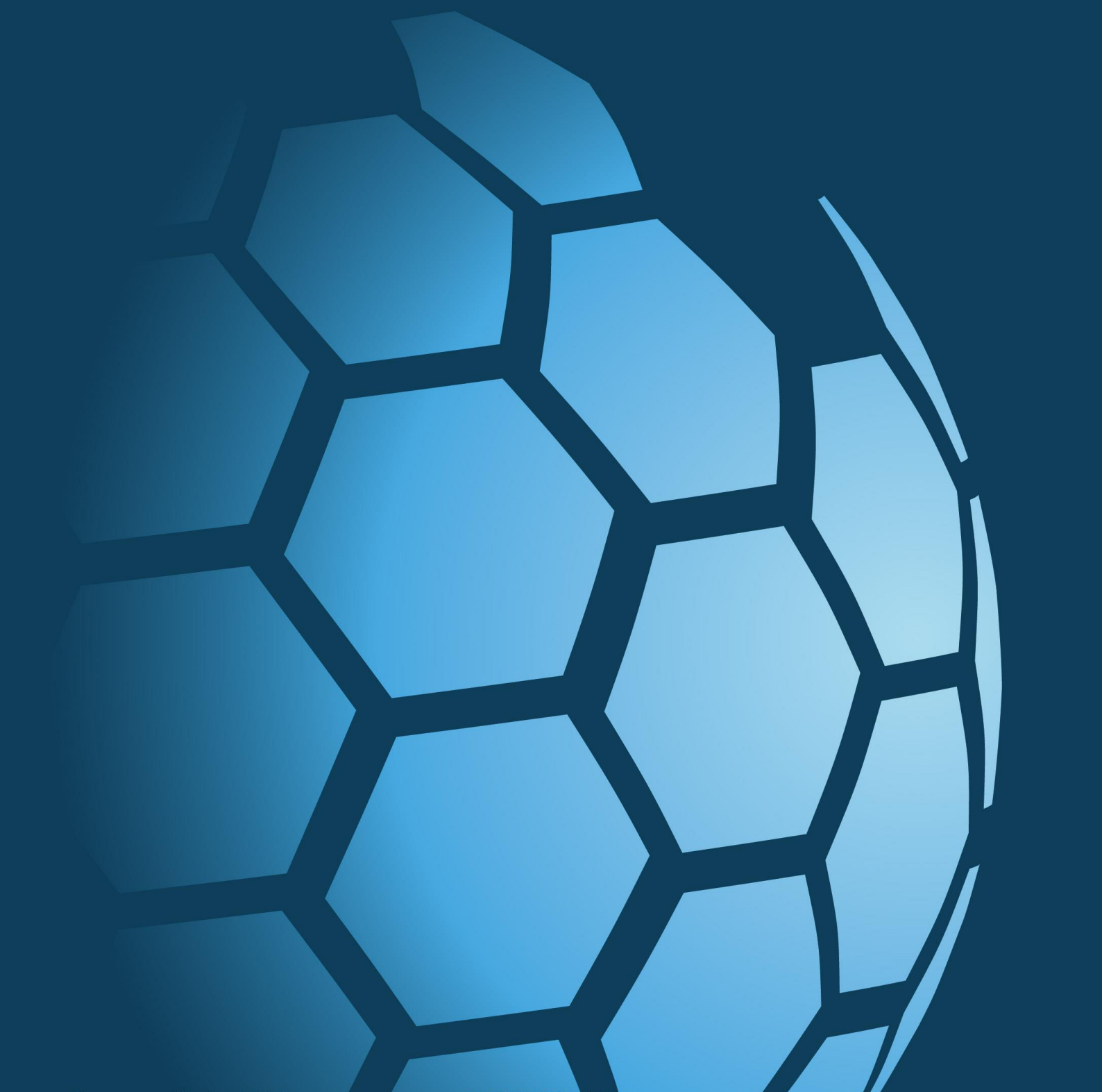
BS EN ISO 22476-3:2005+A1:2011: Geotechnical investigation and testing. Field testing. Standard penetration test.

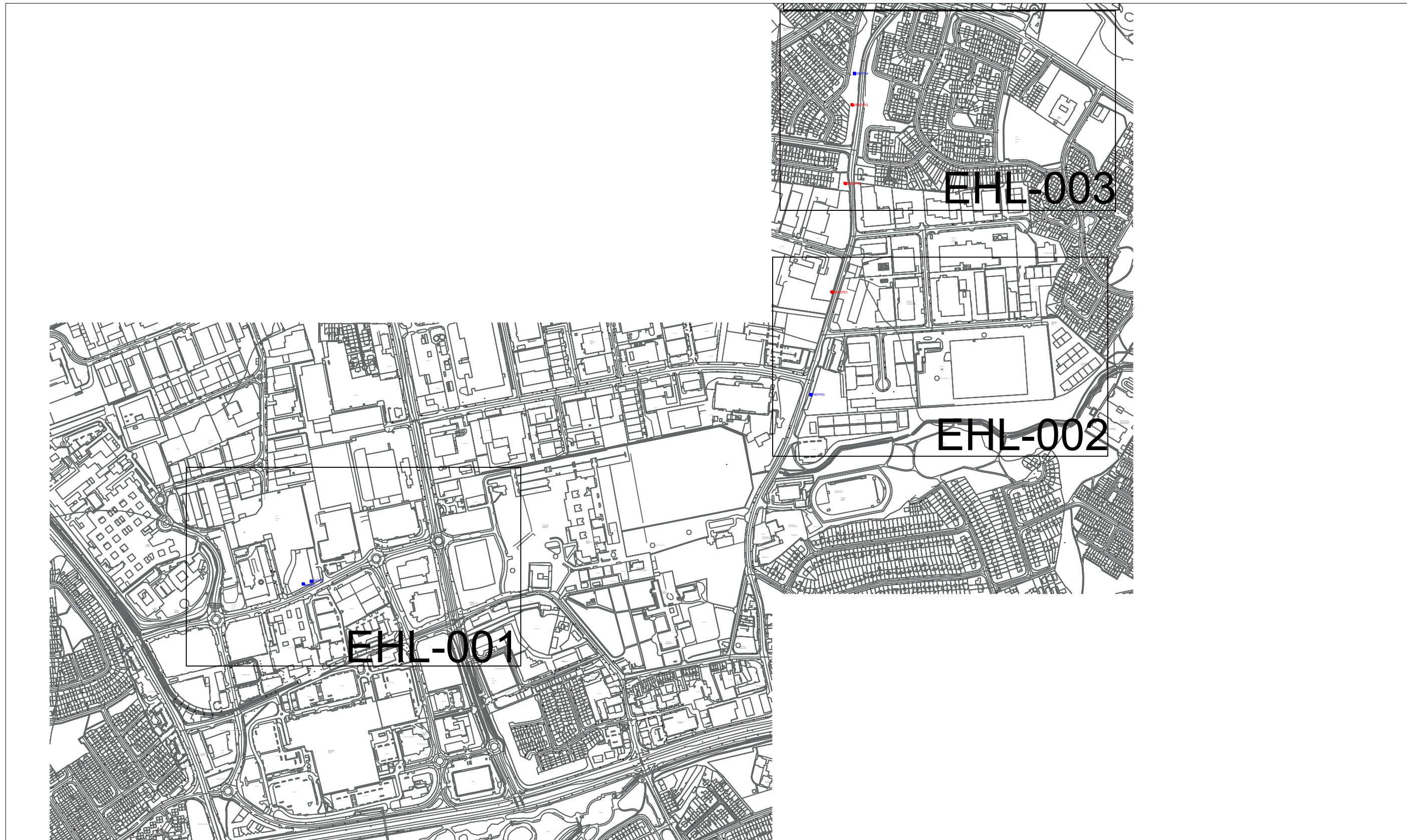


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APPENDIX A

SITE AND EXPLORATORY HOLE LOCATION PLAN





PROJECT: Bus Connects Route 9 Tallaght/Clondalkin to City Centre

TITLE: Exploratory hole location plan (Overview)

CLIENT: National Transport Authority (NTA)

KEY:
● Borehole
■ Trial Pits



SCALE:
NTS@A3

DATE:
23/11/2020

ENGINEER: AECOM/Mott MacDonald

DRWN: BS
 CHCK: CH

SERIES:
1 of 2

DWG No:
20-0399D-EHL-001



PROJECT: Bus Connects Route 9 Tallaght/Clondalkin to City Centre

TITLE: Exploratory hole location plan (Overview)

CLIENT: National Transport Authority (NTA)

KEY:
● Borehole
■ Trial Pits



SCALE: NTS@A3

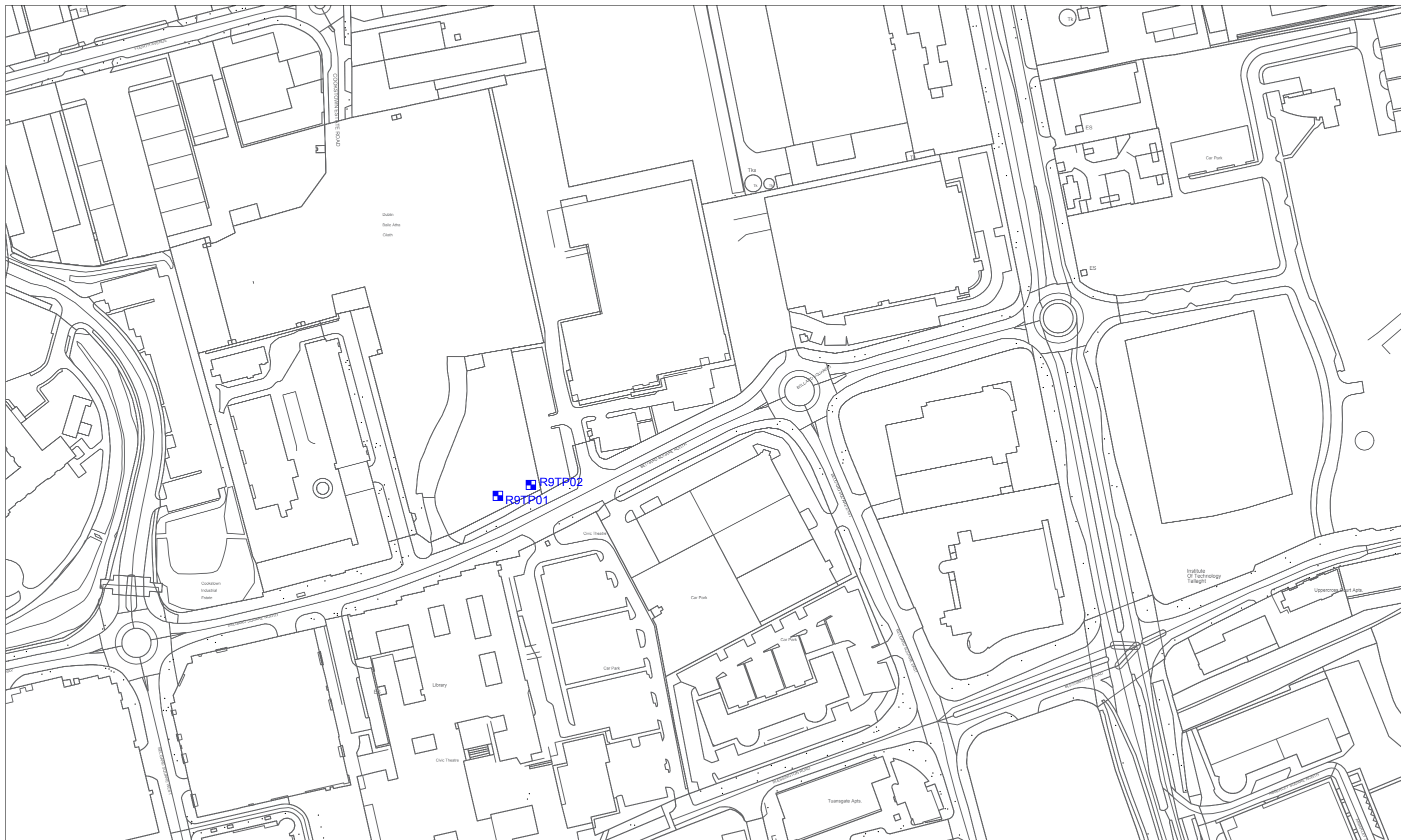
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ENGINEER: AECOM/Mott MacDonald

DRWN: BS
 CHCK: CH

SERIES: 2 of 2

DWG No: 20-0399D-EHL-002



PROJECT: Bus Connects Route 9 Tallaght/Clondalkin to City Centre

TITLE: Exploratory hole location plan

CLIENT: National Transport Authority (NTA)

KEY:
● Borehole
■ Trial Pits



SCALE: NTS@A3

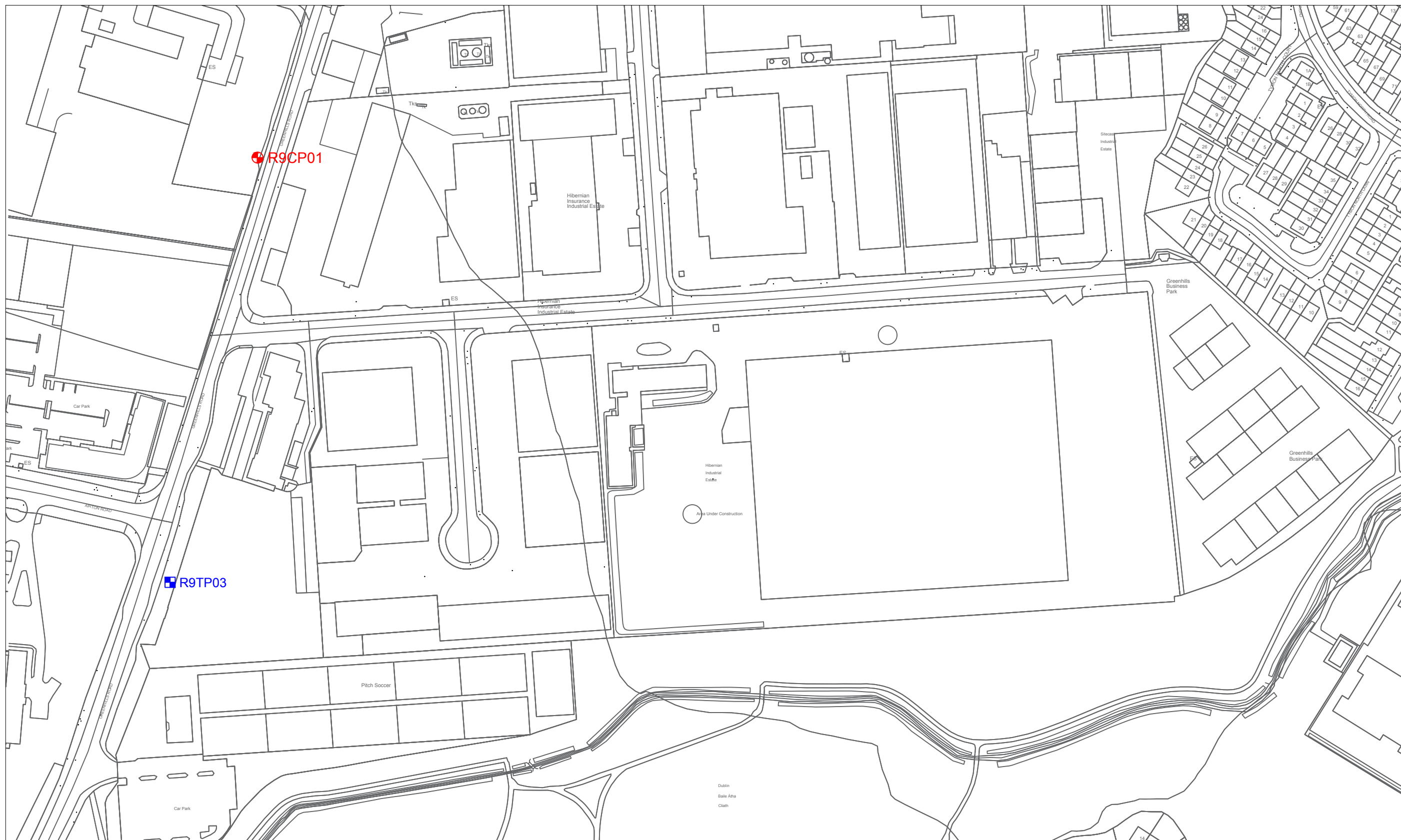
DATE: 23/11/2020

ENGINEER: AECOM/Mott MacDonald

DRWN: BS
 CHCK: CH

SERIES: 1 of 7

DWG No: 20-0399D-EHL-001



PROJECT: Bus Connects Route 9 Tallaght/Clondalkin to City Centre

TITLE: Exploratory hole location plan

CLIENT: National Transport Authority (NTA)

KEY:
● Borehole
■ Trial Pits



SCALE: NTS@A3

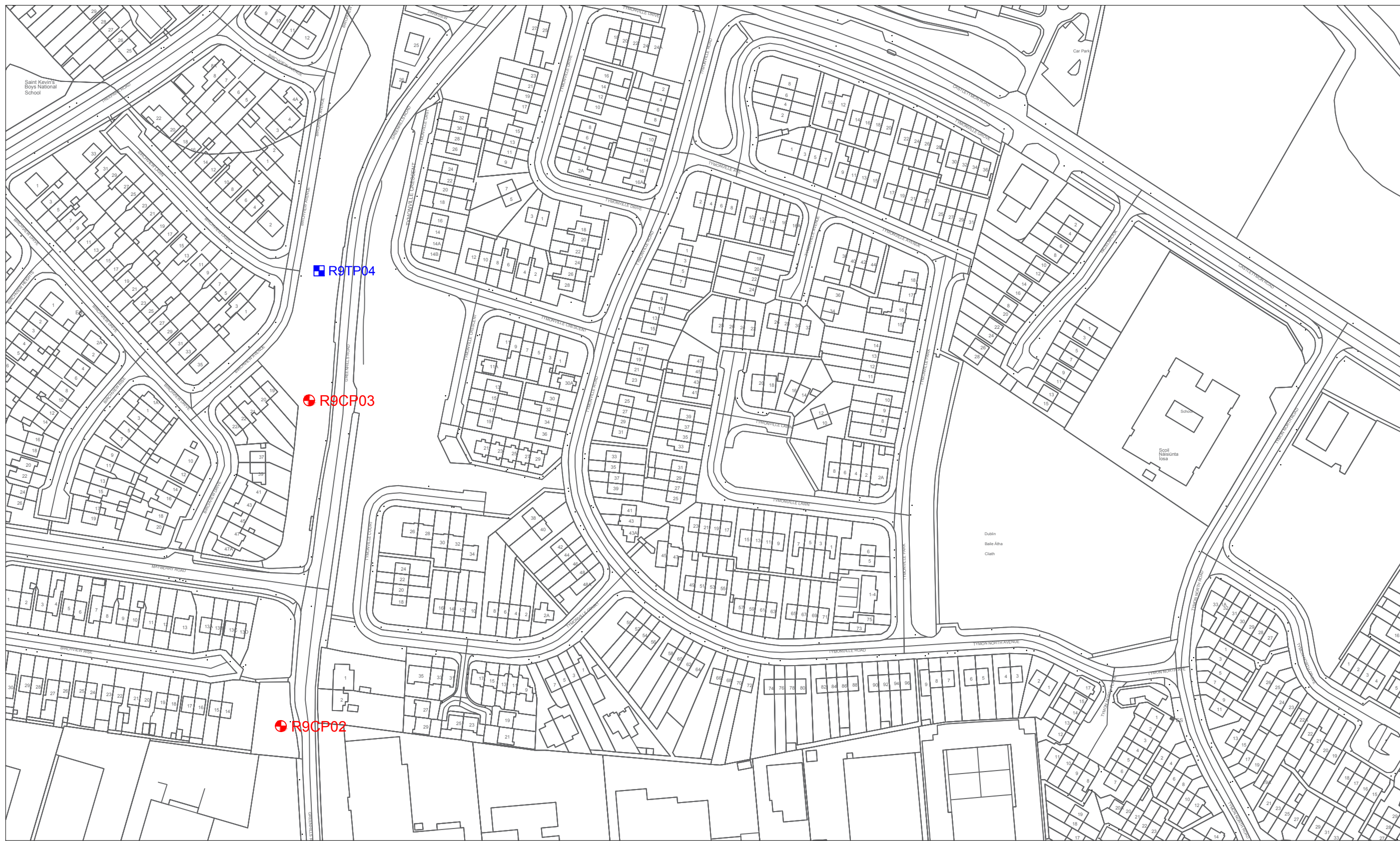
DATE: 23/11/2020

ENGINEER: AECOM/Mott MacDonald

DRWN: BS
 CHCK: CH

SERIES: 2 of 7

DWG No: 20-0399D-EHL-002



PROJECT: Bus Connects Route 9 Tallaght/Clondalkin to City Centre

TITLE: Exploratory hole location plan

CLIENT: National Transport Authority (NTA)

KEY:
● Borehole
■ Trial Pits



SCALE:
NTS@A3

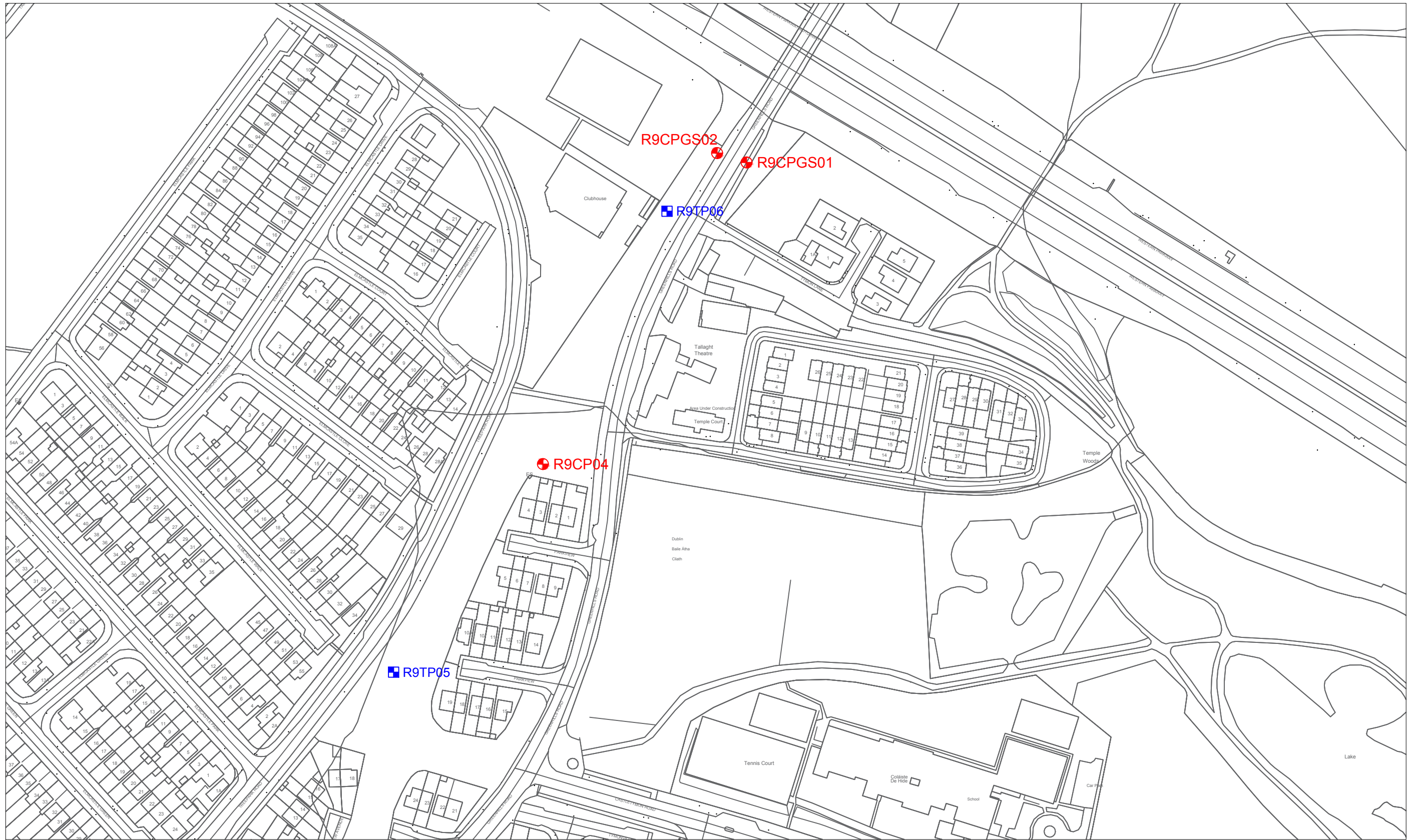
DATE:
23/11/2020

ENGINEER: AECOM/Mott MacDonald

DRWN: BS
CHCK: CH

SERIES:
3 of 7

DWG No:
20-0399D-EHL-003



PROJECT: Bus Connects Route 9 Tallaght/Clondalkin to City Centre

TITLE: Exploratory hole location plan

CLIENT: National Transport Authority (NTA)

KEY:
● Borehole
■ Trial Pits

ENGINEER: AECOM/Mott MacDonald



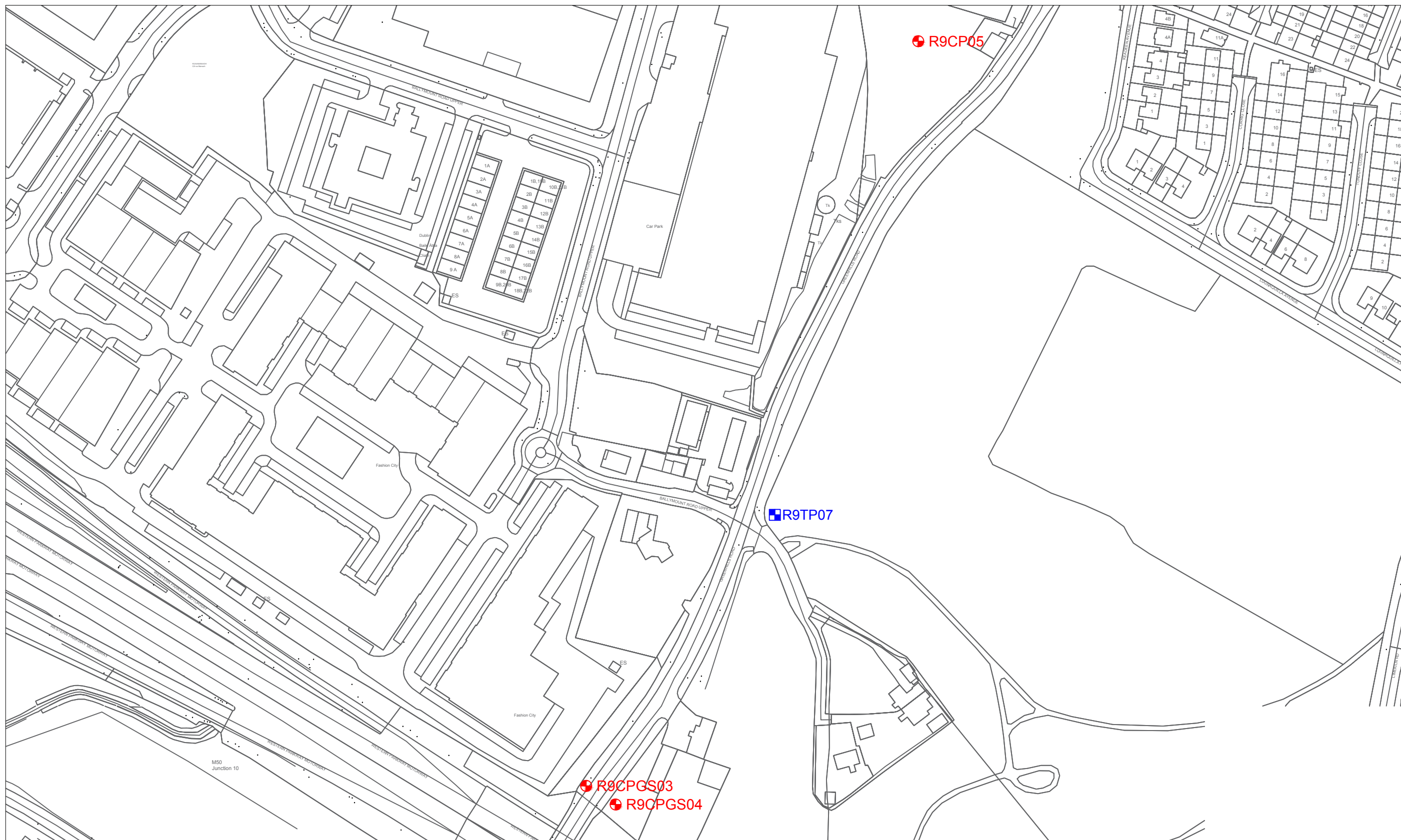
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DATE: 23/11/2020

DRWN: BS
 CHCK: CH

SERIES: 4 of 7

DWG No: 20-0399D-EHL-004



PROJECT: Bus Connects Route 9 Tallaght/Clondalkin to City Centre

TITLE: Exploratory hole location plan

CLIENT: National Transport Authority (NTA)

KEY:
● Borehole
■ Trial Pits

ENGINEER: AECOM/Mott MacDonald



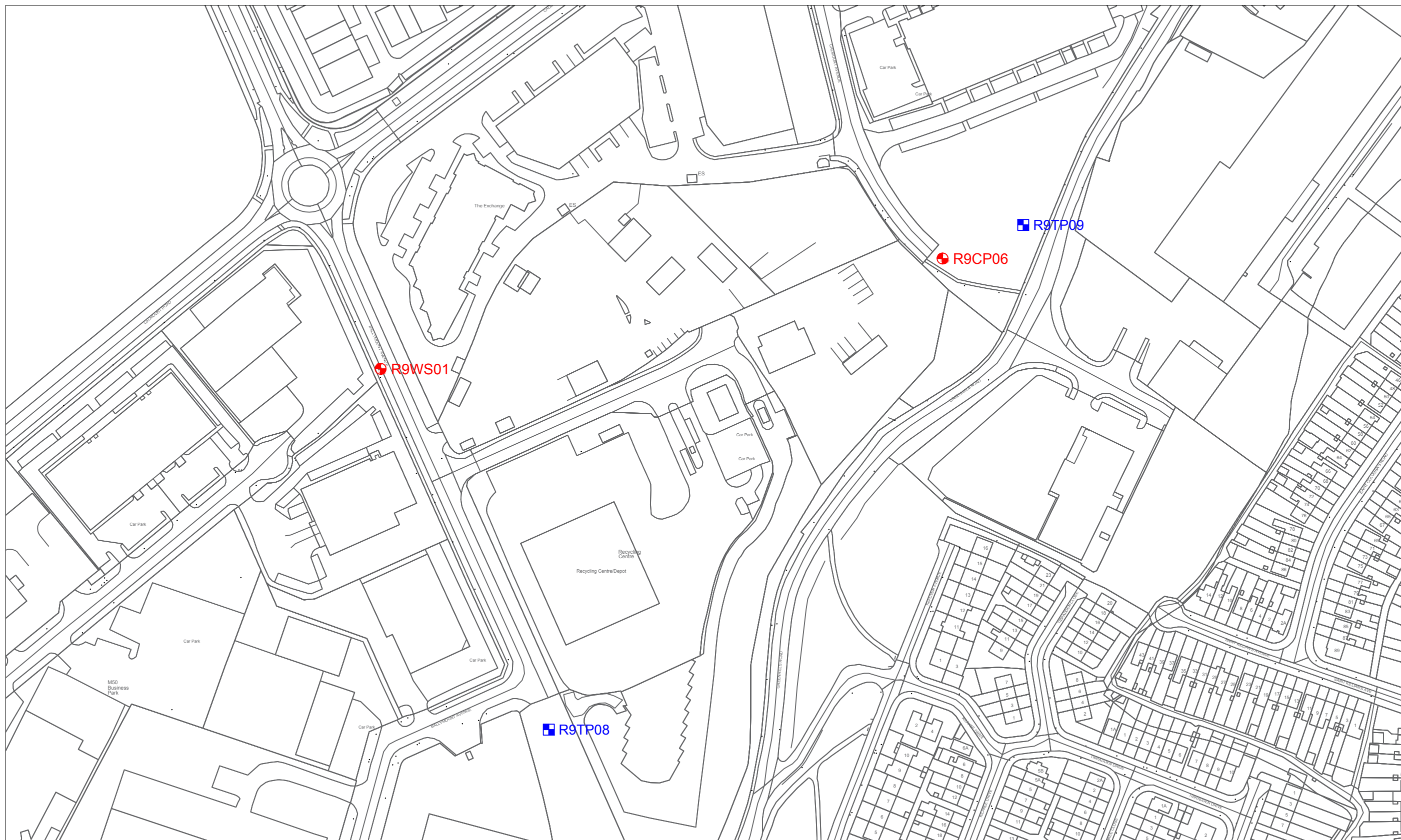
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DATE: 23/11/2020

DRWN: BS
 CHCK: CH

SERIES: 5 of 7

DWG No: 20-0399D-EHL-005



PROJECT: Bus Connects Route 9 Tallaght/Clondalkin to City Centre

TITLE: Exploratory hole location plan

CLIENT: National Transport Authority (NTA)

KEY:
● Borehole
■ Trial Pits

ENGINEER: AECOM/Mott MacDonald



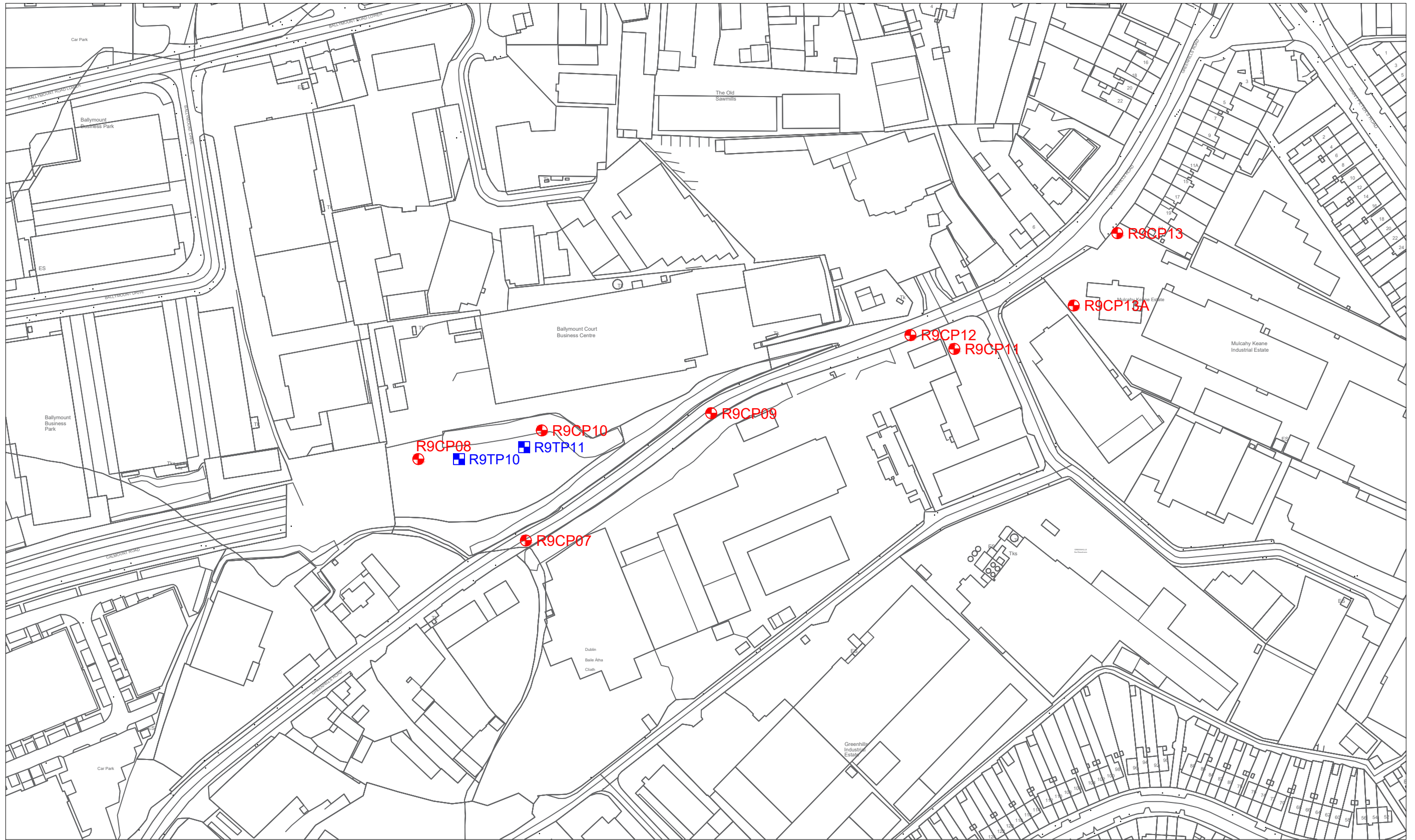
SCALE: NTS@A3

DATE: 23/11/2020

DRWN: BS
 CHCK: CH

SERIES: 6 of 7

DWG No: 20-0399D-EHL-006



PROJECT: Bus Connects Route 9 Tallaght/Clondalkin to City Centre

TITLE: Exploratory hole location plan

CLIENT: National Transport Authority (NTA)

KEY:
● Borehole
■ Trial Pits

ENGINEER: AECOM/Mott MacDonald

SCALE: NTS@A3

DATE: 23/11/2020

C:\Users\will.campbell\Documents\Causeway_Geotech_Colour.jpg

DRWN: BS
 CHCK: CH

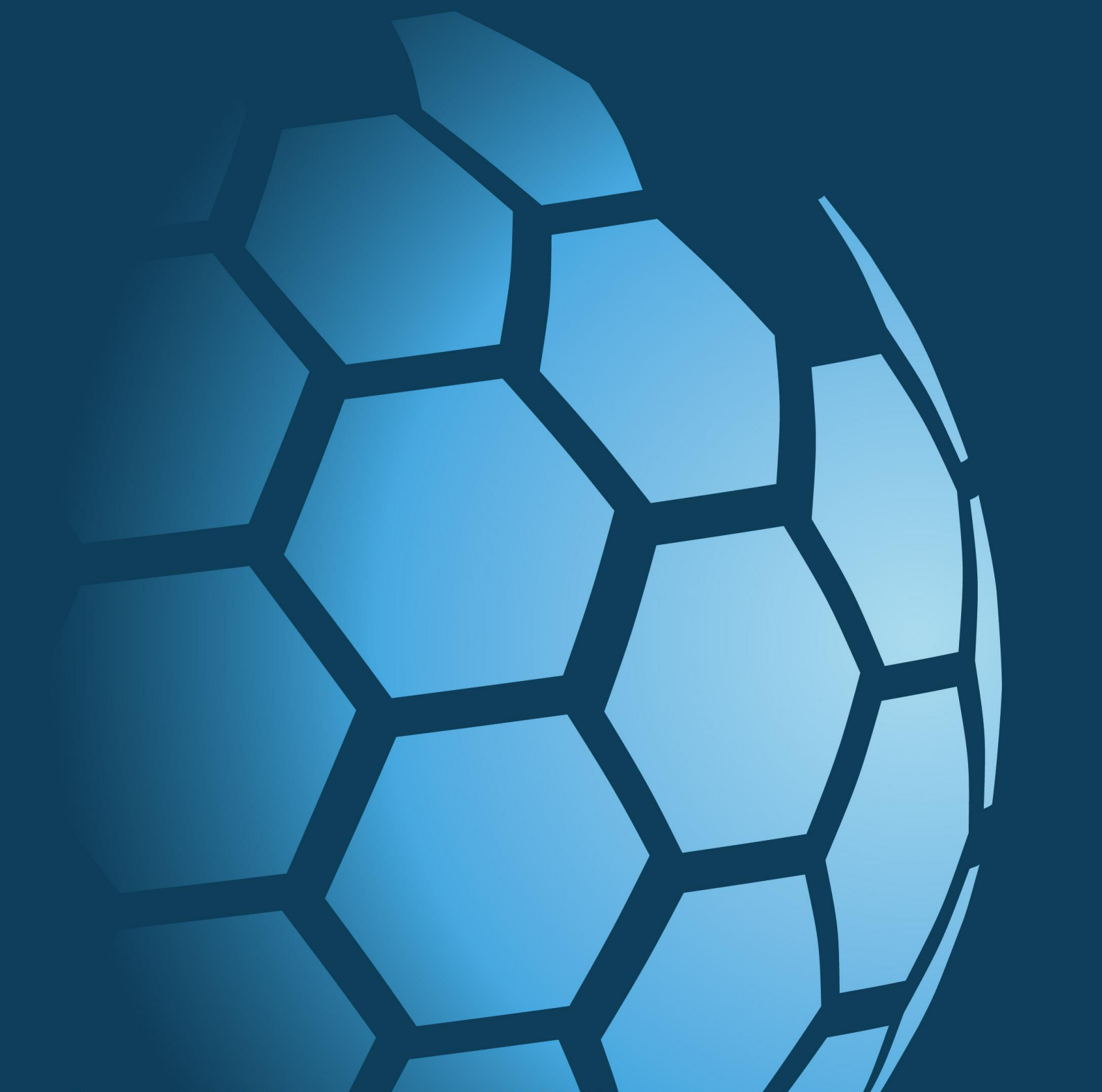
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DWG No: 20-0399D-EHL-007



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— GEOTECH

APPENDIX B
BOREHOLE LOGS





Method	Plant Used	Top (m)	Base (m)	Coordinates	Final Depth: 6.20 m	Start Date: 29/09/2020	Driller: BM	Sheet 1 of 1 Scale: 1:40
Cable Percussion	Dando 2000	0.00	6.20	709660.16 E 728495.79 N	Elevation: 87.89 mOD	End Date: 29/09/2020	Logger: CH	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill		
0.50	B5				87.49	0.40		MADE GROUND: Soft brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.				
0.50	ES											Stiff becoming very stiff brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium of mixed lithologies.
0.50	ES1											
1.00	B6	N=35 (3,3/3,5,12,15) Hammer SN = 0643	1.00	Dry	84.89							
1.00	ES2											
1.00	ES6											
1.20	D12											
1.20 - 1.65	SPT (S)											
2.00	B7	N=50 (25 for 75mm/50 for 25mm) Hammer SN = 0643	1.50	Dry								
2.00	D13											
2.00	ES3											
2.00 - 2.10	SPT (S)											
3.00	B8	Ublow=40 100%	3.00	Dry								
3.00	ES4											
3.00 - 3.45	U18											
3.50	D14											
4.00	B9	N=40 (12,7/8,10,10,12) Hammer SN = 0643	3.00	Dry								
4.00	D15											
4.00 - 4.45	SPT (S)											
5.00	B10	Ublow=60 100% Slow seepage at 5.00m	3.00	5.00								
5.00	D16											
5.00 - 5.45	U19											
6.00	B11	N=50 (18 for 100mm/50 for 35mm) Hammer SN = 0643	3.00	5.60	81.89							
6.00	D17											
6.00 - 6.14	SPT (S)										81.69	6.20

Water Strikes				Chiselling Details			Remarks Hand dug inspection pit excavated to 1.20m.
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)	
5.00	5.00						
Casing Details		Water Added					
To (m)	Diameter	From (m)	To (m)				
3.00	200						
Termination Reason							Last Updated
Terminated on refusal.							16/12/2020





Project No.
20-0399D

Project Name: Bus Connects Route 9 Tallaght/Clondalkin to City Centre
Client: National Transport Authority (NTA)
Client's Rep: AECOM/Mott MacDonald

Borehole ID
R9CP02

Method Cable Percussion	Plant Used Dando 2000	Top (m) 0.00	Base (m) 3.10	Coordinates 709689.76 E 728736.49 N	Final Depth: 3.10 m	Start Date: 01/10/2020	Driller: BM	Sheet 1 of 1 Scale: 1:40
					Elevation: 85.84 mOD	End Date: 01/10/2020	Logger: CH	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
0.50	B5				85.74	0.10	TOPSOIL			
0.50	ES1				85.44	0.40	MADE GROUND: Grey angular fine to coarse GRAVEL of mixed lithologies.			
1.00	B6				85.04	0.80	MADE GROUND: Brownish grey sandy clayey subangular to subrounded fine to coarse GRAVEL of mixed lithologies with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies. Cobbles are subrounded of mixed lithologies.			
1.00	ES2				84.54	1.30	MADE GROUND: Stiff brownish grey sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.			
1.00	ES6									
1.16	EW									
1.20 - 1.45	U12	Ublow=25 100%	1.00	Dry				Firm brown slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.		
1.70	D9									
2.00	B7									
2.00	D10									
2.00	ES3									
2.00 - 2.45	SPT (S)	N=11 (2,2/2,3,3,3) Hammer SN = 0643	1.50	Dry						
3.00	B8				83.04	2.80				
3.00	D11				82.74	3.10		Very stiff greyish black slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies. Cobbles are subrounded of mixed lithologies.		
3.00	ES4									
3.00 - 3.15	SPT (S)	N=50 (40 for 135mm/50 for 15mm) Hammer SN = 0643	3.00	Dry				End of Borehole at 3.10m		

Water Strikes				Chiselling Details			Remarks	
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)		
				3.00	3.10	01:00		Hand dug inspection pit excavated to 1.20m. No groundwater encountered.
Casing Details		Water Added						
To (m)	Diameter	From (m)	To (m)					
3.00	200							
Termination Reason							Last Updated	
Terminated on refusal.							16/12/2020	





Project No.
20-0399D

Project Name: Bus Connects Route 9 Tallaght/Clondalkin to City Centre

Borehole ID
R9CP03

Client: National Transport Authority (NTA)

Client's Rep: AECOM/Mott MacDonald

Method	Plant Used	Top (m)	Base (m)	Coordinates	Final Depth: 8.00 m	Start Date: 06/10/2020	Driller: BM	Sheet 1 of 2 Scale: 1:40
Cable Percussion	Dando 2000	0.00	8.00	709704.90 E 728910.79 N	Elevation: 81.19 mOD	End Date: 06/10/2020	Logger: CH	

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
0.50	B11				80.79	0.40	[Pattern]	TOPSOIL		
0.50	ES1						[Pattern]	MADE GROUND: Firm brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.		
1.00	B12						[Pattern]			
1.00	ES2						[Pattern]			
1.00	ES3						[Pattern]			
1.20	U26	Ublow=20 90%	0.00	Dry			[Pattern]			
2.00	B13				79.19	2.00	[Pattern]	Stiff brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.		
2.00	D19						[Pattern]			
2.00	ES4						[Pattern]			
2.00 - 2.45	SPT (S)	N=19 (2,2/2,4,6,7) Hammer SN = 0643	0.00	Dry			[Pattern]			
2.50	ES5						[Pattern]			
3.00	B14						[Pattern]			
3.00	D20						[Pattern]			
3.00	ES6						[Pattern]			
3.00 - 3.45	SPT (S)	N=29 (4,4/6,7,7,9) Hammer SN = 0643	0.00	Dry			[Pattern]			
3.50	ES7						[Pattern]			
4.00	B15				77.19	4.00	[Pattern]	Stiff becoming very stiff greyish black slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies. Cobbles are subrounded of mixed lithologies.		
4.00	D21						[Pattern]			
4.00	ES8						[Pattern]			
4.00 - 4.45	SPT (S)	N=24 (4,4/5,5,7,7) Hammer SN = 0643	0.00	Dry			[Pattern]			
5.00	B16						[Pattern]			
5.00	D22						[Pattern]			
5.00	ES22						[Pattern]			
5.00	ES9						[Pattern]			
5.00 - 5.45	SPT (S)	N=30 (4,5/6,7,7,10) Hammer SN = 0643	0.00	Dry			[Pattern]			
6.00	B17						[Pattern]			
6.00	D23						[Pattern]			
6.00	ES10						[Pattern]			
6.00 - 6.45	SPT (S)	N=38 (5,7/9,9,9,11) Hammer SN = 0643	0.00	Dry			[Pattern]			
7.00	D24						[Pattern]			
7.00 - 7.45	SPT (S)	N=38 (5,6/8,8,10,12) Hammer SN = 0643	0.00	Dry			[Pattern]			

Water Strikes				Chiselling Details			Remarks Hand dug inspection pit excavated to 1.20m. No groundwater encountered.
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)	
Casing Details		Water Added					
To (m)	Diameter	From (m)	To (m)				
Termination Reason							Last Updated
Terminated at scheduled depth.							16/12/2020





Method Cable Percussion	Plant Used Dando 2000	Top (m) 0.00	Base (m) 8.00	Coordinates 709704.90 E 728910.79 N	Final Depth: 8.00 m	Start Date: 06/10/2020	Driller: BM	Sheet 2 of 2 Scale: 1:40
					Elevation: 81.19 mOD	End Date: 06/10/2020	Logger: CH	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
7.50	B18							Stiff becoming very stiff greyish black slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies. Cobbles are subrounded of mixed lithologies.		
8.00	D25				73.19	8.00		End of Borehole at 8.00m		
8.00 - 8.45	SPT (S)	N=41 (5,6/9,10,10,12) Hammer SN = 0643	0.00	Dry						

Water Strikes				Chiselling Details			Remarks Hand dug inspection pit excavated to 1.20m. No groundwater encountered.	
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)		
Casing Details		Water Added						
To (m)	Diameter	From (m)	To (m)					
Termination Reason Terminated at scheduled depth.							Last Updated 16/12/2020	



CAUSEWAY
GEOTECH

Project No.
20-0399D

Project Name: Bus Connects Route 9 Tallaght/Clondalkin to City Centre

Borehole ID
R9CP04

Client: National Transport Authority (NTA)

Client's Rep: AECOM/Mott MacDonald

Method Cable Percussion	Plant Used Dando 2000	Top (m) 0.00	Base (m) 3.00	Coordinates 709837.71 E 729319.29 N	Final Depth: 3.00 m	Start Date: 05/10/2020	Driller: BM	Sheet 1 of 1 Scale: 1:40
					Elevation: 73.67 mOD	End Date: 05/10/2020	Logger: CH	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
0.50	B5				73.47	0.20		TOPSOIL		
0.50	ES1							Soft becoming firm brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.		
1.00	B6									
1.00	ES2									
1.00	ES6									
1.20	D9									
1.20 - 1.65	SPT (S)	N=9 (2,2/2,2,2,3) Hammer SN = 0643	0.00	Dry						
1.50	ES									
1.50	ES3									
2.00	B7				71.67	2.00		Stiff brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.		
2.00	D10									
2.00	ES4									
2.00 - 2.45	SPT (S)	N=18 (2,2/3,3,5,7) Hammer SN = 0643	0.00	Dry						
3.00	B8				70.67	3.00		End of Borehole at 3.00m		
3.00	D11									
3.00 - 3.02	SPT (S)	N=50 (25 for 10mm/50 for 15mm) Hammer SN = 0643	0.00	Dry						

Water Strikes				Chiselling Details			Remarks
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)	
				3.00	3.10	01:00	
Casing Details		Water Added					Termination Reason
To (m)	Diameter	From (m)	To (m)				
							Last Updated
							16/12/2020





Project No.
20-0399D

Project Name: Bus Connects Route 9 Tallaght/Clondalkin to City Centre

Borehole ID
R9CP05

Client: National Transport Authority (NTA)

Client's Rep: AECOM/Mott MacDonald

Method	Plant Used	Top (m)	Base (m)	Coordinates	Final Depth: 8.00 m	Start Date: 12/10/2020	Driller: BM	Sheet 1 of 2 Scale: 1:40
Cable Percussion	Dando 2000	0.00	8.00	710173.58 E 729983.05 N	Elevation: 73.20 mOD	End Date: 12/10/2020	Logger: CH	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill								
0.50	B10	N=8 (2,2/2,2,2,2) Hammer SN = 0643	0.00	Dry	68.40	4.80		MADE GROUND: Soft becoming firm brown sandy gravelly CLAY with fragments of wood and pieces of cloth and plastic. Sand is fine to coarse. Gravel is subangular to surrounded fine to coarse.										
0.50	ES1																	
1.00	B11																	
1.00	ES2																	
1.20	D19																	
1.20 - 1.65	SPT (S)																	
1.50	ES																	
1.50	ES3																	
2.00	B12										N=9 (2,3/2,2,2,3) Hammer SN = 0643	1.50	Dry	67.20	6.00		Medium dense brown very sandy silty subangular to subrounded fine to coarse GRAVEL of mixed lithologies. Sand is fine to coarse.	
2.00	D20																	
2.00	ES20																	
2.00	ES4																	
2.00 - 2.45	SPT (S)																	
2.50	ES5																	
3.00	B13	N=11 (2,3/3,2,3,3) Hammer SN = 0643	3.00	Dry	66.20	7.00		Medium dense brown slightly gravelly very silty fine to coarse SAND. Gravel is subrounded fine of mixed lithologies.										
3.00	D21																	
3.00	ES6																	
3.00 - 3.45	SPT (S)																	
4.00	B14	N=13 (2,3/3,4,3,3) Hammer SN = 0643	3.00	Dry	66.20	7.00		Medium dense brown sandy subangular to subrounded fine to coarse GRAVEL of mixed lithologies. Sand is fine to coarse.										
4.00	D22																	
4.00	ES7																	
4.00 - 4.45	SPT (S)																	
5.00	B15	N=18 (2,3/4,4,5,5) Hammer SN = 0643	4.50	Dry	66.20	7.00		Medium dense brown sandy subangular to subrounded fine to coarse GRAVEL of mixed lithologies. Sand is fine to coarse.										
5.00	D23																	
5.00	ES8																	
5.00 - 5.45	SPT (C)																	
6.00	B16	N=23 (3,4/5,5,6,7)	6.00	Dry	66.20	7.00		Medium dense brown sandy subangular to subrounded fine to coarse GRAVEL of mixed lithologies. Sand is fine to coarse.										
6.00	D24																	
6.00	ES9																	
6.00 - 6.45	SPT (C)																	
7.00	B17	N=26 (4,5/6,6,7,7) Hammer SN = 0643	6.00	Dry	66.20	7.00		Medium dense brown sandy subangular to subrounded fine to coarse GRAVEL of mixed lithologies. Sand is fine to coarse.										
7.00	D25																	
7.00 - 7.45	SPT (C)																	

Water Strikes				Chiselling Details			Remarks Hand dug inspection pit excavated to 1.20m. No groundwater encountered.
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)	
Casing Details		Water Added					
To (m)	Diameter	From (m)	To (m)				
6.00	200						
Termination Reason							Last Updated
Terminated at scheduled depth.							16/12/2020





CAUSEWAY
GEOTECH

Project No.
20-0399D

Project Name: Bus Connects Route 9 Tallaght/Clondalkin to City Centre

Borehole ID
R9CP05

Client: National Transport Authority (NTA)

Client's Rep: AECOM/Mott MacDonald

Method Cable Percussion	Plant Used Dando 2000	Top (m) 0.00	Base (m) 8.00	Coordinates 710173.58 E 729983.05 N	Final Depth: 8.00 m	Start Date: 12/10/2020	Driller: BM	Sheet 2 of 2 Scale: 1:40
					Elevation: 73.20 mOD	End Date: 12/10/2020	Logger: CH	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
8.00	B18	Ublow=30 100%	6.00	Dry	65.70	7.50		Medium dense brown sandy subangular to subrounded fine to coarse GRAVEL of mixed lithologies. Sand is fine to coarse.		
8.00 - 8.40	U26				65.40	7.80		Firm brown slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies. Cobbles are subrounded of mixed lithologies.		
					65.20	8.00		Stiff greyish black slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies. Cobbles are subrounded of mixed lithologies.		
								End of Borehole at 8.00m		

Water Strikes				Chiselling Details			Remarks Hand dug inspection pit excavated to 1.20m. No groundwater encountered.
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)	
Casing Details		Water Added					
To (m)	Diameter	From (m)	To (m)				
6.00	200						
Termination Reason							Last Updated
Terminated at scheduled depth.							16/12/2020





Project No.
20-0399D

Project Name: Bus Connects Route 9 Tallaght/Clondalkin to City Centre

Borehole ID
R9CP06

Client: National Transport Authority (NTA)

Client's Rep: AECOM/Mott MacDonald

Method Cable Percussion	Plant Used Dando 2000	Top (m) 0.00	Base (m) 6.00	Coordinates 710348.72 E 730324.95 N	Final Depth: 6.00 m	Start Date: 29/10/2020	Driller: BM	Sheet 1 of 1 Scale: 1:40
					Elevation: 66.81 mOD	End Date: 29/10/2020	Logger: GH	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
0.50 0.50	B1 ES7				66.71	0.10		MADE GROUND: Grey sandy slightly clayey subangular fine to coarse GRAVEL of mixed lithologies. Sand is fine to coarse. MADE GROUND: Firm becoming stiff dark brownish black sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.		
1.00 1.00 1.00 1.20 1.20 - 1.65	B2 ES ES8 D14 SPT (S)	N=18 (3,4/5,4,4,5) Hammer SN = 0643	1.00	Dry						
2.00 2.00 2.00 - 2.45	D15 ES9 SPT (S)	N=8 (4,2/2,2,2,2) Hammer SN = 0643	1.50	Dry	64.81	2.00		MADE GROUND: Firm brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.		
3.00 3.00 3.00 3.00 - 3.45	B3 D16 ES10 SPT (S)	N=8 (2,1/2,2,2,2) Hammer SN = 0643	3.00	Dry						
4.00 4.00 4.00 4.00 - 4.45	B4 D17 ES11 SPT (S)	N=13 (2,2/3,3,3,4) Hammer SN = 0643	3.00	Dry	62.81	4.00		Medium dense grey very sandy clayey subangular to subrounded fine to coarse GRAVEL of mixed lithologies. Sand is fine to coarse.		
5.00 5.00 5.00 5.00 - 5.45	B5 D18 ES12 SPT (S)	N=16 (3,4/4,3,4,5) Hammer SN = 0643	3.00	Dry						
6.00 6.00 6.00 6.00 - 6.45	B6 D19 ES13 SPT (S)	N=18 (4,5/4,4,5,5) Hammer SN = 0643	3.00	Dry	60.81	6.00		End of Borehole at 6.00m		

Water Strikes				Chiselling Details			Remarks Hand dug inspection pit excavated to 1.20m. No groundwater encountered.
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)	
Casing Details		Water Added					
To (m)	Diameter	From (m)	To (m)				
3.00	200						
Termination Reason Terminated at scheduled depth.							Last Updated 16/12/2020





Project No.
20-0399D

Project Name: Bus Connects Route 9 Tallaght/Clondalkin to City Centre

Borehole ID
R9CP07

Client: National Transport Authority (NTA)

Client's Rep: AECOM/Mott MacDonald

Method	Plant Used	Top (m)	Base (m)	Coordinates	Final Depth:	Start Date:	Driller:	Sheet 1 of 1
Cable Percussion	Dando 2000	0.00	6.00	710674.83 E 730617.42 N	6.00 m	10/10/2020	BM	Scale: 1:40
					Elevation:	End Date:	Logger:	FINAL
					63.72 mOD	10/10/2020	CH	

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
0.50	B5				63.52	0.20		BITMAC		
0.50	ES1				63.22	0.50		MADE GROUND: Grey angular fine to coarse GRAVEL of mixed lithologies.		
1.00	B6							Medium dense brown sandy slightly silty subangular to subrounded fine to coarse GRAVEL of mixed lithologies with low cobble content. Sand is fine to coarse.		
1.00	ES2									
1.20	D12									
1.20 - 1.65	SPT (C)	N=14 (2,3/3,3,4,4) Hammer SN = 0643	1.00	Dry						
2.00	B7									
2.00	D13									
2.00	ES3									
2.00 - 2.45	SPT (C)	N=18 (3,4/5,4,4,5) Hammer SN = 0643	2.00	1.80						
3.00	B8				60.72	3.00		Medium dense brown very sandy slightly silty subangular to subrounded fine to coarse GRAVEL of mixed lithologies with low cobble content. Sand is fine to coarse.		
3.00	D14									
3.00	ES4									
3.00 - 3.45	SPT (C)	N=19 (4,5/5,4,5,5) Hammer SN = 0643	3.00	2.70						
4.00	B9									
4.00	D15									
4.00 - 4.45	SPT (C)	N=23 (4,5/5,6,6,6) Hammer SN = 0643	4.00	3.50						
5.00	B10									
5.00	D16									
5.00 - 5.45	SPT (C)	N=23 (4,5/6,5,6,6) Hammer SN = 0643	5.00	3.00						
6.00	B11				57.72	6.00				
6.00	D17									
6.00 - 6.45	SPT (C)	N=27 (7,9/9,6,6,6) Hammer SN = 0643	6.00	3.50				End of Borehole at 6.00m		

Water Strikes				Chiselling Details			Remarks	
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)		
				6.00	6.20	01:00		Hand dug inspection pit excavated to 1.20m. No noticeable groundwater encountered, water added during drilling.
Casing Details		Water Added						
To (m)	Diameter	From (m)	To (m)					
6.00	200	1.20	6.00					
Termination Reason							Last Updated	
Terminated at scheduled depth.							16/12/2020	





Project No.
20-0399D

Project Name: Bus Connects Route 9 Tallaght/Clondalkin to City Centre
Client: National Transport Authority (NTA)
Client's Rep: AECOM/Mott MacDonald

Borehole ID
R9CP08

Method Cable Percussion	Plant Used Dando 2000	Top (m) 0.00	Base (m) 5.10	Coordinates 710617.34 E 730660.94 N	Final Depth: 5.10 m	Start Date: 07/10/2020	Driller: BM	Sheet 1 of 1 Scale: 1:40
					Elevation: 56.04 mOD	End Date: 07/10/2020	Logger: CH	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
0.50	B6				55.84	0.20		MADE GROUND: Grey angular fine to coarse GRAVEL		
0.50	ES1							MADE GROUND: Soft to firm brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.		
1.00	B7									
1.20	D13									
1.20 - 1.65	SPT (S)	N=8 (2,2/2,2,2,2) Hammer SN = 0643	0.00	Dry						
1.50	ES									
1.50	ES2									
2.00	B8									
2.00	D14									
2.00	ES3									
2.00 - 2.45	SPT (S)	N=6 (2,1/1,2,1,2) Hammer SN = 0643	1.50	Dry	53.64	2.40		Soft brown sandy gravelly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.		
3.00	B9									
3.00	ES4									
3.00 - 3.45	U18	Ublow=20 100%	3.00	Dry	53.04	3.00		Stiff brown sandy gravelly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.		
3.50	D15									
4.00	B10									
4.00	D16									
4.00	ES5									
4.00 - 4.45	SPT (S)	N=34 (4,5/8,8,9,9) Hammer SN = 0643	4.00	4.00	52.54	3.50		Stiff to very stiff brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium of mixed lithologies.		
4.10	EW	Slow seepage at 4.10								
5.00	B11									
5.00	D17				51.04	5.00				
5.00 - 5.22	SPT (S)	N=31 (15,25/31 for 75mm) Hammer SN = 0643	4.50	4.80	50.94	5.10		Grey BOULDER of limestone. Recovered through chiselling as grey angular gravel of limestone.		
5.10	B12							End of Borehole at 5.10m		

Water Strikes				Chiselling Details			Remarks
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)	
4.10	4.10	20	4.00	5.00	5.10	01:00	Hand dug inspection pit excavated to 1.20m.
Casing Details		Water Added					
To (m)	Diameter	From (m)	To (m)				
4.50	200						
Termination Reason							Last Updated
Terminated on refusal.							16/12/2020





CAUSEWAY
GEOTECH

Project No.
20-0399D

Project Name: Bus Connects Route 9 Tallaght/Clondalkin to City Centre

Borehole ID
R9CP09

Client: National Transport Authority (NTA)

Client's Rep: AECOM/Mott MacDonald

Method Cable Percussion	Plant Used Dando 2000	Top (m) 0.00	Base (m) 2.30	Coordinates 710773.86 E 730685.45 N	Final Depth: 2.30 m	Start Date: 10/10/2020	Driller: BM	Sheet 1 of 1 Scale: 1:40
					Elevation: 61.79 mOD	End Date: 10/10/2020	Logger: CH	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
0.50	B5	N=16 (2,3/3,4,4,5) Hammer SN = 0643	1.00	Dry	59.49	61.59	0.20	BITMAC	Medium dense brown very gravelly silty fine to coarse SAND. Gravel is subangular to subangular fine to coarse of mixed lithologies.	[Black Bar]
0.50	ES1					61.39	0.40	MADE GROUND: Grey angular fine to coarse GRAVEL of mixed lithologies.		
1.00	B6									
1.00	ES2									
1.20	D8									
1.20 - 1.65	SPT (S)									
1.50	ES3									
2.00	B7									
2.00	D9									
2.00 - 2.05	SPT (S)					N=50 (25 for 25mm/50 for 25mm) Hammer SN = 0643	2.00	1.50		
2.30	ES4									

Water Strikes				Chiselling Details			Remarks Hand dug inspection pit excavated to 1.20m. No noticeable groundwater encountered, water added during drilling.
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)	
				2.30	2.50	01:00	
Casing Details		Water Added					
To (m)	Diameter	From (m)	To (m)				
2.00	200	1.20	2.30				
Termination Reason						Last Updated	
Terminated on refusal.						16/12/2020	



Project No.
20-0399D

Project Name: Bus Connects Route 9 Tallaght/Clondalkin to City Centre

Borehole ID
R9CP10

Client: National Transport Authority (NTA)

Client's Rep: AECOM/Mott MacDonald

Method Cable Percussion	Plant Used Dando 2000	Top (m) 0.00	Base (m) 3.00	Coordinates 710683.34 E 730676.26 N	Final Depth: 3.00 m	Start Date: 07/10/2020	Driller: BM	Sheet 1 of 1 Scale: 1:40
					Elevation: 55.12 mOD	End Date: 07/10/2020	Logger: CH	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
0.00	ES1				54.92	0.20		MADE GROUND: Grey angular fine to coarse GRAVEL of mixed lithologies.		
0.50	B6							MADE GROUND: Soft to firm brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.		
1.00	B7									
1.00	ES2									
1.20	D10									
1.20 - 1.65	SPT (S)	N=9 (2,3/2,3,2,2) Hammer SN = 0643	0.00	Dry	53.72	1.40		Soft brown sandy gravelly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.		
1.50	ES3									
2.00	B8									
2.00	D11									
2.00	ES4									
2.00 - 2.45	SPT (S)	N=6 (1,1/1,1,2,2) Hammer SN = 0643	0.00	Dry	52.52	2.60		Grey BOULDER of limestone. Recovered through chiselling as grey angular gravel of limestone.		
3.00	B9				52.12	3.00		End of Borehole at 3.00m		
3.00	D12									
3.00	ES5									
3.00 - 3.05	SPT (S)	N=50 (25 for 25mm/50 for 25mm) Hammer SN = 0643	0.00	Dry						

Water Strikes				Chiselling Details			Remarks Hand dug inspection pit excavated to 1.20m. No groundwater encountered.
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)	
				2.60	3.00	01:00	
Casing Details		Water Added					
To (m)	Diameter	From (m)	To (m)				
Termination Reason						Last Updated	
Terminated on refusal.						16/12/2020	



Project No.
20-0399D

Project Name: Bus Connects Route 9 Tallaght/Clondalkin to City Centre
Client: National Transport Authority (NTA)
Client's Rep: AECOM/Mott MacDonald

Borehole ID
R9CP11

Method	Plant Used	Top (m)	Base (m)	Coordinates	Final Depth: 4.30 m	Start Date: 30/09/2020	Driller: BM	Sheet 1 of 1 Scale: 1:40
Cable Percussion	Dando 2000	0.00	4.30	710903.81 E 730719.84 N	Elevation: 54.07 mOD	End Date: 30/09/2020	Logger: CH	

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
0.50	B5				53.87	0.20	CONCRETE			
0.50	ES1				53.67	0.40	MADE GROUND: Grey angular fine to coarse GRAVEL			
1.00	B6						Medium dense becoming dense brown sandy silty subangular to subrounded fine to coarse GRAVEL of mixed lithologies with low cobble content. Sand is fine to coarse. Cobbles are subrounded of mixed lithologies.			
1.00	ES2									
1.20	U12	Ublow=50 0%	1.00	Dry						
2.00	B7						Very stiff greyish black sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.			
2.00	D10									
2.00	ES3									
2.00 - 2.45	SPT (C)	N=18 (2,4/4,4,5,5)	2.00	1.90						
3.00	B8						Very stiff greyish black sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.			
3.00	D11									
3.00	ES4									
3.00 - 3.45	SPT (C)	N=31 (5,6/6,7,9,9)	3.00	2.50						
3.28	EW									
4.00	B9				50.37	3.70				
4.00 - 4.05	SPT (S)	N=50 (25 for 25mm/50 for 25mm)	4.00	Dry	49.77	4.30				
4.30 - 4.32	SPT (S)	N=50 (0 for 0mm/50 for 25mm)	4.00	Dry				End of Borehole at 4.30m		

Water Strikes				Chiselling Details			Remarks	
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)		
				4.00	4.30	01:00		Hand dug inspection pit excavated to 1.20m. No noticeable groundwater encountered, water added during drilling.
Casing Details		Water Added						
To (m)	Diameter	From (m)	To (m)					
4.00	200	1.50	3.50					
Termination Reason							Last Updated	
Terminated on refusal.							16/12/2020	





Project No.
20-0399D

Project Name: Bus Connects Route 9 Tallaght/Clondalkin to City Centre
Client: National Transport Authority (NTA)
Client's Rep: AECOM/Mott MacDonald

Borehole ID
R9CP12

Method Cable Percussion	Plant Used Dando 2000	Top (m) 0.00	Base (m) 6.00	Coordinates 710880.38 E 730727.20 N	Final Depth: 6.00 m	Start Date: 11/10/2020	Driller: BM	Sheet 1 of 1 Scale: 1:40
					Elevation: 56.99 mOD	End Date: 11/10/2020	Logger: CH	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
0.50	B5	N=14 (2,2/3,3,3,5) Hammer SN = 0643	1.20	Dry	56.79	0.20		BITMAC		
0.50	ES1					0.50		MADE GROUND: Grey angular fine to coarse GRAVEL of mixed lithologies.		
1.00	B6	N=19 (3,5/4,5,5,5) Hammer SN = 0643	2.00	Dry	52.29	1.20		Medium dense brown sandy silty subangular to subrounded fine to coarse GRAVEL of mixed lithologies with low cobble content. Sand is fine to coarse. Cobbles are subrounded of mixed lithologies.		
1.00	ES2									
1.20	D12									
1.20 - 1.65	SPT (C)									
2.00	B7	N=23 (4,5/5,5,6,7) Hammer SN = 0643	3.00	Dry	51.49	2.00		Firm brown silty sandy CLAY. Sand is fine to coarse.		
2.00	D13									
2.00	ES3									
2.00 - 2.45	SPT (C)									
3.00	B8	N=10 (3,2/2,3,2,3) Hammer SN = 0643	4.00	Dry	50.99	3.00		Very stiff greyish brown slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies. Cobbles are subrounded of mixed lithologies.		
3.00	D14									
3.00	ES4									
3.00 - 3.45	SPT (C)									
4.00	B9	N=50 (25 for 50mm/50 for 25mm) Hammer SN = 0643	6.00	Dry	50.99	4.00		End of Borehole at 6.00m		
4.00	D15									
4.00 - 4.45	SPT (C)									
6.00	B11									
6.00	D17					6.00				
6.00 - 6.08	SPT (S)									

Water Strikes				Chiselling Details			Remarks	
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)		
				5.80	6.00	01:00		Hand dug inspection pit excavated to 1.20m. No noticeable groundwater encountered, water added during drilling.
Casing Details		Water Added						
To (m)	Diameter	From (m)	To (m)					
5.50	200	1.20	4.70					
Termination Reason							Last Updated	
Terminated on refusal.							16/12/2020	





Method Cable Percussion	Plant Used Dando 2000	Top (m) 0.00	Base (m) 2.70	Coordinates 710990.93 E 730781.72 N	Final Depth: 2.70 m	Start Date: 09/10/2020	Driller: BM	Sheet 1 of 1 Scale: 1:40
					Elevation: 52.22 mOD	End Date: 09/10/2020	Logger: CH	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill							
0.50	B5	N=10 (2,3/2,2,3,3) Hammer SN = 0643	1.00	Dry	52.12	0.10		BITMAC	Water level indicated by inverted triangle at 2.00m depth.	Black backfill							
0.50	ES1					51.92	0.30				MADE GROUND: Grey angular fine to coarse GRAVEL of mixed lithologies.						
1.00	B6					51.02	1.20				MADE GROUND: Soft to firm brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.						
1.00	ES2					50.72	1.50	50.72			1.50		Firm brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.				
1.20	D9										1.20		Firm brownish grey slightly gravelly sandy silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.				
1.20 - 1.65	SPT (S)					N=10 (1,2/1,2,3,4) Hammer SN = 0643	1.70	2.00			49.82	2.40		Grey BOULDER of limestone. Recovered through chiselling as grey angular gravel of limestone.			
1.50	ES3											2.60	1.70	49.52	2.70		End of Borehole at 2.70m
2.00	B7																
2.00	D10																
2.00	ES4																
2.00 - 2.45	SPT (S)																
2.60 - 2.65	SPT (S)																
2.70	B8																

Water Strikes				Chiselling Details			Remarks Hand dug inspection pit excavated to 1.20m.
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)	
2.00				2.40	2.70	01:00	
Casing Details		Water Added					
To (m)	Diameter	From (m)	To (m)				
2.60	200						
Termination Reason							Last Updated
Terminated on refusal.							16/12/2020



Project No.
20-0399D

Project Name: Bus Connects Route 9 Tallaght/Clondalkin to City Centre
Client: National Transport Authority (NTA)
Client's Rep: AECOM/Mott MacDonald

Borehole ID
R9CP13A

Method Cable Percussion	Plant Used Dando 2000	Top (m) 0.00	Base (m) 2.00	Coordinates 710967.63 E 730743.05 N	Final Depth: 2.00 m	Start Date: 08/10/2020	Driller: BM	Sheet 1 of 1 Scale: 1:40
					Elevation: 52.38 mOD	End Date: 08/10/2020	Logger: CH	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
					52.28	0.10	CONCRETE	Void encountered - possible old tank.		
					50.38	2.00		End of Borehole at 2.00m		

Water Strikes				Chiselling Details			Remarks Void encountered - possible old tank. Moved to new position - R9CP13.	
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)		
Casing Details		Water Added						
To (m)	Diameter	From (m)	To (m)					
Termination Reason Terminated on refusal.							Last Updated 16/12/2020	



Method	Plant Used	Top (m)	Base (m)	Coordinates	Final Depth:	Start Date:	Driller:	Sheet 1 of 2
Cable Percussion Rotary Drilling Rotary Coring	Dando 2000 Beretta T44 Beretta T44	0.00 6.00 12.00	6.00 12.00 17.50	709946.53 E 729480.52 N	17.50 m	04/10/2020	BM+GT	Scale: 1:50
								FINAL
					Elevation:	End Date:	Logger:	
					72.60 mOD	10/10/2020	CH+RS	

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill	
72.30	0.30						TOPSOIL				
0.50	B8						Possible MADE GROUND: Firm to stiff brown slightly sandy gravelly SILT with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies. Cobbles are subrounded of mixed lithologies.				
0.50	ES1										
1.00	B9										
1.00	ES2										
1.20	D15										
1.20 - 1.65	SPT (S)	N=9 (2,2/2,2,2,3) Hammer SN = 0643	0.00	Dry							
2.00	B10										
2.00	D16										
2.00	ES10										
2.00	ES3										
2.00 - 2.45	SPT (S)	N=11 (2,3/2,3,3,3) Hammer SN = 0643	0.00	Dry							
3.00	B11										
3.00	D17										
3.00	ES4										
3.00 - 3.45	SPT (S)	N=16 (3,4/4,4,4,4) Hammer SN = 0643	0.00	Dry							
4.00	B12										
4.00	D18										
4.00	ES12										
4.00	ES5										
4.00 - 4.45	SPT (S)	N=14 (2,3/3,3,4,4) Hammer SN = 0643	0.00	Dry							
5.00	B13										
5.00	D19										
5.00	ES6										
5.00 - 5.45	SPT (S)	N=18 (4,5/4,5,4,5) Hammer SN = 0643	0.00	Dry							
6.00	B14										
6.00	D20										
6.00	ES7										
6.50 - 6.95	SPT (C)	N=27 (7,8/8,6,6,7) Hammer SN = 0209	6.50		66.60	6.00	Stiff brown sandy gravelly CLAY with cobbles and boulders. (Driller's description)				
8.00	EW										
8.00 - 8.15	SPT (C)	N=50 (25 for 75mm/50 for 75mm) Hammer SN = 0209	8.00								
		Water strike at 9.00m									

Water Strikes				Chiselling Details			Remarks	
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)		
9.00	9.00							Hand dug inspection pit excavated to 1.20m. Services encountered in hand pit.
Casing Details		Water Added		Core Barrel	Flush Type	Termination Reason	Last Updated	
To (m)	Diam (mm)	From (m)	To (m)					
8.00	200			SK6L	Polymer	Terminated at scheduled depth.	16/12/2020	



Method	Plant Used	Top (m)	Base (m)	Coordinates	Final Depth:	Start Date:	Driller:	Sheet 2 of 2
Cable Percussion Rotary Drilling Rotary Coring	Dando 2000 Beretta T44 Beretta T44	0.00 6.00 12.00	6.00 12.00 17.50	709946.53 E 729480.52 N	17.50 m	04/10/2020	BM+GT	Scale: 1:50
								FINAL
					Elevation:	End Date:	Logger:	
					72.60 mOD	10/10/2020	CH+RS	

Depth (m)	Sample / Tests	Field Records				Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
9.50 - 9.95	SPT (C)	N=26 (4,4/6,6,7,7) Hammer SN = 0209				9.50			62.60	10.00	Stiff brown sandy gravelly CLAY with cobbles and boulders. (Driller's description)		
11.00 - 11.45	SPT (C)	N=27 (7,8/8,6,6,7) Hammer SN = 0209				11.0					Medium dense brownish grey sandy clayey GRAVEL. (Driller's description)		
12.00 - 13.50	C							60.60	12.00	Medium strong thinly laminated black argillaceous LIMESTONE. Partially weathered: probably slightly reduced strength. Probably slightly closer fracture spacing.			
12.30	C									Discontinuities: 1. 0 to 30 degree bedding fractures very closely spaced (5/40/185), planar, smooth. 2. 90 degree joint from 12.90m to 13.10m, undulating, rough. 3. 90 degree joint from 16.80m to 17.15m, undulating, rough.			
12.55	C												
12.80	C	100	80	33									
13.20	C												
13.50	C												
13.75	C												
14.00	C												
14.15	C	100	100	46									
14.50	C				16								
15.00	C								(5.50)				
15.35	C												
15.85	C	100	85	49									
16.50	C												
17.20	C	100	72	22									
17.40	C												
17.50	C							55.10	17.50	End of Borehole at 17.50m			
		TCR	SCR	RQD	FI								

Water Strikes				Remarks			
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)				
9.00	9.00			Hand dug inspection pit excavated to 1.20m. Services encountered in hand pit.			
Casing Details		Water Added					
To (m)	Diam (mm)	From (m)	To (m)				
8.00	200			Core Barrel	Flush Type	Termination Reason	Last Updated
				SK6L	Polymer	Terminated at scheduled depth.	16/12/2020





Method	Plant Used	Top (m)	Base (m)	Coordinates	Final Depth:	Start Date:	Driller:	Sheet 1 of 2
Cable Percussion Rotary Drilling Rotary Coring	Dando 2000 Beretta T44 Beretta T44	0.00 5.00 10.50	5.00 10.50 18.00	709930.78 E 729485.56 N	18.00 m	03/10/2020	BM+GT	Scale: 1:50
								FINAL
					Elevation:	End Date:	Logger:	
					72.38 mOD	09/10/2020	CH+RS	

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill	
72.18						0.20	TOPSOIL				
0.50	B7						MADE GROUND: Firm becoming stiff brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.				
0.50	ES1										
1.00	B8						MADE GROUND: Firm becoming stiff brownish grey sandy gravelly SILT. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.				
1.00	ES2										
1.00	ES8										
1.20	D13										
1.20 - 1.65	SPT (S)	N=12 (2,2/3,3,3,3) Hammer SN = 0643	0.00	Dry							
2.00	B9						MADE GROUND: Firm becoming stiff brownish grey sandy gravelly SILT. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.				
2.00	ES										
2.00	ES3										
2.00	ES9										
2.00 - 2.45	U17	Ublow=25 100%	0.00	Dry	69.98	2.40					
2.50	D14										
3.00	B10						MADE GROUND: Firm brown sandy gravelly CLAY with fragments of red brick. (Driller's description)				
3.00	D15										
3.00	ES4										
3.00 - 3.45	SPT (S)	N=14 (3,3/3,3,4,4) Hammer SN = 0643	0.00	Dry							
4.00	B11										
4.00	D16						MADE GROUND: Firm brown sandy gravelly CLAY with boulders. (Driller's description)				
4.00	ES5										
4.00 - 4.45	SPT (S)	N=23 (3,4/5,6,6,6) Hammer SN = 0643	0.00	Dry							
5.00	B12										
5.00	ES12										
5.00	ES6										
6.50 - 6.95	SPT (C)	N=11 (2,2/3,3,3,2) Hammer SN = 0209	6.50		65.88	6.50	Firm brownish grey sandy gravelly silty CLAY with boulders. (Driller's description)				
8.00 - 8.45	SPT (C)	N=14 (2,2/3,3,4,4) Hammer SN = 0209	8.00		64.38	8.00	Firm brown sandy gravelly CLAY with boulders. (Driller's description)				
		Water strike at 9.00m									

Water Strikes				Chiselling Details			Remarks	
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)		
9.00								Hand dug inspection pit excavated to 1.20m. Service encountered at 5.00m.. BH moved 2m for rotary section.
Casing Details				Water Added				
To (m)	Diam (mm)	From (m)	To (m)					
10.50	200	9.00	18.00					
				Core Barrel	Flush Type	Termination Reason	Last Updated	
				SK6L	Polymer	Terminated at scheduled depth.	16/12/2020	



Method	Plant Used	Top (m)	Base (m)	Coordinates	Final Depth:	Start Date:	Driller:	Sheet 1 of 2
Cable Percussion Rotary Drilling Rotary Coring	Dando 2000 Beretta T44 Beretta T44	0.00 5.00 10.50	5.00 10.50 16.00	709995.89 E 729584.51 N	16.00 m	03/10/2020	BM+GT	Scale: 1:50
								FINAL
					Elevation:	End Date:	Logger:	
					72.99 mOD	11/10/2020	CH+RS	

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
0.50	B6				72.79	0.20	TOPSOIL			
0.50	ES1						MADE GROUND: Firm brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.			
1.00	B7									
1.00	ES2									
1.20	D12									
1.20 - 1.65	SPT (S)	N=15 (3,3/4,3,4,4) Hammer SN = 0643	0.00	Dry						
2.00	B8				70.99	2.00				
2.00	D13									
2.00	ES3									
2.00	ES8									
2.00 - 2.45	SPT (S)	N=20 (4,5/4,5,5,6) Hammer SN = 0643	0.00	Dry				Stiff brown slightly gravelly sandy SILT. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.		
3.00	B9				69.79	3.20				
3.00	ES4									
3.00 - 3.45	U16	Ublow=25 80%	0.00	Dry				Dense brown gravelly very silty fine to coarse SAND. Gravel is subangular to subrounded fine to medium of mixed lithologies.		
4.00	B10									
4.00	D14									
4.00	ES10									
4.00	ES5									
4.00 - 4.45	SPT (S)	N=32 (4,5/6,8,8,10) Hammer SN = 0643	0.00	Dry						
5.00	B11				67.99	5.00				
5.00	D15									
5.00 - 5.45	SPT (S)	N=37 (5,7/7,9,10,11) Hammer SN = 0643	0.00	Dry				Very stiff brown sandy gravelly CLAY. (Driller's description)		
8.00 - 8.45	SPT (S)	N=24 (4,4/5,5,7,7) Hammer SN = 0209	8.00		64.99	8.00		Medium dense brown fine to coarse SAND and GRAVEL. (Driller's description)		
		Water strike at 9.00								

Water Strikes				Chiselling Details			Remarks	
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)		
9.00								Hand dug inspection pit excavated to 1.20m.
Casing Details		Water Added						
To (m)	Diam (mm)	From (m)	To (m)					
10.50	200	9.00	16.00					
				Core Barrel	Flush Type	Termination Reason	Last Updated	
					Polymer	Terminated at scheduled depth.	16/12/2020	



Method	Plant Used	Top (m)	Base (m)	Coordinates	Final Depth:	Start Date:	Driller:	Sheet 1 of 2
Cable Percussion Rotary Drilling Rotary Coring	Dando 2000 Beretta T44 Beretta T44	0.00 6.00 10.50	6.00 10.50 16.00	710011.67 E 729574.57 N	16.00 m	02/10/2020	BM+G	Scale: 1:50
								FINAL
					Elevation:	End Date:	Logger:	
					73.07 mOD	08/10/2020	CH+RS	

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
					72.97	0.10	TOPSOIL			
0.50	B6				72.77	0.30	MADE GROUND: Grey angular fine to coarse GRAVEL of mixed lithologies.			
0.50	ES2						MADE GROUND: Firm brownish sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.			
1.00	B7				71.77	1.30	Stiff to very stiff brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.			
1.00	ES3									
1.00	ES7									
1.20	D13									
1.20 - 1.65	SPT (S)	N=18 (3,3/3,5,5,5) Hammer SN = 0643	0.00	Dry						
2.00	B8				70.07	3.00	Medium dense brown gravelly silty fine to coarse SAND. Gravel is subangular to subrounded fine to coarse of mixed lithologies.			
2.00	D14									
2.00	ES4									
2.00 - 2.45	SPT (S)	N=38 (5,6/7,10,10,11) Hammer SN = 0643	0.00	Dry						
3.00	B9									
3.00	ES5									
3.00 - 3.45	U19	Ublow=25 100%	0.00	Dry						
3.50	D15									
4.00	B10				67.07	6.00	Medium dense brown silty SAND and GRAVEL. (Driller's description)			
4.00	D16									
4.00 - 4.45	SPT (C)	N=17 (3,4/4,4,4,5) Hammer SN = 0643	0.00	Dry						
5.00	B11									
5.00	D17									
5.00	ES11									
5.00 - 5.45	SPT (C)	N=18 (4,4/5,5,4,4) Hammer SN = 0643	0.00	Dry						
6.00	B12									
6.00	D18									
6.00 - 6.45	SPT (C)	N=19 (4,4/4,5,5,5) Hammer SN = 0643	0.00	Dry						
7.50 - 7.95	SPT (C)	N=18 (4,4/4,5,5,4) Hammer SN = 0209	7.50							
8.92	EW									
9.00 - 9.45	SPT (C)	N=20 (4,4/5,5,5,5) Hammer SN = 0209 Water strike at 9.00m	9.00							

Water Strikes				Chiselling Details			Remarks
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)	
9.00							Hand dug inspection pit excavated to 1.20m.
Casing Details		Water Added					
To (m)	Diam (mm)	From (m)	To (m)				
10.50	200	9.00	16.00				
				Core Barrel	Flush Type	Termination Reason	Last Updated
					Polymer	Terminated at scheduled depth.	16/12/2020





Method Light Percussion	Plant Used Dando Terrier	Top (m) 0.00	Base (m) 1.20	Coordinates 710048.06 E 730265.91 N	Final Depth: 1.20 m	Start Date: 19/10/2020	Driller: JC	Sheet 1 of 1 Scale: 1:50
					Elevation: 64.16 mOD	End Date: 19/10/2020	Logger: GH	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
0.50	ES1							TOPSOIL with rootlets		
0.60 - 1.20	B2				63.56	0.60		MADE GROUND: Soft brown sandy gravelly SILT with concrete fragments. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.		
1.00	ES3				62.96	1.20		End of Borehole at 1.20m		

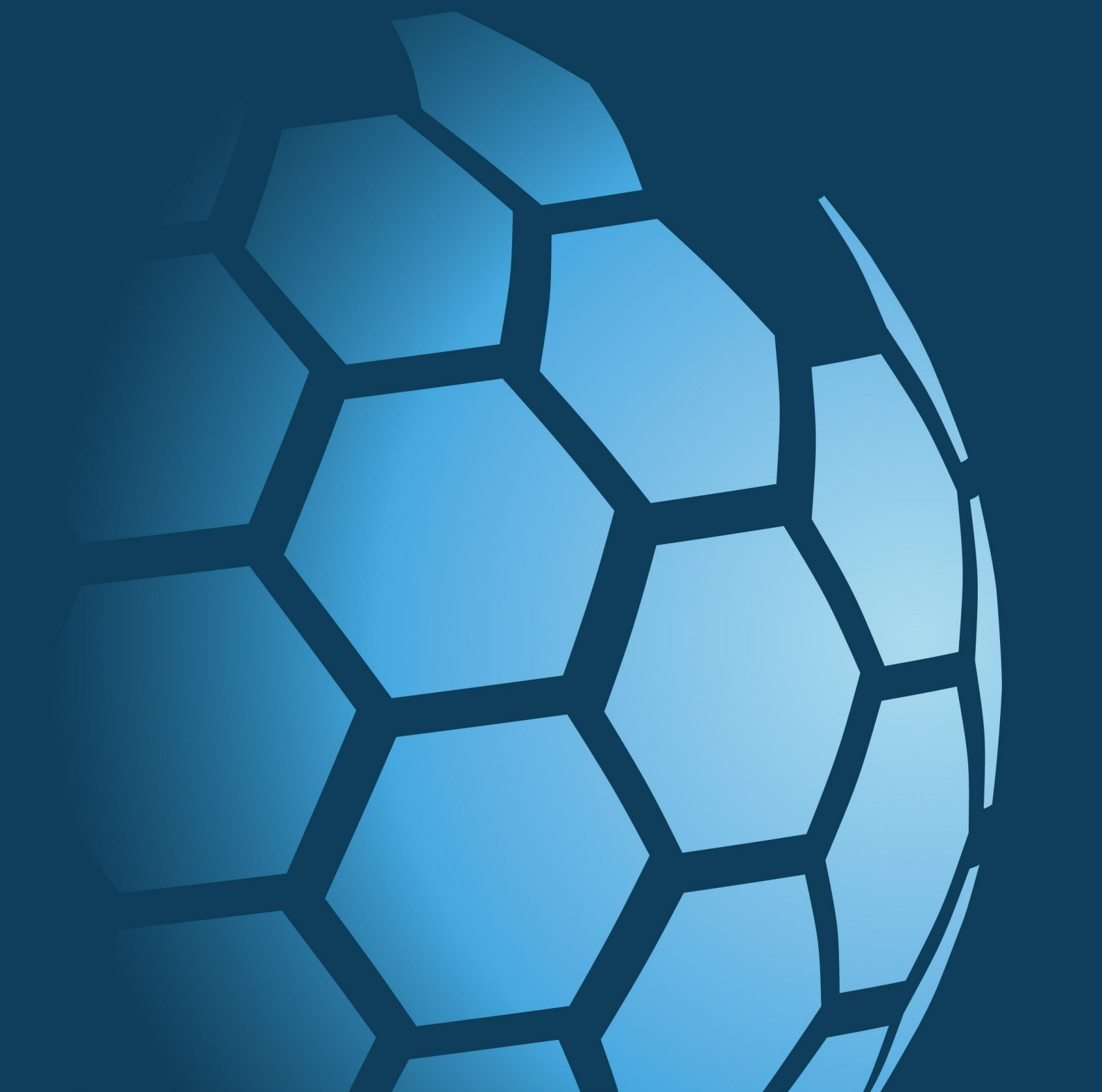
Water Strikes				Casing Details		Remarks
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	To (m)	Diameter	
						Hand dug inspection pit excavated to 1.20m. ESB cable struck at 1.27m.
Termination Reason						Last Updated
Terminated due to encountering service.						16/12/2020





CAUSEWAY
— GEOTECH

APPENDIX C
CORE PHOTOGRAPHS





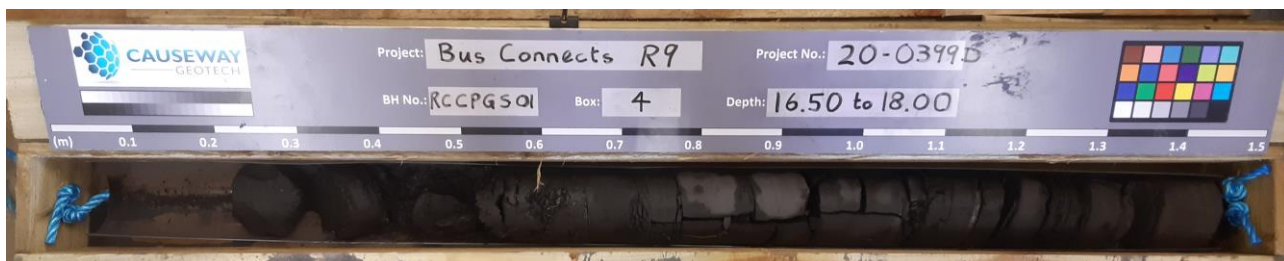
R9-CPGS01 Box 1 12.00-13.50m



R9-CPGS01 Box 2 13.00-15.00m



R9-CPGS01 Box 3 15.00-16.50m



R9-CPGS01 Box 4 16.50-18.00m



R9-CPGS02 Box 1 10.50-12.00m



R9-CPGS02 Box 2 12.00-13.50m



R9-CPGS02 Box 3 13.50-15.00m



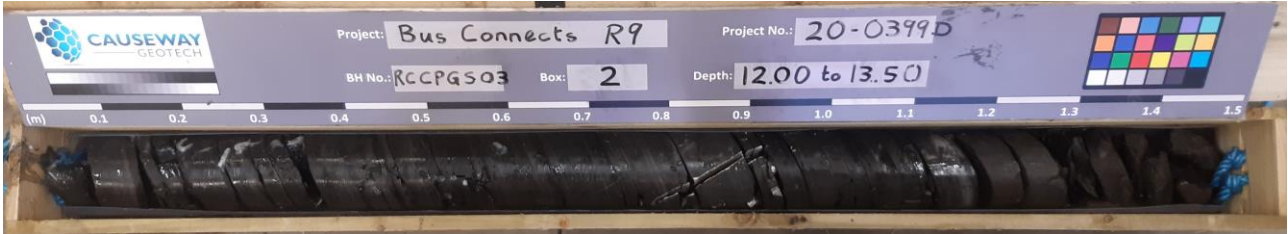
R9-CPGS02 Box 4 15.00-16.50m



R9-CPGS02 Box 5 16.50-18.00m



R9-CPGS03 Box 1 10.50-12.00m



R9-CPGS03 Box 2 12.00-13.50m



R9-CPGS03 Box 3 13.50-15.00m



R9-CPGS03 Box 4 15.00-16.00m



R9-CPGS04 Box 1 10.50-12.00m



R9-CPGS04 Box 2 12.00-13.50m



R9-CPGS04 Box 3 13.50-15.00m

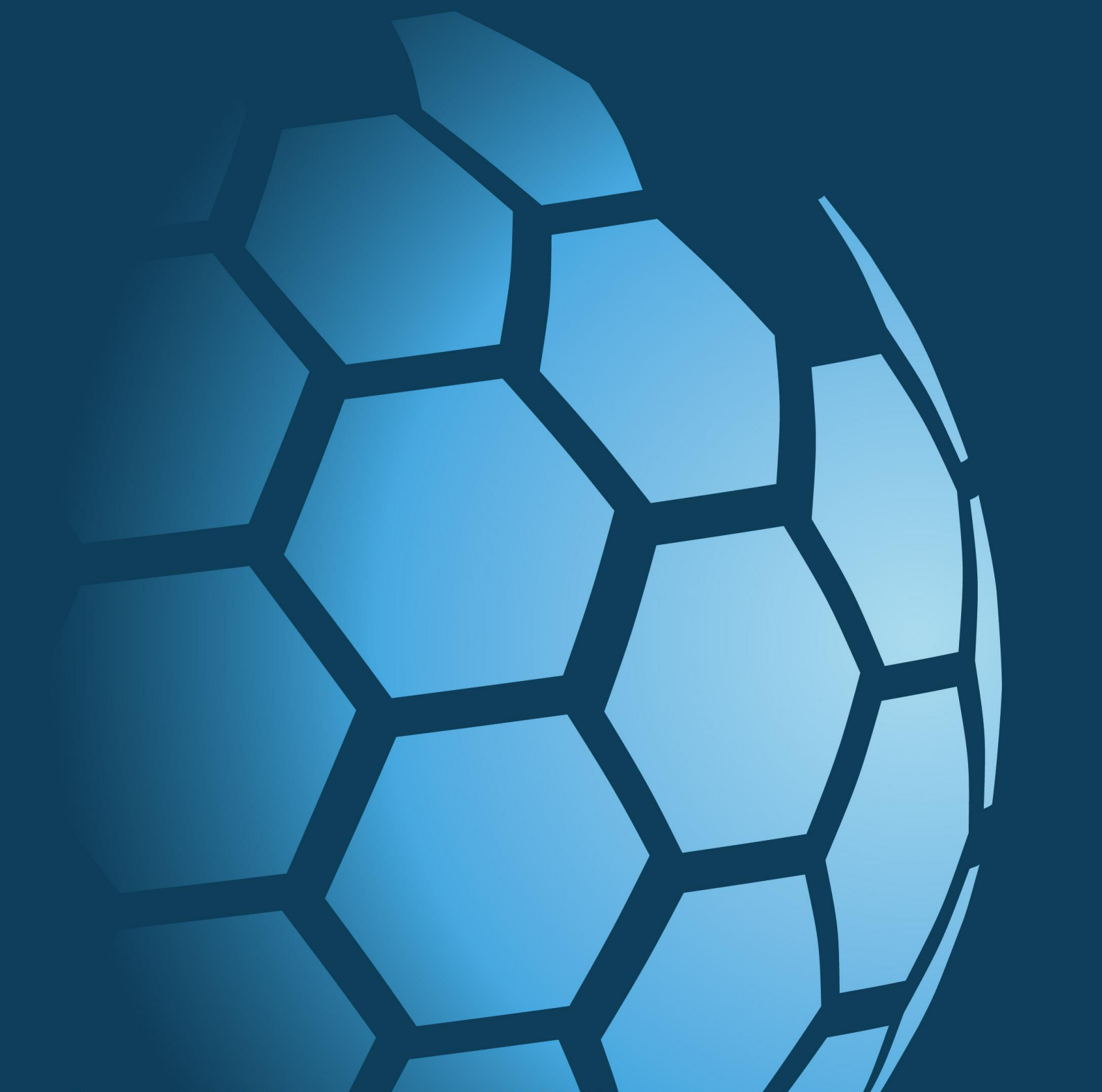


R9-CPGS04 Box 4 15.00-16.00m



CAUSEWAY
— GEOTECH

APPENDIX D
TRIAL PIT LOGS





Project No.

20-0399D

Project Name:

Bus Connects Route 9 Tallaght/Clondalkin to City Centre

Trial Pit ID

R9TP01

Coordinates

708488.70 E
727849.19 N

Client:

National Transport Authority (NTA)

Client's Representative:

AECOM/Mott MacDonald

Sheet 1 of 1
Scale: 1:25

Method:

Trial Pitting

Plant:

JCB 3CX

Elevation

101.70 mOD

Date:

08/10/2020

Logger:

RS

FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
0.50 0.50 0.50 0.50	ES1	HVP=108, HVR=17 HVP=115, HVR=17 HVP=161, HVR=26	101.4 0	0.30	TOPSOIL	MADE GROUND: Stiff greyish brown slightly sandy gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular fine to coarse of limestone. Cobbles are of limestone.	0.5
1.00 1.00 1.00 1.00	B2 ES3	HVP=175, HVR=9 HVP=201, HVR=29 HVP=201, HVR=80					1.0
1.50	ES4						1.5
2.00 2.00	B5 ES6		99.70	2.00		End of trial pit at 2.00m	2.0
							2.5
							3.0
							3.5
							4.0
							4.5

Water Strikes		Depth: 2.00 Width: 0.60 Length: 3.00	Remarks: No groundwater encountered.	Termination Reason: Terminated on refusal.	Last Updated 16/12/2020	
Struck at (m)	Remarks					
		Stability: Stable				



Project No.
20-0399D

Project Name:
Bus Connects Route 9 Tallaght/Clondalkin to City Centre

Trial Pit ID

Coordinates
708506.36 E
727855.02 N

Client:
National Transport Authority (NTA)
Client's Representative:
AECOM/Mott MacDonald

R9TP02

Method:
Trial Pitting

Sheet 1 of 1
Scale: 1:25

Plant:
JCB 3CX

Elevation
101.68 mOD

Date:
08/10/2020

Logger:
RS

FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
0.50 0.50 0.50 0.50	ES1	HVP=147, HVR=20 HVP=178, HVR=26 HVP=184, HVR=34	101.38	0.30		TOPSOIL	
1.00 1.00 1.00 1.00 1.00	B2 ES3	HVP=124, HVR=26 HVP=195, HVR=14 HVP=201, HVR=32				Stiff brown slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular fine to coarse of limestone. Cobbles are of limestone.	0.5 1.0
1.50	ES4						1.5
2.00 2.00	B5 ES6		99.28	2.40		End of trial pit at 2.40m	2.0 2.5 3.0 3.5 4.0 4.5

Water Strikes		Depth: 2.40 Width: 0.60 Length: 3.00	Remarks: No groundwater encountered.	Last Updated 16/12/2020	
Struck at (m)	Remarks				
		Stability: Stable	Termination Reason: Terminated on refusal.		



Project No. 20-0399D	Project Name: Bus Connects Route 9 Tallaght/Clondalkin to City Centre	Trial Pit ID R9TP03
Coordinates 709613.40 E 728268.52 N	Client: National Transport Authority (NTA)	Sheet 1 of 1 Scale: 1:25
	Client's Representative: AECOM/Mott MacDonald	
Method: Trial Pitting	Elevation 87.31 mOD	Date: 09/10/2020
Plant: JCB 3CX		Logger: RS
FINAL		

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
0.50 0.50	B2 ES1		87.21	0.10		MADE GROUND: Grey rounded coarse GRAVEL of mixed lithologies.	
			86.96	0.35		MADE GROUND: Greyish brown very sandy very silty subangular fine to coarse GRAVEL of mixed lithologies. Sand is fine to coarse.	
			86.41	0.90		MADE GROUND: Dark grey sandy subangular fine to coarse GRAVEL of limestone with high cobble content. Sand is fine to coarse. Cobbles are of limestone.	
			86.31	1.00		CONCRETE	
						End of trial pit at 1.00m	

Water Strikes		Depth: 1.00 Width: 0.60 Length: 2.50	Remarks: No groundwater encountered. Potential water main below cement cover No hand vane tests possible due to granular material.
Struck at (m)	Remarks		
		Stability: Unstable	Termination Reason: Terminated on concrete.
			Last Updated 16/12/2020



Project No.
20-0399D

Project Name:
Bus Connects Route 9 Tallaght/Clondalkin to City Centre

Trial Pit ID

Coordinates
709710.24 E
728980.16 N

Client:
National Transport Authority (NTA)
Client's Representative:
AECOM/Mott MacDonald

R9TP04

Method:
Trial Pitting

Sheet 1 of 1
Scale: 1:25

Plant:
JCB 3CX

Elevation
78.40 mOD

Date:
08/10/2020

Logger:
RS

FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
			78.10	0.30	TOPSOIL		
0.50 0.50	ES1	HVP=201, HVR=29				MADE GROUND: Stiff brown slightly sandy slightly gravelly CLAY with low cobble content and fragments of red brick. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies. Cobbles are of mudstone.	0.5
1.00 1.00 1.00	B2 ES2 ES3		77.30	1.10		MADE GROUND: Stiff yellowish brown slightly sandy slightly gravelly CLAY with fragments of red brick. Sand is fine to coarse. Gravel is subangular fine to coarse of mudstone.	1.0
1.50 1.50 1.50	B4 ES ES5		76.70	1.70		Grey sandy very clayey subrounded fine to coarse GRAVEL of limestone with low cobble content. Sand is fine to coarse. Cobbles are of limestone.	1.5
2.00 2.00	B6 ES7		76.40	2.00		End of trial pit at 2.00m	2.0
							2.5
							3.0
							3.5
							4.0
							4.5

Water Strikes		Depth: 2.00 Width: 0.60 Length: 3.00	Remarks: No groundwater encountered.
Struck at (m)	Remarks		
		Stability: Stable	Termination Reason: Terminated on refusal.
		Last Updated 16/12/2020	



Project No. 20-0399D	Project Name: Bus Connects Route 9 Tallaght/Clondalkin to City Centre	Trial Pit ID R9TP05
Coordinates 709757.92 E 729208.08 N	Client: National Transport Authority (NTA)	
Method: Trial Pitting	Client's Representative: AECOM/Mott MacDonald	Sheet 1 of 1 Scale: 1:25
Plant: JCB 3CX	Elevation 75.20 mOD	Date: 08/10/2020
	Logger: RS	FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
0.50 0.50 0.50 0.50	ES1	HVP=158, HVR=26 HVP=50, HVR=9 HVP=78, HVR=20				MADE GROUND: Firm brown slightly sandy slightly gravelly CLAY with medium cobble content and fragments of red brick and wood and pieces of rubber and carpet. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium of mixed lithologies. Cobbles are of mixed lithologies.	
1.00 1.00 1.00 1.00	B2 ES ES2 ES3	HVP=53, HVR=7 HVP=55, HVR=10 HVP=86, HVR=11					
1.00 1.00 1.00 1.50	ES4	Rapid water strike at 1.60m					
			73.40	1.80			

Water Strikes		Depth: 1.80 Width: 0.60 Length: 3.00	Remarks:
Struck at (m) 1.60	Remarks Rapid water strike at 1.60m		
Stability: Unstable	Termination Reason: Terminated due to water ingress and wall collapse.	Last Updated 16/12/2020	



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Project No.
20-0399D

Project Name:
Bus Connects Route 9 Tallaght/Clondalkin to City Centre

Trial Pit ID
R9TP06

Coordinates
709904.05 E
729454.47 N

Client:
National Transport Authority (NTA)
Client's Representative:
AECOM/Mott MacDonald

Sheet 1 of 1
Scale: 1:25

Method:
Trial Pitting

Plant:
JCB 3CX

Elevation
70.98 mOD

Date:
08/10/2020

Logger:
RS

FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
0.50	ES	HVP=118, HVR=26 HVP=132, HVR=20	70.88	0.10		TOPSOIL	
0.50	ES1		70.78	0.20		MADE GROUND: Firm orangish brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subrounded fine to coarse of mudstone.	
0.50						MADE GROUND: Stiff greyish brown slightly sandy gravelly CLAY with medium cobble and boulder content and fragments of concrete, red brick and pieces of rubber tubes. Sand is fine to coarse. Gravel is subrounded fine to coarse of predominantly limestone. Cobbles and boulders are of limestone.	
1.00	B2						
1.00	ES3		69.93	1.05		End of trial pit at 1.05m	

Water Strikes		Depth: 1.05 Width: 0.60 Length: 3.00	Remarks: No groundwater encountered.	Last Updated 16/12/2020	
Struck at (m)	Remarks				
		Stability: Unstable	Termination Reason: Terminated on refusal.		



Project No.
20-0399D

Project Name:
Bus Connects Route 9 Tallaght/Clondalkin to City Centre

Trial Pit ID
R9TP07

Coordinates
710096.86 E
729729.58 N

Client:
National Transport Authority (NTA)
Client's Representative:
AECOM/Mott MacDonald

Sheet 1 of 1
Scale: 1:25

Method:
Trial Pitting

Plant:
3T Tracked Excavator

Elevation
74.80 mOD

Date:
24/10/2020

Logger:
GH

FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
			74.50	0.30		TOPSOIL	
0.50 0.50 0.50	B1 ES ES4					MADE GROUND: Firm brown slightly sandy slightly gravelly silty CLAY with medium cobble and boulder content and pieces of red brick and concrete. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies. Cobbles and boulders are angular of mixed lithologies.	0.5
1.00 1.00	B2 ES5						1.0
2.00 2.00	B3 ES6		73.00 72.80	1.80 2.00		Brown gravelly silty fine to coarse SAND. Gravel is subrounded fine to medium.	1.5 2.0
						End of trial pit at 2.00m	2.5 3.0 3.5 4.0 4.5

Water Strikes		Depth: 2.00 Width: 0.55 Length: 2.80	Remarks: Hand dug inspection pit excavated to 1.20m.	Last Updated 16/12/2020	
Struck at (m)	Remarks				
		Stability: Stable	Termination Reason: Terminated on instruction of engineer.		



Project No.
20-0399D

Project Name:
Bus Connects Route 9 Tallaght/Clondalkin to City Centre

Trial Pit ID

R9TP08

Coordinates
710138.06 E
730072.84 N

Client:
National Transport Authority (NTA)
Client's Representative:
AECOM/Mott MacDonald

Sheet 1 of 1
Scale: 1:25

Method:
Trial Pitting

Plant:
JCB 3CX

Elevation
67.36 mOD

Date:
08/10/2020

Logger:
RS

FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
0.50 0.50	ES ES1		66.81	0.55		MADE GROUND: Stiff brown slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subrounded fine to coarse of limestone.	0.5
1.00 1.00	B2 ES3		66.06	1.30		Brown sandy clayey subangular fine to coarse GRAVEL of limestone. Sand is fine to coarse.	1.0
						End of trial pit at 1.30m	1.5 2.0 2.5 3.0 3.5 4.0 4.5

Water Strikes		Depth: 1.30 Width: 0.60 Length: 2.00	Remarks: No groundwater encountered. No hand vane tests possible due to granular nature of clay.
Struck at (m)	Remarks		
		Stability: Unstable	Termination Reason: Terminated on refusal.
			Last Updated 16/12/2020





Project No. 20-0399D	Project Name: Bus Connects Route 9 Tallaght/Clondalkin to City Centre	Trial Pit ID R9TP09
Coordinates 710391.88 E 730342.97 N	Client: National Transport Authority (NTA)	Sheet 1 of 1 Scale: 1:25
	Client's Representative: AECOM/Mott MacDonald	
Method: Trial Pitting	Elevation 69.54 mOD	Date: 09/10/2020
Plant: JCB 3CX		Logger: RS
		FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
0.50	ES1		69.39	0.15		MADE GROUND: Grey sandy very silty subangular fine to coarse GRAVEL of limestone. Sand is fine to coarse.	
			69.29	0.25		MADE GROUND: Light yellowish brown slightly sandy clayey subangular fine to coarse GRAVEL of mudstone. Sand is fine to coarse.	
			69.19	0.35		MADE GROUND: Brown very sandy very clayey subangular to subrounded fine to coarse GRAVEL of mixed lithologies. Sand is fine to coarse.	
			69.09	0.45		MADE GROUND: Dark brown very gravelly very silty fine to coarse SAND. Gravel is subangular fine to coarse of mixed lithologies.	
1.00	B3						
1.00	ES						
1.00	ES2						
1.50	ES4						
2.00	ES						
2.00	ES5						
2.50	B6		67.34	2.20		Yellowish brown sandy silty subrounded fine to coarse GRAVEL of mixed lithologies with low cobble content. Cobbles are subrounded of limestone.	
2.50	ES7		66.79	2.75		End of trial pit at 2.75m	

Water Strikes		Depth: 2.75 Width: 0.60 Length: 3.00	Remarks: No groundwater encountered.
Struck at (m)	Remarks		
		Stability: Stable	Termination Reason: Terminated on refusal.
		Last Updated 16/12/2020	



Project No. 20-0399D	Project Name: Bus Connects Route 9 Tallaght/Clondalkin to City Centre	Trial Pit ID R9TP11
Coordinates 710673.95 E 730667.32 N	Client: National Transport Authority (NTA)	
Method: Trial Pitting	Client's Representative: AECOM/Mott MacDonald	Sheet 1 of 1 Scale: 1:25
Plant: JCB 3CX	Elevation 56.61 mOD	Date: 08/10/2020
	Logger: RS	FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
0.50 0.50 0.50 0.50	ES1	HVP=201, HVR=25 HVP=201, HVR=29 HVP=201, HVR=31	55.71	0.90		MADE GROUND: Stiff brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subrounded fine to coarse of mixed lithologies.	0.5
1.00 1.00 1.00 1.00 1.00 1.00	B2 ES ES3	HVP=141, HVR=44 HVP=201, HVR=80 HVP=55, HVR=9				MADE GROUND: Stiff yellowish brown slightly sandy slightly gravelly CLAY and fragments of ceramic. Sand is fine to coarse. Gravel is subangular fine to medium of mudstone.	1.0
1.50	ES4		55.01	1.60		Stiff brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subrounded fine of mixed lithologies. Contains occasional lenses of brown fine to medium SAND.	1.5
2.00 2.00	B5 ES6						2.0
3.00 3.00	B7 ES8						3.0
			53.01	3.60		End of trial pit at 3.60m	3.5
							4.0
							4.5

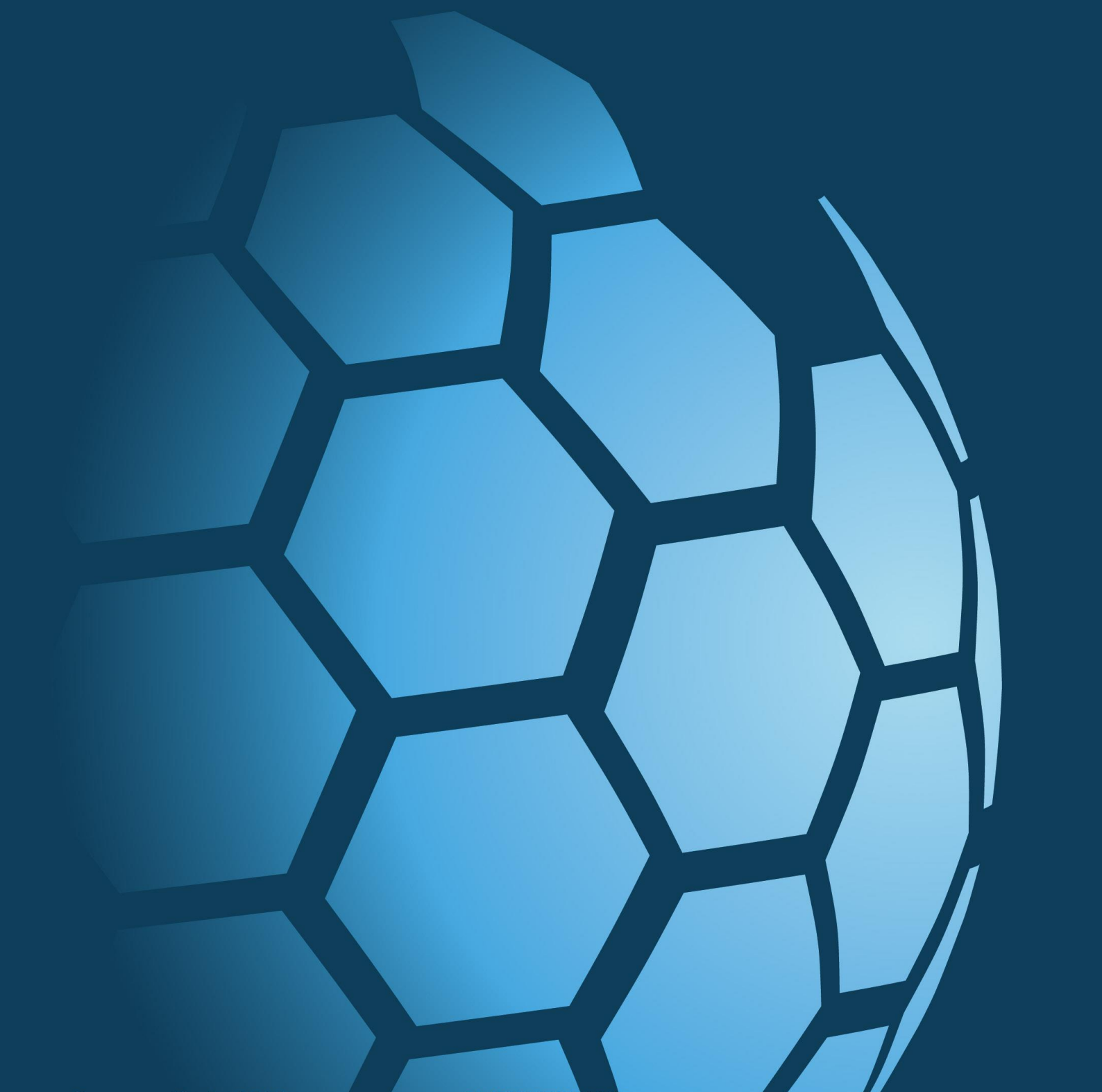
Water Strikes		Depth: 3.60 Width: 0.60 Length: 3.00	Remarks: No groundwater encountered.
Struck at (m)	Remarks		
		Stability: Stable	Termination Reason: Terminated on refusal.
			Last Updated 16/12/2020





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APPENDIX E
TRIAL PIT PHOTOGRAPHS





R9-TP01



R9-TP01



R9-TP01



R9-TP01



R9-TP01



R9-TP01



R9-TP01



R9-TP01



R9-TP02



R9-TP02



R9-TP02



R9-TP02



R9-TP02



R9-TP02



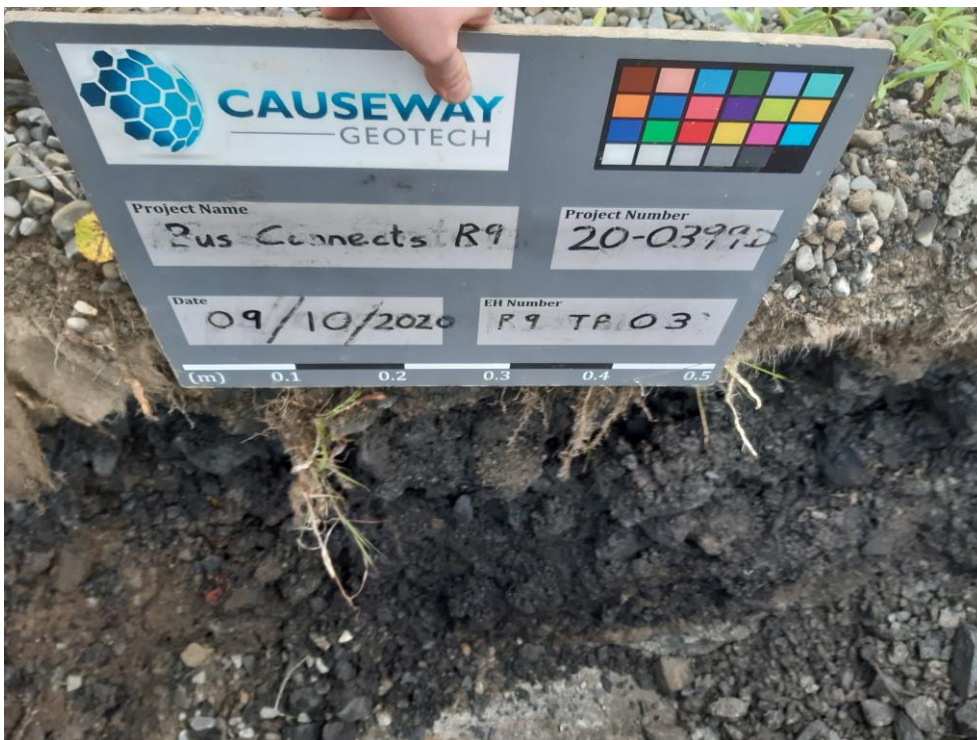
R9-TP02



R9-TP03



R9-TP03



R9-TP03



R9-TP03



R9-TP03



R9-TP03



R9-TP03



R9-TP04



R9-TP04



R9-TP04



R9-TP04



R9-TP04



R9-TP04



R9-TP04



R9-TP05



R9-TP05



R9-TP05



R9-TP05



R9-TP05



R9-TP05



R9-TP05



R9-TP06



R9-TP06



R9-TP06



R9-TP06



R9-TP06



R9-TP06



R9-TP06



R9-TP06



R9-TP06



R9-TP07



R9-TP07



R9-TP07



R9-TP07



R9-TP07



R9-TP07



R9-TP07



R9-TP08



R9-TP08



R9-TP08



R9-TP08



R9-TP08



R9-TP08



R9-TP08



R9-TP08



R9-TP08



R9-TP09



R9-TP09



R9-TP09



R9-TP09



R9-TP09



R9-TP09



R9-TP09



R9-TP10



R9-TP10



R9-TP10



R9-TP10



R9-TP10



R9-TP10



R9-TP10



R9-TP11



R9-TP11



R9-TP11



R9-TP11



R9-TP11



R9-TP11



R9-TP11



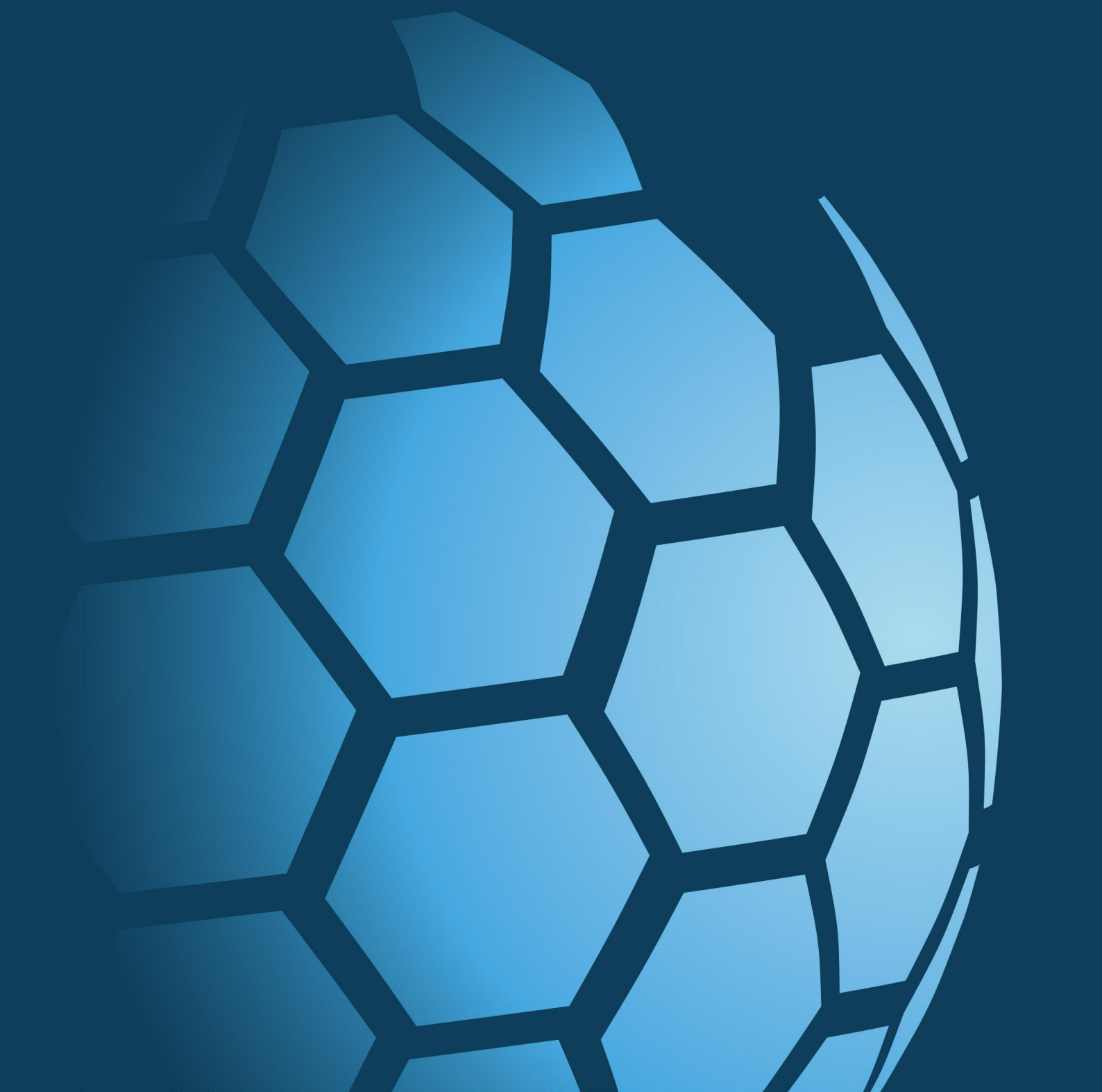
R9-TP11



CAUSEWAY
— GEOTECH

APPENDIX F

INDIRECT IN-SITU CBR TEST RESULTS



Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project Number	20-0399D
Project Name	Bus Connects Route 9
Site Location	R9-TP05

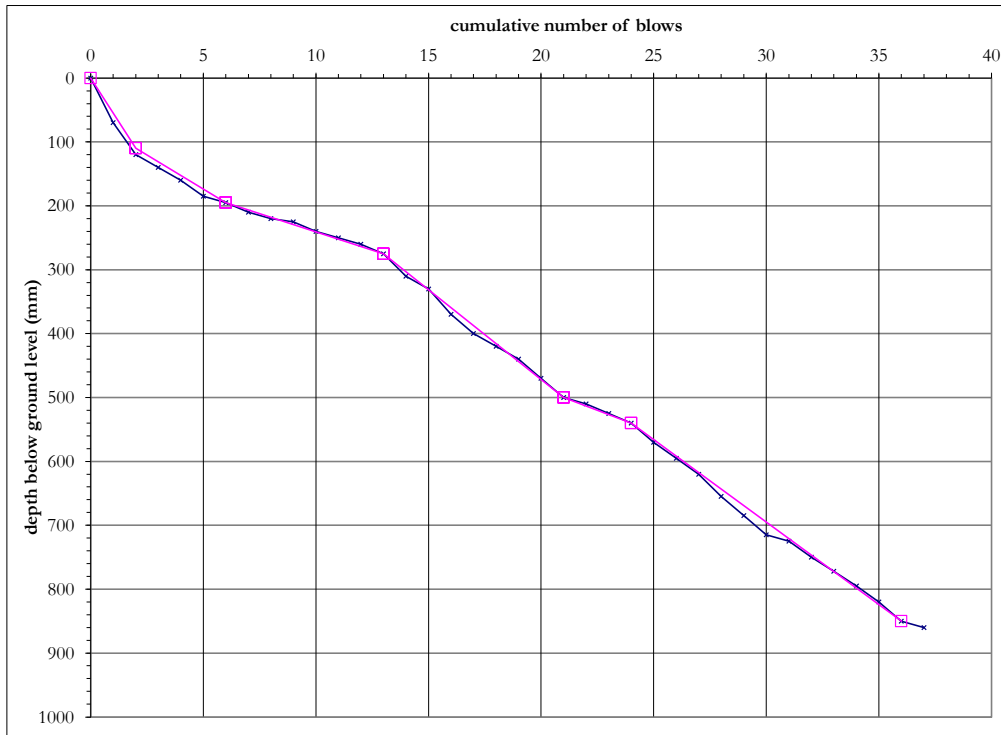


Test Number	1
Depth bgl (m)	0.00

Date Tested	30/10/2020
Weather	Raining

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4.
 CBR calculated using the TRL equation: $\log_{10}(\text{CBR}) = 2.48 - 1.057 \times \log_{10}(\text{mm/blow})$ iaw IAN 73/06 Rev 1 2009.

Surface preparation	Description of surface material
Natural Ground	Topsoil



top / base of layer (mm)	mm/ blow	CBR (%)
0	55	4.4
110		
110	21	12
195		
195	11	23
275		
275	28	8.9
500		
500	13	20
540		
540	26	9.7
850		

CBR Range	Min: 4.4 Max: 23	The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value.
------------------	---------------------	---

Deviation(s) from standard procedure	None
---	------

Observations and comments	
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Approved Name and Appointment		
Darren O'Mahony Director		November 2020



Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project Number	20-0399D
Project Name	Bus Connects Route 9
Site Location	R9-TP07

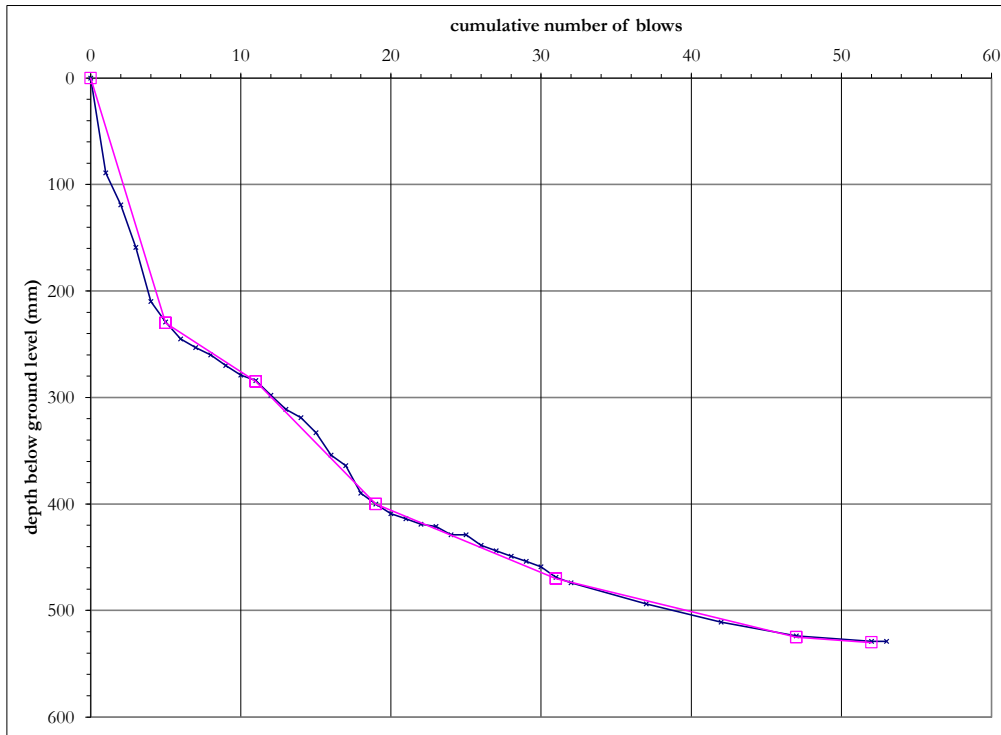


Test Number	1
Depth bgl (m)	0.00

Date Tested	30/10/2020
Weather	Raining

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4.
 CBR calculated using the TRL equation: $\log_{10}(\text{CBR}) = 2.48 - 1.057 \times \log_{10}(\text{mm/blow})$ iaw IAN 73/06 Rev 1 2009.

Surface preparation	Description of surface material
Natural Ground	Topsoil



top / base of layer (mm)	mm/ blow	CBR (%)
0	46	5.3
230		
230	9.2	29
285		
285	14	18
400		
400	5.8	47
470		
470	3.4	82
525		
525	1	>100
530		

CBR Range	Min: 5.3 Max: >100	The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value.
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Deviation(s) from standard procedure	None
---	------

Observations and comments	
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Approved Name and Appointment		
Darren O'Mahony Director		November 2020

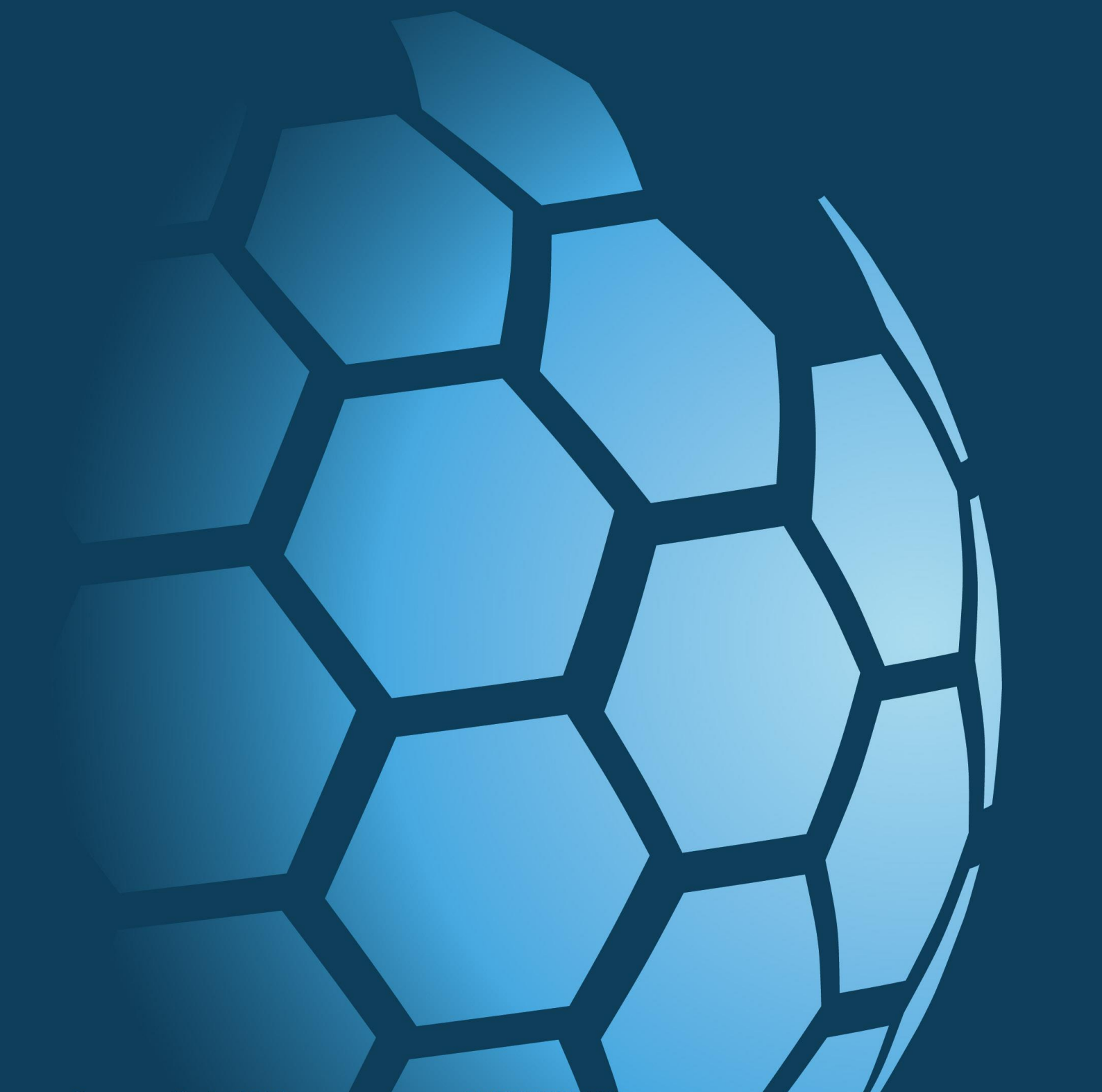




CAUSEWAY
— GEOTECH

APPENDIX G

GEOTECHNICAL LABORATORY TEST RESULTS





**SOIL AND ROCK SAMPLE ANALYSIS
LABORATORY TEST REPORT**

20 November
2020

Project Name:	Bus Connects - Route 9 - Tallaght/Clondalkin to City Centre
Project No.:	20-0399D
Client:	National Transport Authority (NTA)
Engineer:	AECOM/Mott MacDonald

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 9 – Tallaght/Clondalkin to City Centre

Report Reference: Schedule 1 & 2

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	63
SOIL	Liquid and Plastic Limits of soil-1 point cone penetrometer method	BS 1377-2: 1990: Cl 4.4, 5.3 & 5.4	30
SOIL	Particle size distribution - wet sieving	BS 1377-2: 1990: Cl 9.2	32
SOIL	Particle size distribution - sedimentation hydrometer method	BS 1377-2: 1990: Cl 9.5	21
SOIL	Moisture Condition Value at natural moisture content	BS 1377-4: 1990: Cl 5.4	4
SOIL	California Bearing Ratio (CBR)	BS 1377-4: 1990: Cl 7	2
SOIL	Laboratory Vane Shear Strength (3 determinations) *	BS 1377-7: 1990: Cl 3	2
SOIL	Undrained shear strength – triaxial compression without measurement of pore pressure (loads from 0.12 to 24 kN)	BS 1377-7: 1990: Cl 8	7
ROCK	Point load index	ISRM Commission on Testing Methods. Suggested Method for Determining Point Load Strength 1985	43
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 (<i>UKAS 2183</i>)	pH Value of Soil		21
SOIL – Subcontracted to Eurofins Chemtest Ltd (<i>UKAS 2183</i>)	Sulphate Content water extract		21
SOIL – Subcontracted to Eurofins Chemtest Ltd (<i>UKAS 2183</i>)	Sulphate Content Acid extract		8
SOIL – Subcontracted to Eurofins Chemtest Ltd (<i>UKAS 2183</i>)	Total Sulphur		8


Summary of Classification Test Results

Project No. 20-0399D	Project Name Bus Connects Route 9 Tallaght/Clondalkin to City Centre
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Hole No.	Sample				Soil Description	Density		w %	Passing 425µm %	LL %	PL %	PI %	Particle density Mg/m3	Casagrande Classification
	Ref	Top	Base	Type		bulk Mg/m3	dry							
R9CP01	5	0.50		B	Brown sandy slightly gravelly silty CLAY.			20.0						
R9CP01	12	1.20		D	Brown sandy slightly gravelly silty CLAY.			14.0						
R9CP01	7	2.00		B	Brown sandy slightly gravelly silty CLAY.			11.0	68	31 -1pt	19	12		CL
R9CP01	18	3.00		U	Brown sandy slightly gravelly silty CLAY.			16.0						
R9CP01	15	4.00		D	Brownish grey sandy slightly gravelly silty CLAY.			22.0	74	35 -1pt	21	14		CL/CI
R9CP01	19	5.00		U	Brownish grey sandy slightly gravelly silty CLAY.			12.0						
R9CP02	5	0.50		B	Brownish grey sandy clayey subangular fine to coarse GRAVEL.			5.9	42	33 -1pt	20	13		CL
R9CP02	12	1.20		U	Greyish brown slightly sandy slightly gravelly silty CLAY.			21.0						
R9CP02	10	2.00		D	Brownish grey sandy gravelly silty CLAY.			11.0	47	33 -1pt	20	13		CL
R9CP02	11	3.00		D	Brownish grey sandy gravelly silty CLAY.			13.0						
R9CP03	12	1.00		B	Brownish grey sandy gravelly SILT.			21.0	48	24 -1pt	19	5		ML
R9CP03	26	1.20		U	Brownish grey sandy gravelly SILT.			14.0						

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 <p style="text-align: center;">20/11/2020</p>	Approved By <p style="text-align: center;">Stephen.Watson</p>	 10122
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Summary of Classification Test Results

Project No. 20-0399D	Project Name Bus Connects Route 9 Tallaght/Clondalkin to City Centre
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Hole No.	Sample				Soil Description	Density		w %	Passing 425µm %	LL %	PL %	PI %	Particle density Mg/m3	Casagrande Classification
	Ref	Top	Base	Type		bulk Mg/m3	dry							
R9CP03	19	2.00		D	Brownish grey sandy gravelly SILT.			12.0						
R9CP03	20	3.00		D	Brownish grey sandy gravelly silty CLAY.			9.1						
R9CP03	21	4.00		D	Brownish grey sandy gravelly silty CLAY.			11.0						
R9CP03	22	5.00		D	Brownish grey sandy gravelly silty CLAY.			13.0						
R9CP03	23	6.00		D	Brownish grey sandy gravelly silty CLAY.			14.0						
R9CP03	18	7.50		B	Brownish grey sandy gravelly silty CLAY.			15.0	74	30 -1pt	18	12		CL
R9CP03	25	8.00		D	Brownish grey sandy gravelly silty CLAY.			12.0						
R9CP04	9	1.20		D	Brownish grey sandy gravelly silty CLAY.			24.0						
R9CP04	10	2.00		D	Brownish grey sandy gravelly silty CLAY.			33.0						
R9CP04	11	3.00		D	Brownish grey sandy gravelly silty CLAY.			9.7						
R9CP05	10	0.50		B	Brownish grey sandy gravelly silty CLAY.			14.0						
R9CP05	19	1.20		D	Brownish grey sandy gravelly silty CLAY.			12.0						

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 <p style="text-align: center;">20/11/2020</p>	Approved By <p style="text-align: center;">Stephen.Watson</p>	 10122
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Summary of Classification Test Results

Project No. 20-0399D	Project Name Bus Connects Route 9 Tallaght/Clondalkin to City Centre
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Hole No.	Sample				Soil Description	Density		w %	Passing 425µm %	LL %	PL %	PI %	Particle density Mg/m3	Casagrande Classification
	Ref	Top	Base	Type		bulk Mg/m3	dry							
R9CP05	20	2.00		D	Brownish grey sandy gravelly silty CLAY.			14.0	44	31 -1pt	20	11		CL
R9CP05	21	3.00		D	Brownish grey sandy gravelly silty CLAY.			13.0						
R9CP05	22	4.00		D	Brownish grey sandy gravelly silty CLAY.			14.0						
R9CP05	26	8.00		U	Grey sandy slightly gravelly silty CLAY.			9.2						
R9CP06	2	1.00		B	Brownish grey sandy gravelly silty CLAY.			15.0	59	30 -1pt	17	13		CL
R9CP06	3	3.00		B	Brownish grey sandy gravelly silty CLAY.			14.0	63	33 -1pt	14	19		CL
R9CP08	7	1.00		B	Brownish grey sandy gravelly silty CLAY.			15.0						
R9CP08	14	2.00		D	Brownish grey sandy gravelly silty CLAY.			15.0						
R9CP08	18	3.00		U	Grey slightly sandy slightly gravelly silty CLAY.			14.0						
R9CP08	9	3.00		B	Brownish grey sandy gravelly silty CLAY.			13.0	63	24 -1pt	18	6		ML/CL
R9CP08	16	4.00		D	Brownish grey sandy slightly gravelly silty CLAY.			15.0	46	27 -1pt	19	8		CL
R9CP10	6	0.50		B	Brownish grey sandy gravelly silty CLAY.			17.0						

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 <p style="text-align: center;">20/11/2020</p>	Approved By <p style="text-align: center;">Stephen.Watson</p>	 10122
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Summary of Classification Test Results

Project No. 20-0399D	Project Name Bus Connects Route 9 Tallaght/Clondalkin to City Centre
-------------------------	---

Hole No.	Sample				Soil Description	Density		w %	Passing 425µm %	LL %	PL %	PI %	Particle density Mg/m3	Casagrande Classification
	Ref	Top	Base	Type		bulk Mg/m3	dry							
R9CP10	10	1.20		D	Brownish grey sandy gravelly silty CLAY.			21.0						
R9CP10	8	2.00		B	Brownish grey sandy gravelly silty CLAY.			15.0	71	43 -1pt	24	19		CI
R9CP11	9	4.00		B	Brownish grey sandy gravelly silty CLAY.			13.0	67	26 -1pt	18	8		CL
R9CP12	10	5.00		B	Brownish grey silty fine to coarse SAND.			24.0	93	26 -1pt	21	5		ML
R9CP12	16	5.00		D	Brownish grey silty fine to coarse SAND.			28.0						
R9CP12	17	6.00		D	Brownish grey sandy clayey subangular fine to coarse GRAVEL.			7.5						
R9CP13	9	1.20		D	Brownish grey sandy slightly gravelly SILT.			12.0						
R9CPGS01	9	1.00		B	Brownish grey sandy gravelly silty CLAY.			21.0	55	28 -1pt	18	10		CL
R9CPGS01	11	3.00		B	Brownish grey gravelly silty fine to coarse SAND.			9.8	40	21 -1pt	17	4		ML
R9CPGS01	13	5.00		B	Brown sandy gravelly SILT.			15.0	54	21 -1pt	20	1		ML
R9CPGS02	17	2.00		U	Greyish brown slightly sandy silty CLAY.			16.0						
R9CPGS02	9	2.00		B	Greyish brown slightly sandy silty CLAY.			12.0	44	33 -1pt	23	10		ML/CL

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 <p style="text-align: center;">20/11/2020</p>	Approved By <p style="text-align: center;">Stephen.Watson</p>	 10122
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Summary of Classification Test Results

Project No. 20-0399D	Project Name Bus Connects Route 9 Tallaght/Clondalkin to City Centre
-------------------------	---

Hole No.	Sample				Soil Description	Density		w %	Passing 425µm %	LL %	PL %	PI %	Particle density Mg/m3	Casagrande Classification
	Ref	Top	Base	Type		bulk Mg/m3	dry							
R9CPGS02	11	4.00		B	Greyish brown sandy gravelly silty CLAY.			22.0	60	44 -1pt	29	15		MI
R9CPGS02	11	10.50		C	Greyish brown sandy gravelly silty CLAY.			15.0						
R9CPGS02	11	12.00		C	Greyish brown sandy gravelly silty CLAY.			13.0						
R9CPGS03	13	2.00		D	Greyish brown sandy gravelly silty CLAY.			9.9						
R9CPGS03	9	3.00		B	Greyish brown slightly sandy slightly gravelly silty CLAY.			11.0	67	23 -1pt	17	6		ML/CL
R9CPGS04	14	2.00		D	Greyish brown sandy gravelly silty CLAY.			16.0	97	37 -1pt	20	17		CI
R9TP01	2	1.00		B	Greyish brown slightly sandy slightly gravelly silty CLAY.			12.0	63	29 -1pt	17	12		CL
R9TP02	2	1.00		B	Greyish brown slightly sandy slightly gravelly silty CLAY.			14.0	64	34 -1pt	19	15		CL
R9TP04	2	1.00		B	Brown sandy gravelly silty CLAY.			16.0	73	33 -1pt	16	17		CL
R9TP05	2	1.00		B	Brown sandy gravelly silty CLAY.			14.0	59	23 -1pt	17	6		ML/CL
R9TP06	2	1.00		B	Brown sandy gravelly silty CLAY.			12.0	41	32 -1pt	19	13		CL
R9TP07	1	0.50		B	Brown gravelly clayey fine to coarse SAND.			14.0	49	38 -1pt	20	18		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 <p style="text-align: center;">20/11/2020</p>	Approved By <p style="text-align: center;">Stephen.Watson</p>	 10122
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Summary of Classification Test Results

Project No. 20-0399D	Project Name Bus Connects Route 9 Tallaght/Clondalkin to City Centre
-------------------------	---

Hole No.	Sample				Soil Description	Density		w %	Passing 425µm %	LL %	PL %	PI %	Particle density Mg/m3	Casagrande Classification
	Ref	Top	Base	Type		bulk Mg/m3	dry							
R9TP10	9	4.00		B	Brown sandy silty CLAY.			27.0	97	25 -1pt	17	8		CL
R9TP11	2	1.00		B	Brown sandy slightly gravelly silty CLAY.			22.0	77	35 -1pt	22	13		CL/CI
R9TP11	5	2.00		B	Brown slightly sandy silty CLAY.			20.0	97	43 -1pt	20	23		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 <p style="text-align: center;">20/11/2020</p>	Approved By <p style="text-align: center;">Stephen.Watson</p>	
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PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9CP01**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **7**

Soil Description **Brown sandy slightly gravelly silty CLAY.**

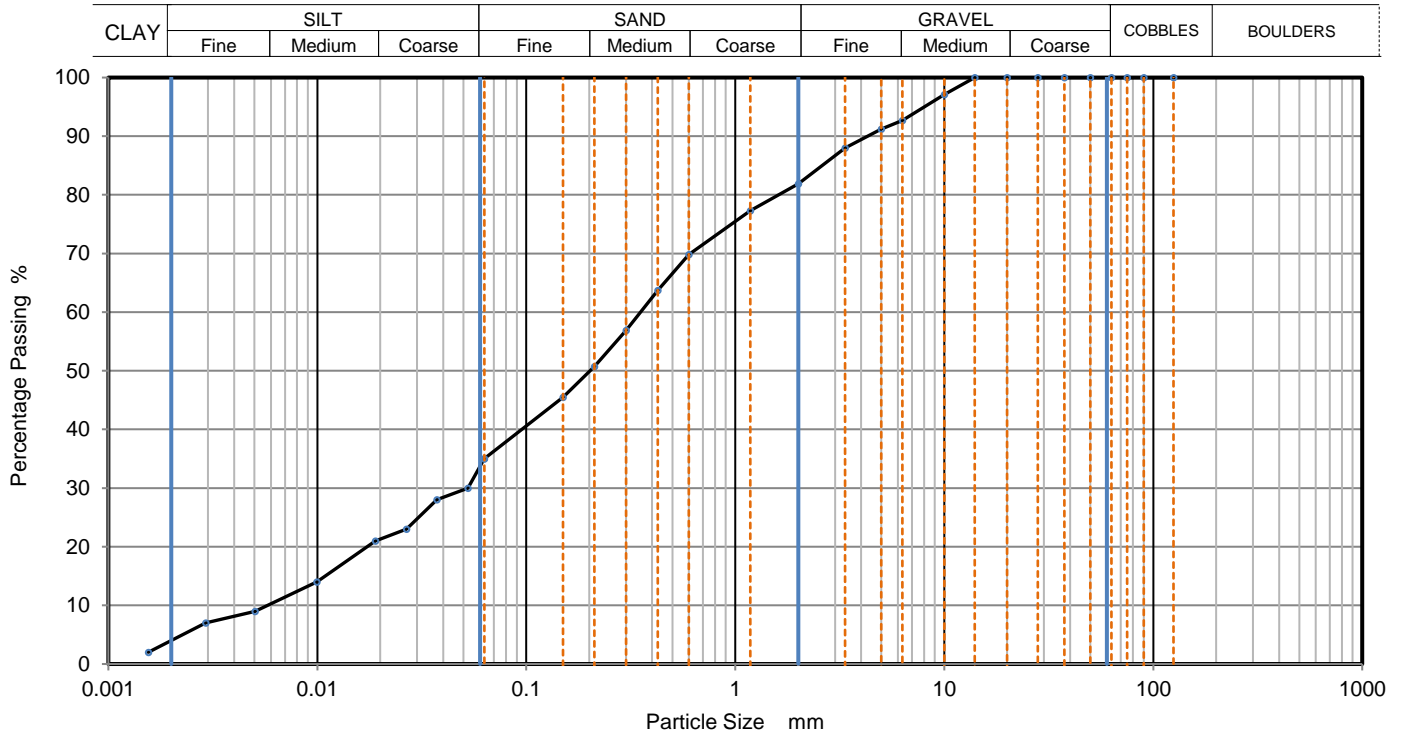
Depth, m **2.00**

Specimen Reference **6** Specimen Depth **2** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clauses 9.2 and 9.5**

KeyLAB ID **Caus202010222**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	35
90	100	0.05248	30
75	100	0.03732	28
63	100	0.02669	23
50	100	0.01897	21
37.5	100	0.00996	14
28	100	0.00503	9
20	100	0.00292	7
14	100	0.00155	2
10	97		
6.3	93		
5	91		
3.35	88		
2	82		
1.18	77		
0.6	70		
0.425	64	Particle density (assumed)	
0.3	57	2.65 Mg/m3	
0.212	51		
0.15	46		
0.063	35		

Dry Mass of sample, g **1003**

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	18.1
Sand	46.9
Silt	30.8
Clay	4.2

Grading Analysis		
D100	mm	
D60	mm	0.351
D30	mm	0.05
D10	mm	0.00555
Uniformity Coefficient		63
Curvature Coefficient		1.3

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



Approved

Stephen.Watson



PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9CP01**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **15**

Soil Description **Brownish grey sandy slightly gravelly silty CLAY.**

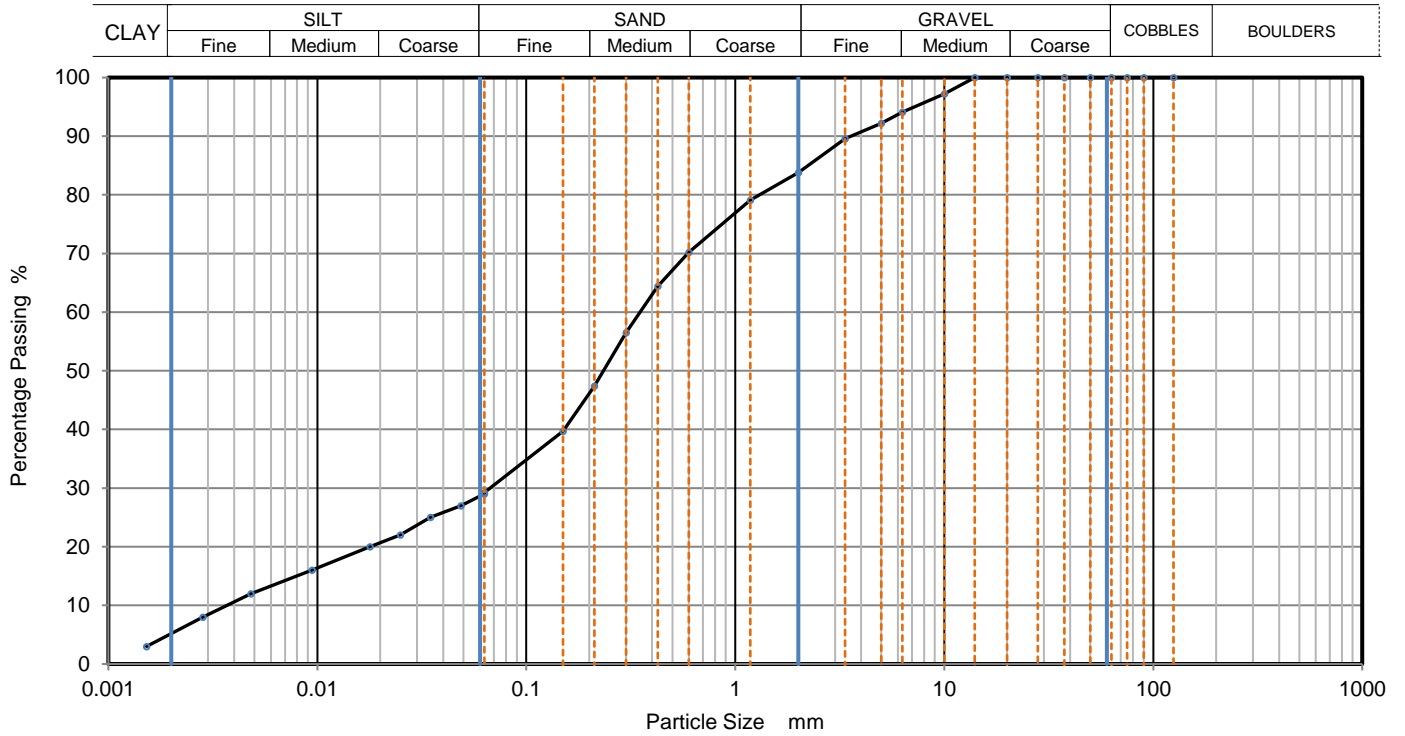
Depth, m **4.00**

Specimen Reference **6** Specimen Depth **4** m

Sample Type **D**

Test Method **BS1377:Part 2:1990, clauses 9.2 and 9.5**

KeyLAB ID **Caus202010224**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	29
90	100	0.04856	27
75	100	0.03479	25
63	100	0.02492	22
50	100	0.01784	20
37.5	100	0.00944	16
28	100	0.00480	12
20	100	0.00283	8
14	100	0.00152	3
10	97		
6.3	94		
5	92		
3.35	90		
2	84		
1.18	79		
0.6	70		
0.425	64	Particle density (assumed) 2.65 Mg/m3	
0.3	57		
0.212	47		
0.15	40		
0.063	29		

Dry Mass of sample, g **519**

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	16.2
Sand	54.6
Silt	23.9
Clay	5.3

Grading Analysis	
D100	mm
D60	mm
D30	mm
D10	mm
Uniformity Coefficient	96
Curvature Coefficient	3.5

Remarks

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

Approved

Stephen.Watson





PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9CP02**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **5**

Soil Description **Brownish grey sandy clayey subangular fine to coarse GRAVEL.**

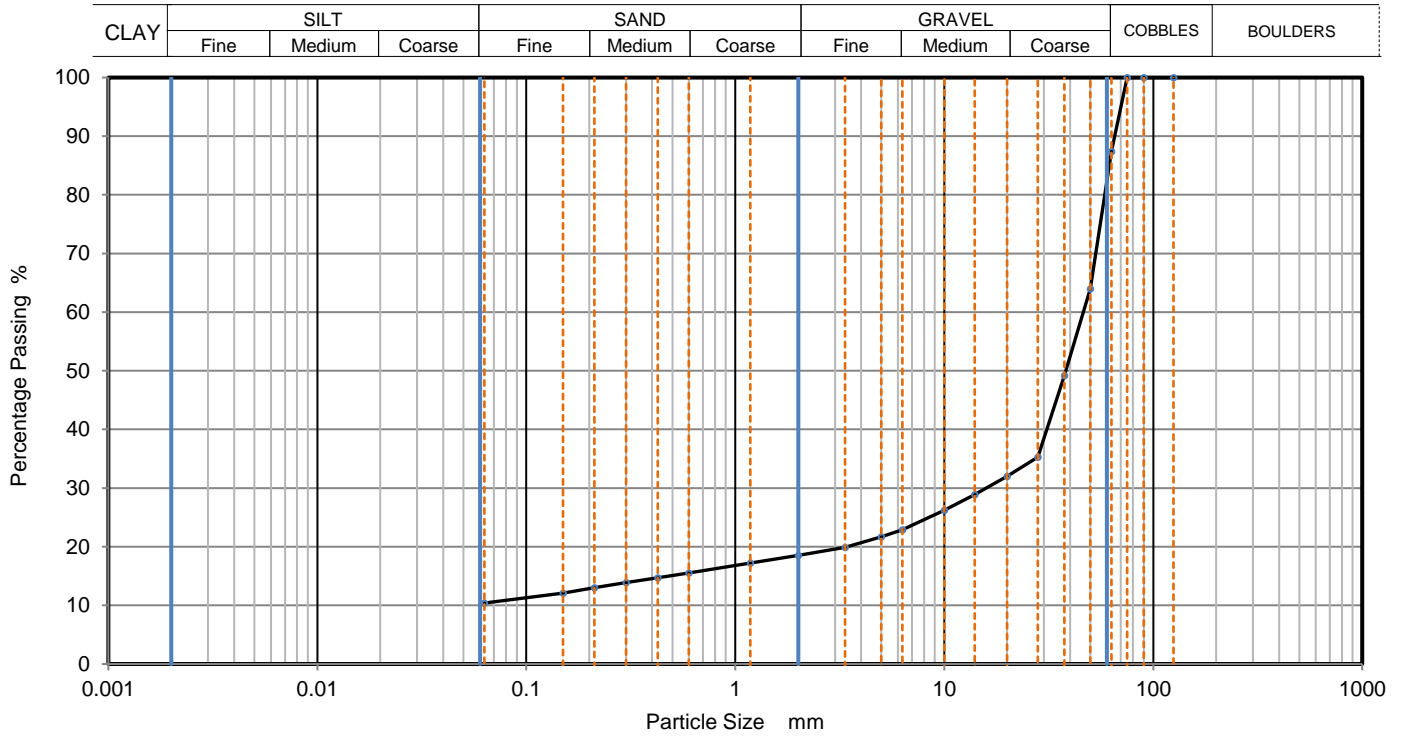
Depth, m **0.50**

Specimen Reference **6** Specimen Depth **0.5** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clause 9.2**

KeyLAB ID **Caus202010226**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	87		
50	64		
37.5	49		
28	35		
20	32		
14	29		
10	26		
6.3	23		
5	22		
3.35	20		
2	19		
1.18	17		
0.6	16		
0.425	15		
0.3	14		
0.212	13		
0.15	12		
0.063	10		

Dry Mass of sample, g

9739

Sample Proportions	% dry mass
Cobbles	12.6
Gravel	68.9
Sand	8.1
Fines <0.063mm	10.0

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

Remarks

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

Approved

Stephen.Watson





PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9CP03**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **17**

Soil Description **Brownish grey sandy gravelly silty CLAY.**

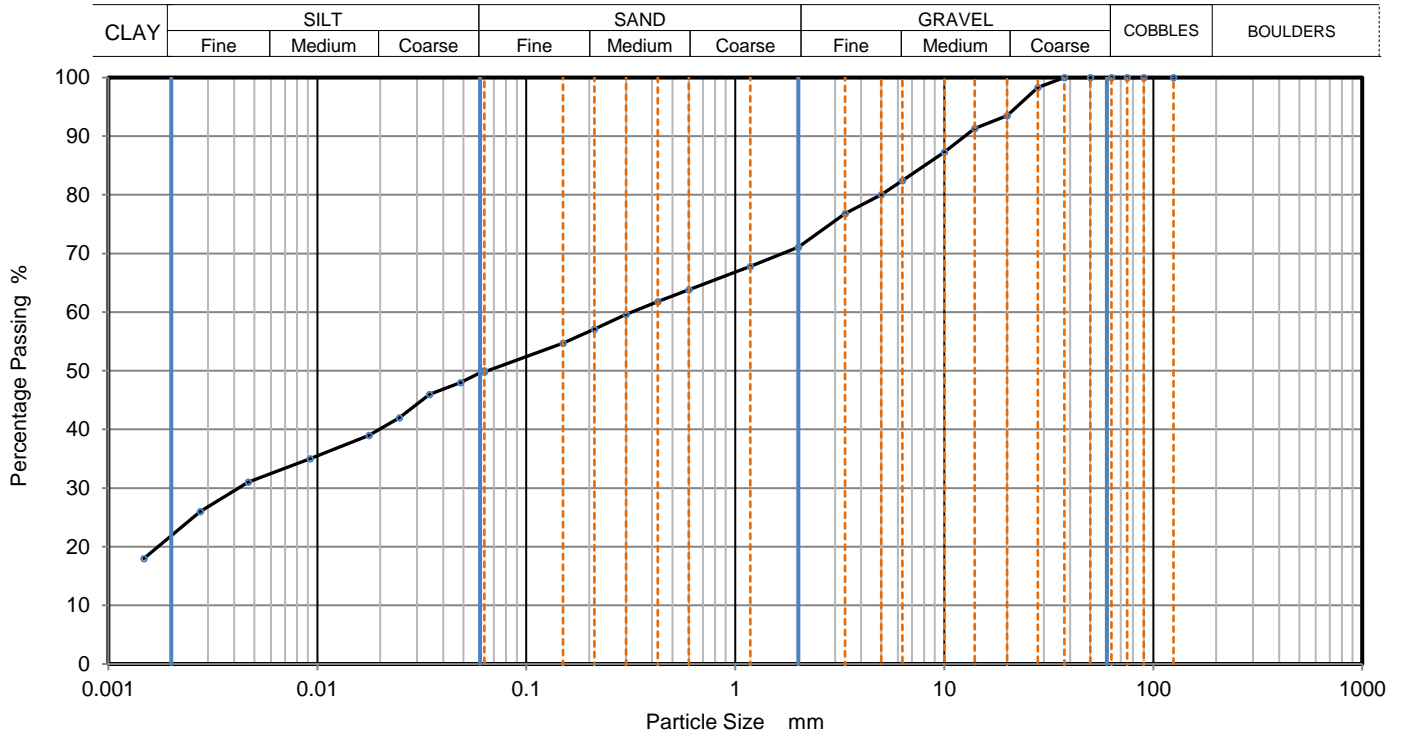
Depth, m **6.00**

Specimen Reference **2** Specimen Depth **6** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clauses 9.2 and 9.5**

KeyLAB ID **Caus2020102217**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	50
90	100	0.04843	48
75	100	0.03447	46
63	100	0.02470	42
50	100	0.01769	39
37.5	100	0.00925	35
28	98	0.00468	31
20	94	0.00275	26
14	91	0.00148	18
10	87		
6.3	82		
5	80		
3.35	77		
2	71		
1.18	68		
0.6	64		
0.425	62	Particle density (assumed) 2.65 Mg/m3	
0.3	60		
0.212	57		
0.15	55		
0.063	50		

Dry Mass of sample, g **2470**

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	28.9
Sand	21.3
Silt	27.8
Clay	22.0

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

Remarks

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

Approved

Stephen.Watson





PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9CP05**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **15**

Soil Description **Brownish grey sandy gravelly silty CLAY.**

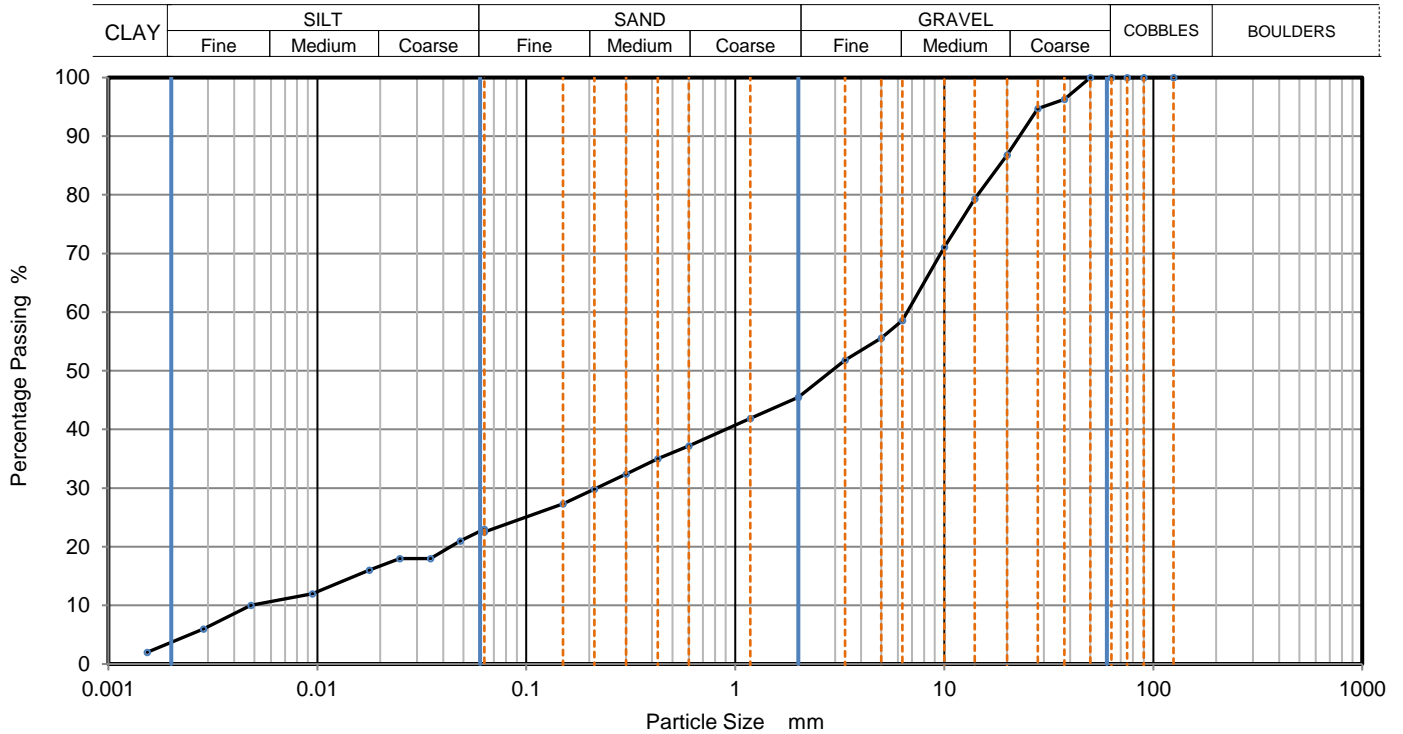
Depth, m **5.00**

Specimen Reference **2** Specimen Depth **5** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clauses 9.2 and 9.5**

KeyLAB ID **Caus2020102230**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	23
90	100	0.04830	21
75	100	0.03483	18
63	100	0.02479	18
50	100	0.01775	16
37.5	96	0.00945	12
28	95	0.00481	10
20	87	0.00285	6
14	79	0.00153	2
10	71		
6.3	59		
5	56		
3.35	52		
2	46		
1.18	42		
0.6	37		
0.425	35	Particle density (assumed)	
0.3	32	2.65 Mg/m3	
0.212	30		
0.15	27		
0.063	23		

Dry Mass of sample, g

9698

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	54.5
Sand	23.0
Silt	18.7
Clay	3.8

Grading Analysis	
D100	mm
D60	mm
D30	mm
D10	mm
Uniformity Coefficient	1200
Curvature Coefficient	1.4

Remarks

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

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LAB 05R Version 4



10122



PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9CP05**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **24**

Soil Description **Brownish grey silty fine to coarse SAND.**

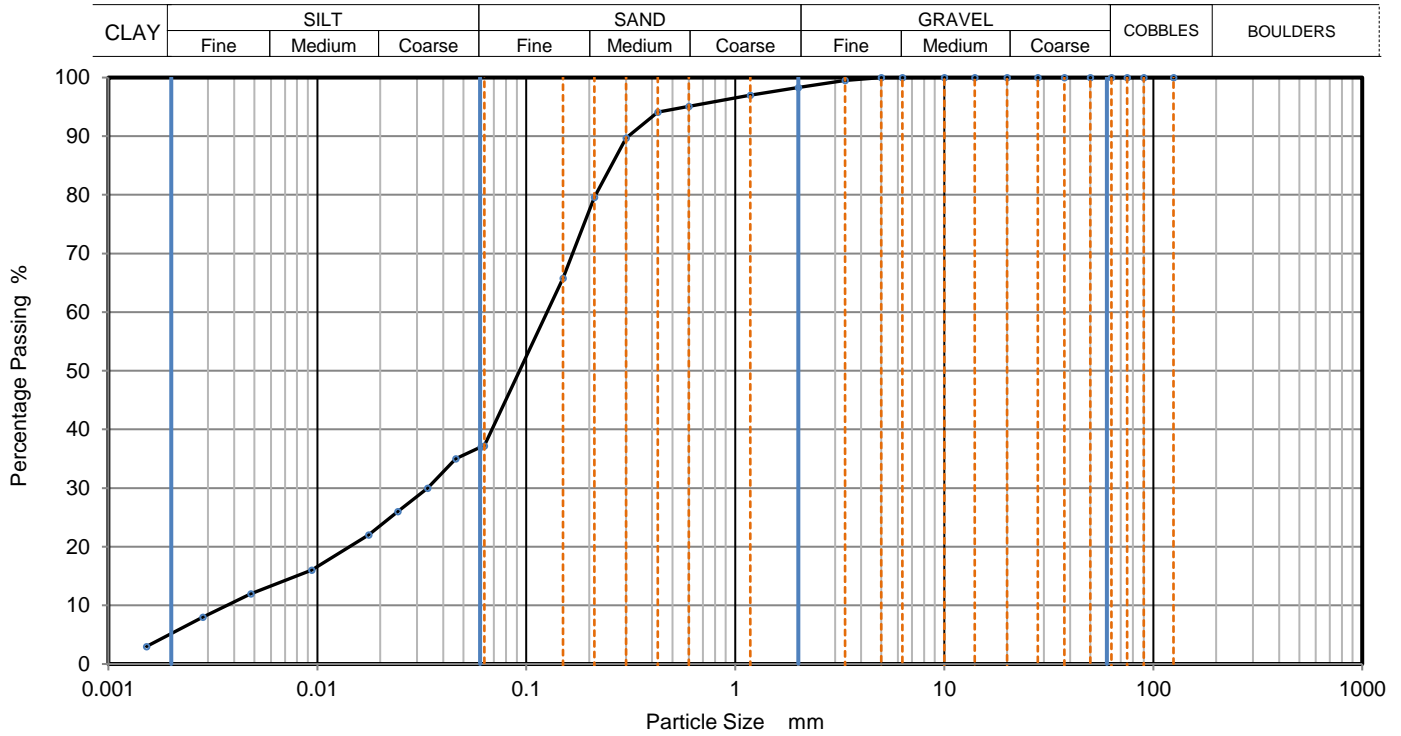
Depth, m **6.00**

Specimen Reference **2** Specimen Depth **6** m

Sample Type **D**

Test Method **BS1377:Part 2:1990, clauses 9.2 and 9.5**

KeyLAB ID **Caus2020102231**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06080	37
90	100	0.04590	35
75	100	0.03364	30
63	100	0.02428	26
50	100	0.01762	22
37.5	100	0.00938	16
28	100	0.00480	12
20	100	0.00283	8
14	100	0.00152	3
10	100		
6.3	100		
5	100		
3.35	100		
2	98		
1.18	97		
0.6	95	Particle density (assumed)	
0.425	94	2.65 Mg/m3	
0.3	90		
0.212	80		
0.15	66		
0.063	37		

Dry Mass of sample, g **215**

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	1.7
Sand	61.1
Silt	32.0
Clay	5.2

Grading Analysis	
D100	mm
D60	mm 0.126
D30	mm 0.0345
D10	mm 0.00376
Uniformity Coefficient	33
Curvature Coefficient	2.5

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



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PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9CP06**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **5**

Soil Description **Brownish grey sandy silty subangular fine to coarse GRAVEL.**

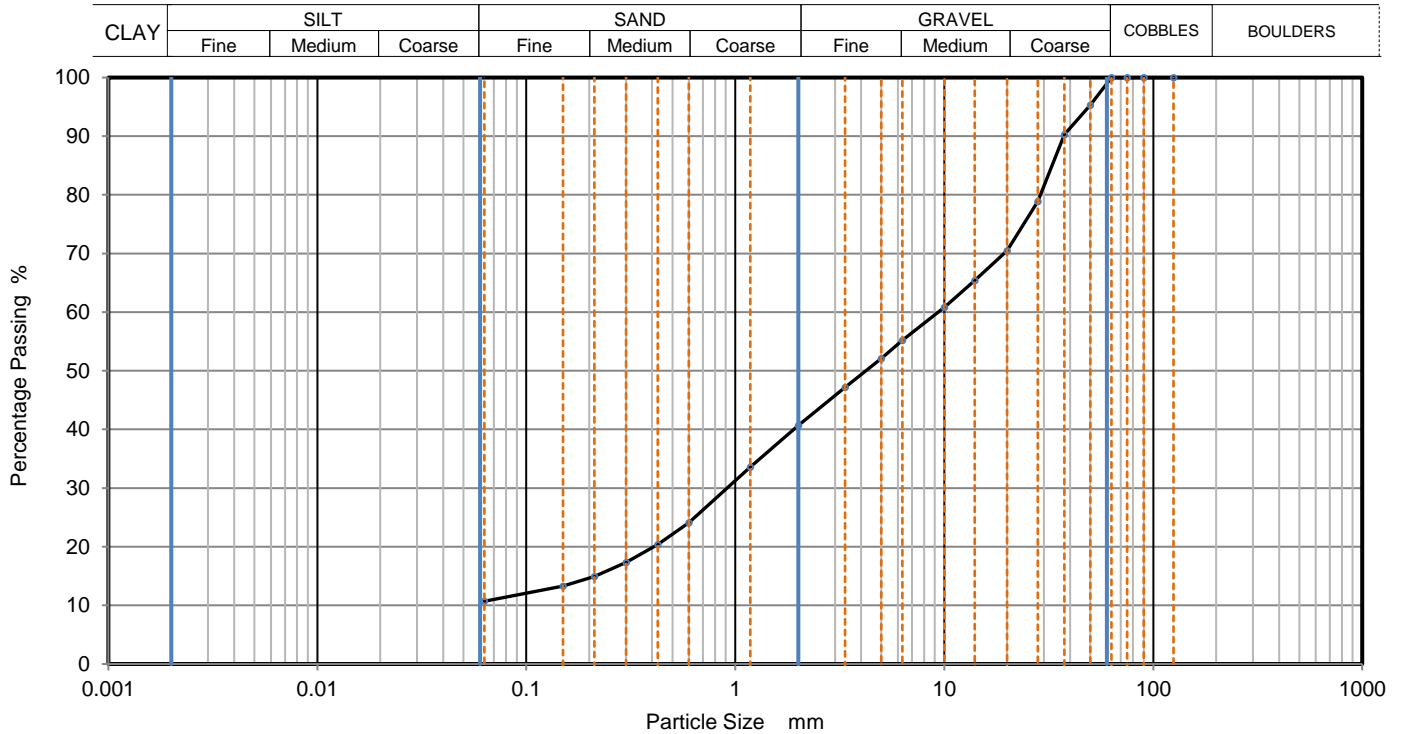
Depth, m **5.00**

Specimen Reference **2** Specimen Depth **5** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clause 9.2**

KeyLAB ID **Caus202011032**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	95		
37.5	90		
28	79		
20	71		
14	65		
10	61		
6.3	55		
5	52		
3.35	47		
2	41		
1.18	34		
0.6	24		
0.425	20		
0.3	17		
0.212	15		
0.15	13		
0.063	11		

Dry Mass of sample, g

6254

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	59.3
Sand	30.0
Fines <0.063mm	11.0

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

Remarks

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

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PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9CP07**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **5**

Soil Description **Brownish grey sandy slightly clayey subangular fine to coarse GRAVEL.**

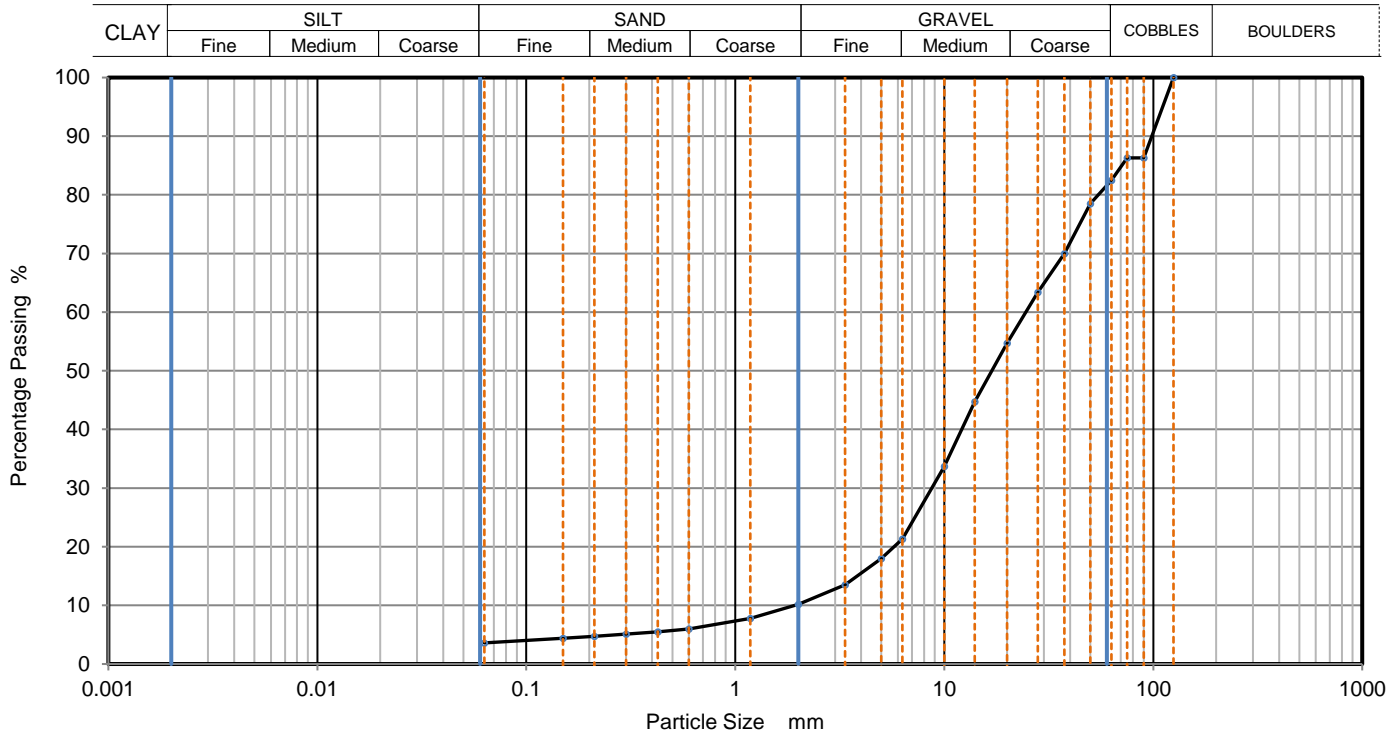
Depth, m **0.50**

Specimen Reference **2** Specimen Depth **0.5** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clause 9.2**

KeyLAB ID **Caus2020102233**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	86		
75	86		
63	83		
50	79		
37.5	70		
28	63		
20	55		
14	45		
10	34		
6.3	21		
5	18		
3.35	14		
2	10		
1.18	8		
0.6	6		
0.425	6		
0.3	5		
0.212	5		
0.15	4		
0.063	4		

Dry Mass of sample, g

16365

Sample Proportions	% dry mass
Cobbles	17.5
Gravel	72.3
Sand	6.6
Fines <0.063mm	4.0

Grading Analysis		
D100	mm	125
D60	mm	24.5
D30	mm	8.72
D10	mm	1.92
Uniformity Coefficient		13
Curvature Coefficient		1.6

Remarks

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

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PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9CP07**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **8**

Soil Description **Brownish grey sandy slightly silty subangular fine to coarse GRAVEL.**

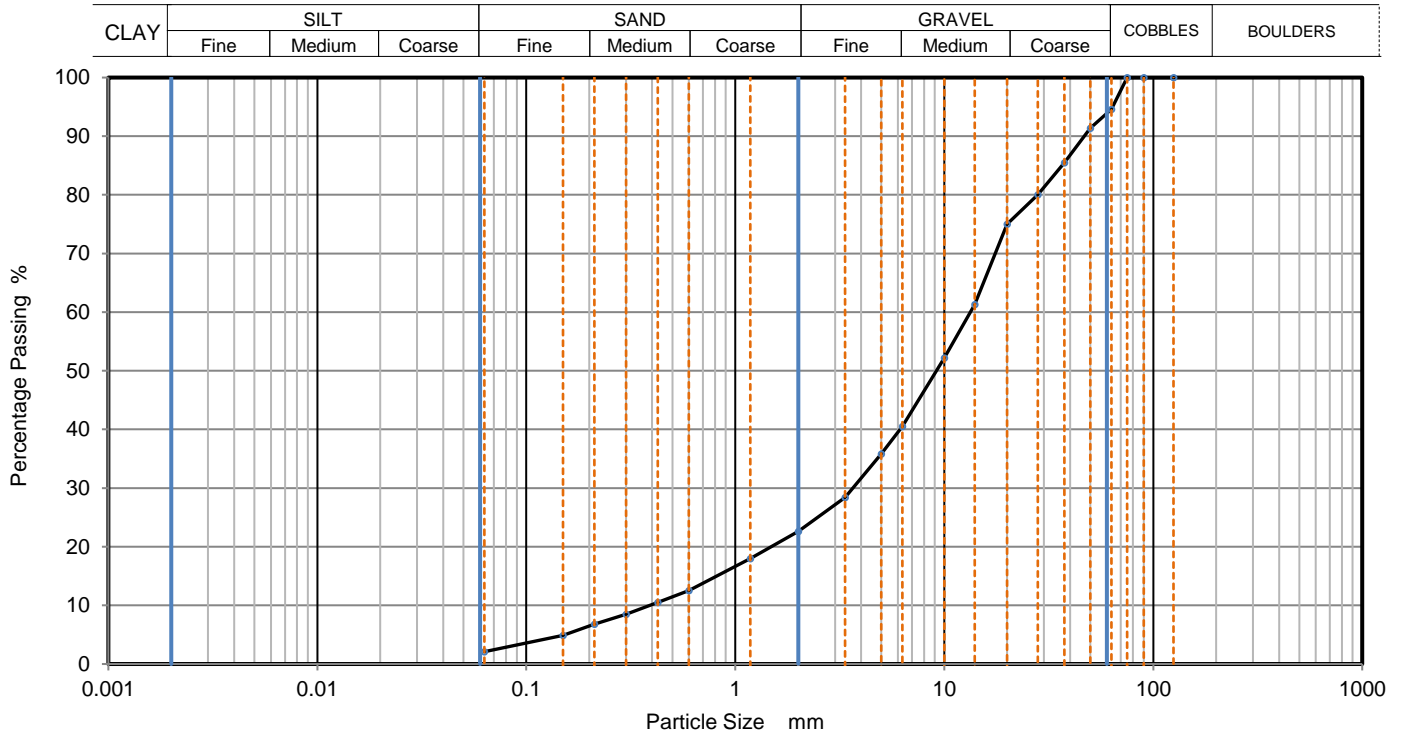
Depth, m **3.00**

Specimen Reference **2** Specimen Depth **3** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clause 9.2**

KeyLAB ID **Caus2020102234**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	95		
50	91		
37.5	86		
28	80		
20	75		
14	61		
10	52		
6.3	41		
5	36		
3.35	28		
2	23		
1.18	18		
0.6	13		
0.425	11		
0.3	9		
0.212	7		
0.15	5		
0.063	2		

Dry Mass of sample, g **17008**

Sample Proportions	% dry mass
Cobbles	5.4
Gravel	72.0
Sand	20.5
Fines <0.063mm	2.0

Grading Analysis	
D100	mm
D60	mm 13.3
D30	mm 3.66
D10	mm 0.39
Uniformity Coefficient	34
Curvature Coefficient	2.6

Remarks

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

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PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9CP07**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **11**

Soil Description **Brownish grey sandy slightly silty subangular fine to coarse GRAVEL.**

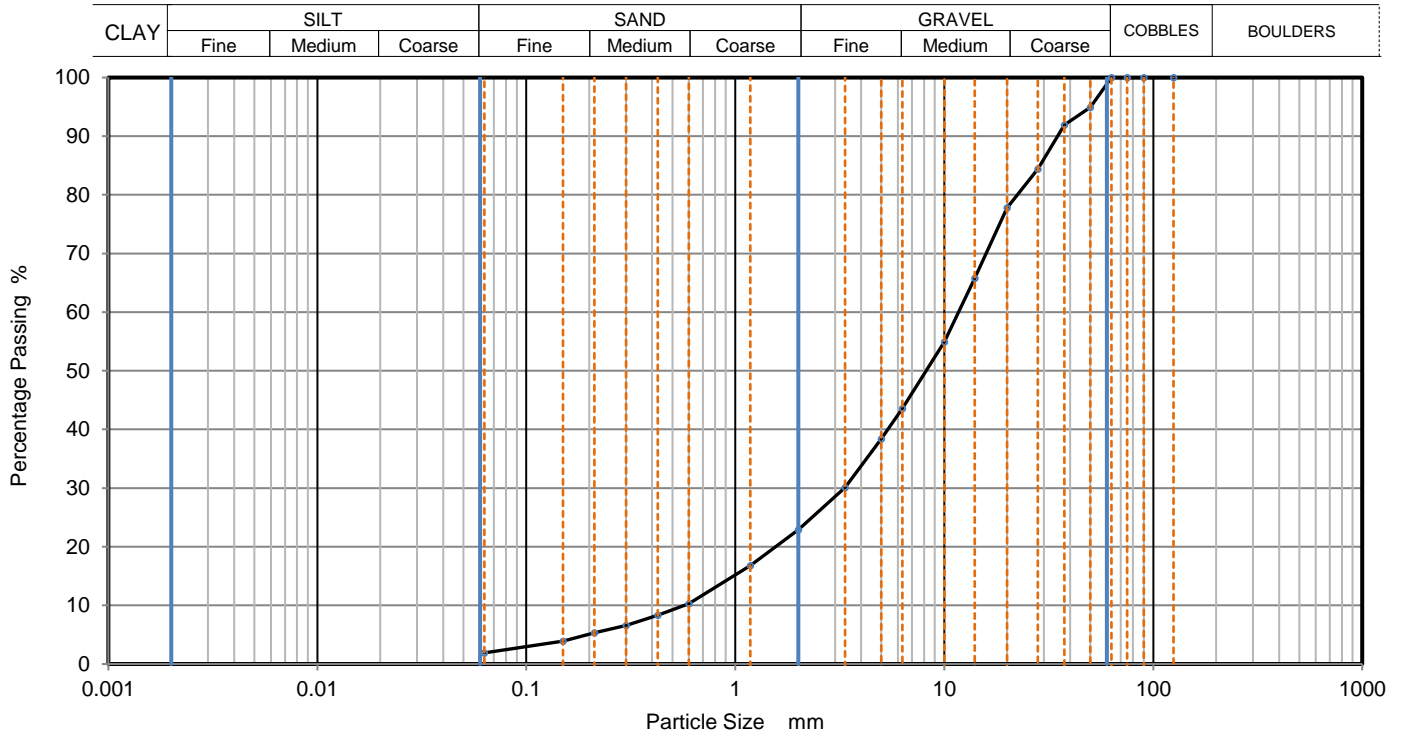
Depth, m **6.00**

Specimen Reference **2** Specimen Depth **6** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clause 9.2**

KeyLAB ID **Caus2020102235**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	95		
37.5	92		
28	84		
20	78		
14	66		
10	55		
6.3	44		
5	38		
3.35	30		
2	23		
1.18	17		
0.6	10		
0.425	8		
0.3	7		
0.212	5		
0.15	4		
0.063	2		

Dry Mass of sample, g

16691

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	77.1
Sand	21.0
Fines <0.063mm	2.0

Grading Analysis	
D100	mm
D60	mm 11.7
D30	mm 3.33
D10	mm 0.569
Uniformity Coefficient	21
Curvature Coefficient	1.7

Remarks

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

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LAB 05R Version 4



10122



PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9CP09**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **7**

Soil Description **Brownish grey gravelly silty fine to coarse SAND.**

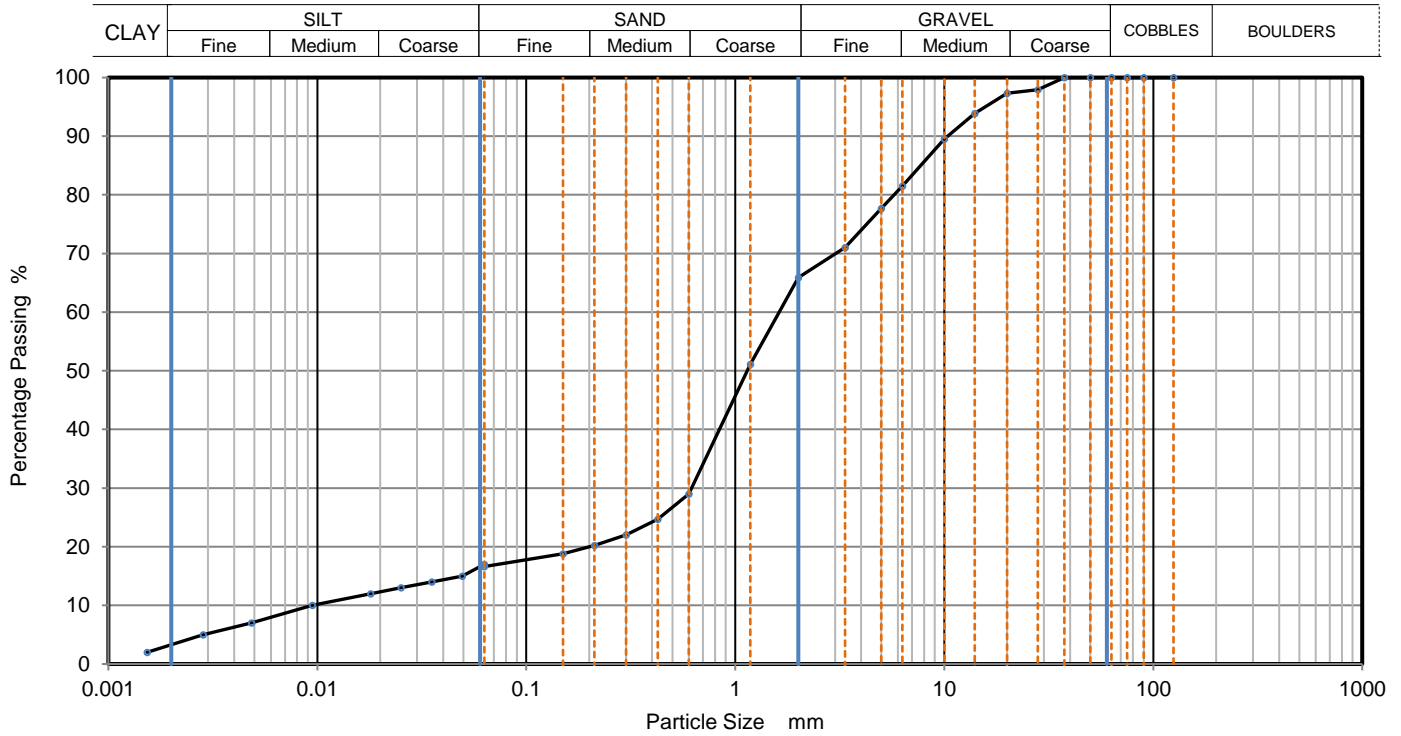
Depth, m **2.00**

Specimen Reference **2** Specimen Depth **2** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clauses 9.2 and 9.5**

KeyLAB ID **Caus2020102242**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	17
90	100	0.04926	15
75	100	0.03528	14
63	100	0.02511	13
50	100	0.01797	12
37.5	100	0.00945	10
28	98	0.00483	7
20	97	0.00284	5
14	94	0.00153	2
10	90		
6.3	82		
5	78		
3.35	71		
2	66		
1.18	51		
0.6	29		
0.425	25	Particle density (assumed) 2.65 Mg/m3	
0.3	22		
0.212	20		
0.15	19		
0.063	17		

Dry Mass of sample, g **7046**

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	34.1
Sand	49.3
Silt	13.2
Clay	3.4

Grading Analysis	
D100	mm
D60	mm 1.62
D30	mm 0.619
D10	mm 0.00957
Uniformity Coefficient	170
Curvature Coefficient	25

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



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PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9CP11**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **6**

Soil Description **Brownish grey sandy silty subangular fine to coarse GRAVEL.**

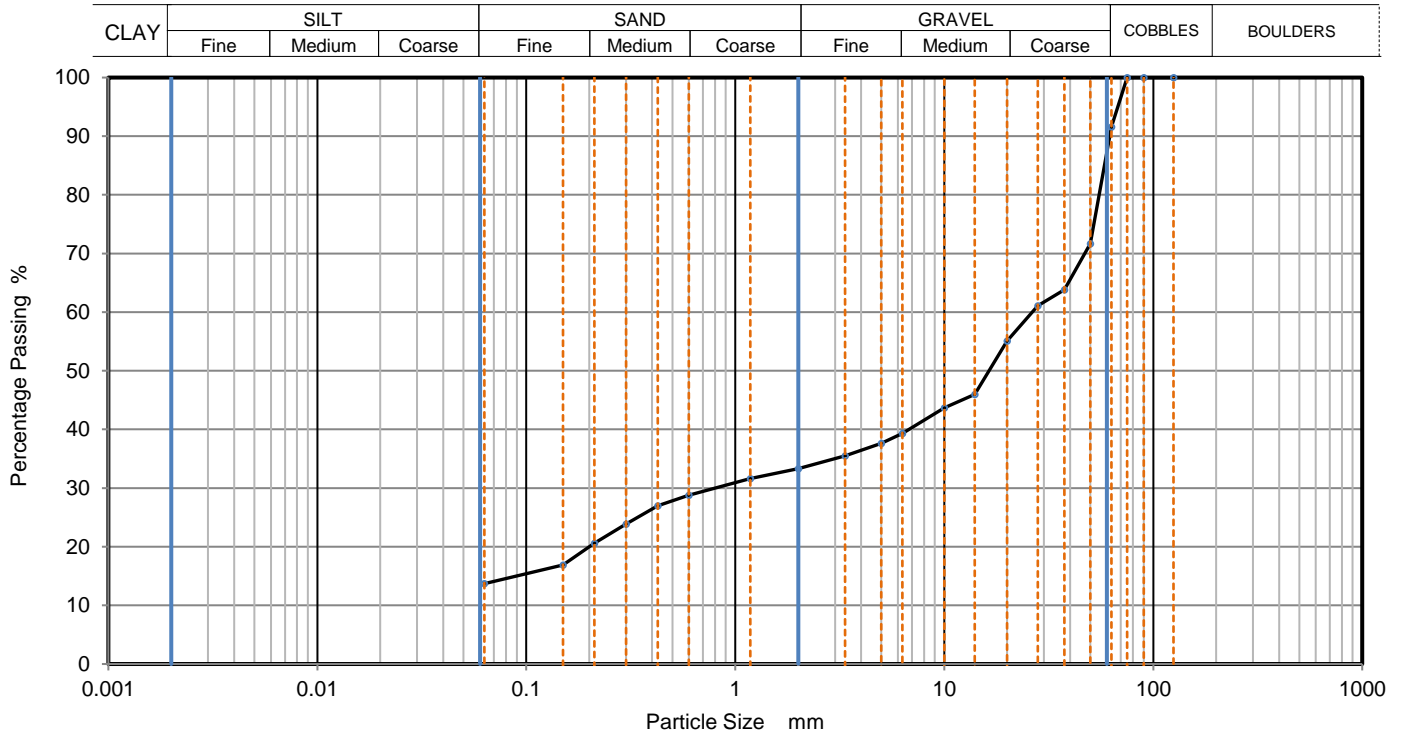
Depth, m **1.00**

Specimen Reference **2** Specimen Depth **1** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clause 9.2**

KeyLAB ID **Caus2020102246**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	92		
50	72		
37.5	64		
28	61		
20	55		
14	46		
10	44		
6.3	39		
5	38		
3.35	36		
2	33		
1.18	32		
0.6	29		
0.425	27		
0.3	24		
0.212	21		
0.15	17		
0.063	14		

Dry Mass of sample, g

12486

Sample Proportions	% dry mass
Cobbles	8.4
Gravel	58.3
Sand	19.6
Fines <0.063mm	14.0

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

Remarks

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

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PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9CP12**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **8**

Soil Description **Brownish grey sandy silty subangular fine to coarse GRAVEL.**

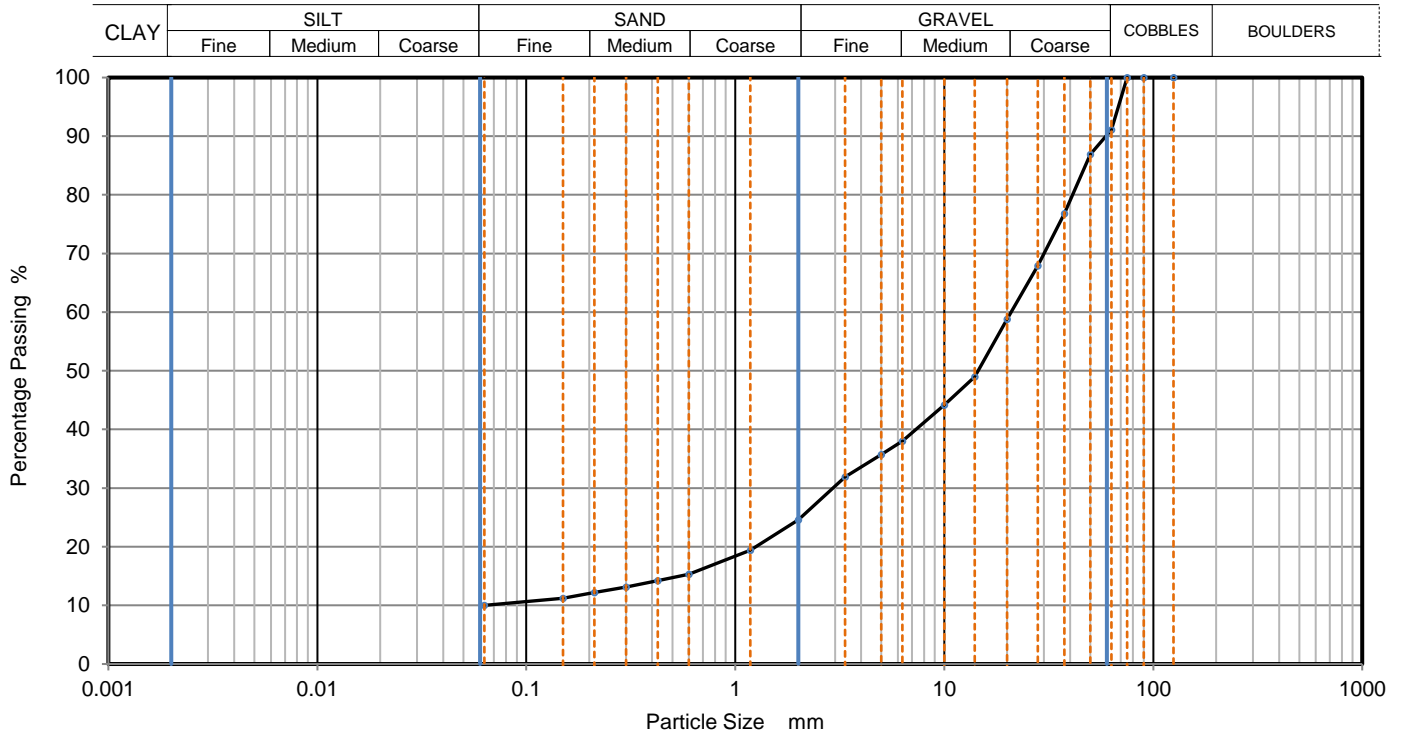
Depth, m **3.00**

Specimen Reference **2** Specimen Depth **3** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clause 9.2**

KeyLAB ID **Caus2020102248**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	91		
50	87		
37.5	77		
28	68		
20	59		
14	49		
10	44		
6.3	38		
5	36		
3.35	32		
2	25		
1.18	19		
0.6	15		
0.425	14		
0.3	13		
0.212	12		
0.15	11		
0.063	10		

Dry Mass of sample, g

16119

Sample Proportions	% dry mass
Cobbles	8.9
Gravel	66.5
Sand	14.6
Fines <0.063mm	10.0

Grading Analysis	
D100	mm
D60	mm 20.9
D30	mm 2.93
D10	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks

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

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PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9CP13**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **7**

Soil Description **Brownish grey sandy slightly gravelly SILT.**

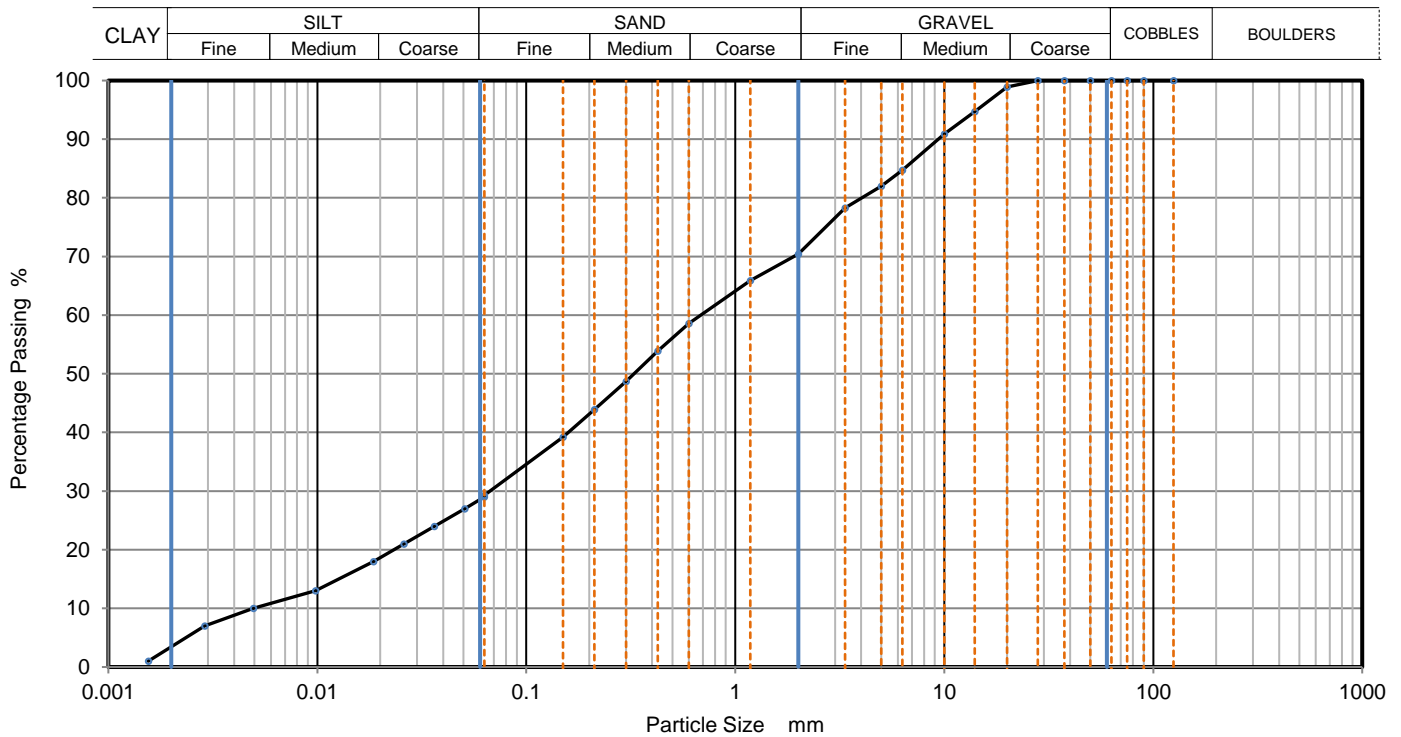
Depth, m **2.00**

Specimen Reference **2** Specimen Depth **2** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clauses 9.2 and 9.5**

KeyLAB ID **Caus2020102253**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	29
90	100	0.05065	27
75	100	0.03625	24
63	100	0.02594	21
50	100	0.01855	18
37.5	100	0.00980	13
28	100	0.00495	10
20	99	0.00289	7
14	95	0.00155	1
10	91		
6.3	85		
5	82		
3.35	78		
2	70		
1.18	66		
0.6	59		
0.425	54	Particle density (assumed) 2.65 Mg/m3	
0.3	49		
0.212	44		
0.15	39		
0.063	29		

Dry Mass of sample, g

2361

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	29.6
Sand	41.1
Silt	25.6
Clay	3.7

Grading Analysis	
D100	mm
D60	mm
D30	mm
D10	mm
Uniformity Coefficient	130
Curvature Coefficient	1.3

Remarks

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

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LAB 05R Version 4



10122



PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9CPGS01**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **11**

Soil Description **Brownish grey gravelly silty fine to coarse SAND.**

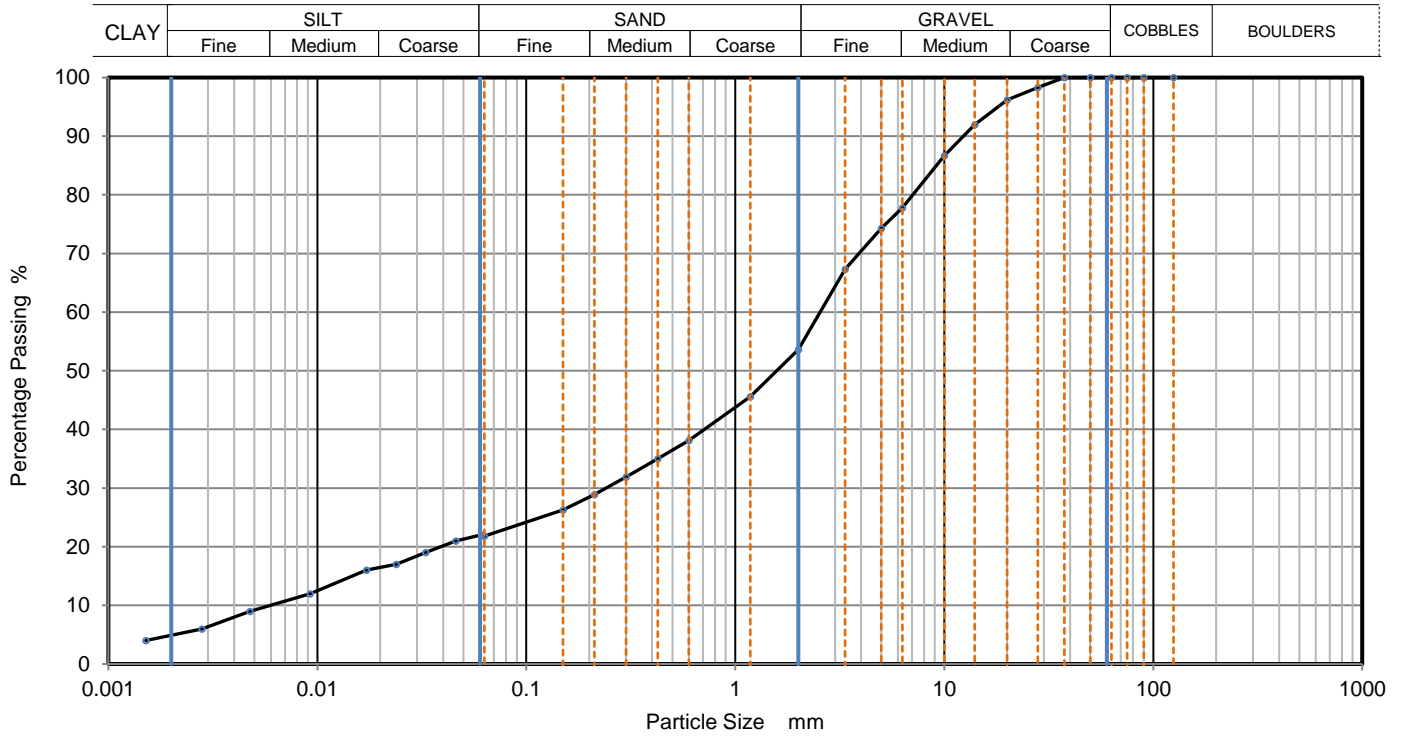
Depth, m **3.00**

Specimen Reference **6** Specimen Depth **3** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clauses 9.2 and 9.5**

KeyLAB ID **Caus2020102255**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06088	22
90	100	0.04596	21
75	100	0.03298	19
63	100	0.02382	17
50	100	0.01719	16
37.5	100	0.00922	12
28	98	0.00475	9
20	96	0.00281	6
14	92	0.00151	4
10	87		
6.3	78		
5	74		
3.35	67		
2	54		
1.18	46		
0.6	38		
0.425	35	Particle density (assumed)	
0.3	32	2.65 Mg/m3	
0.212	29		
0.15	26		
0.063	22		

Dry Mass of sample, g **2472**

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	46.4
Sand	31.8
Silt	16.9
Clay	4.9

Grading Analysis	
D100	mm
D60	mm
D30	mm
D10	mm
Uniformity Coefficient	410
Curvature Coefficient	3.6

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



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Stephen.Watson



PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9CPGS01**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **14**

Soil Description **Brown sandy gravelly SILT.**

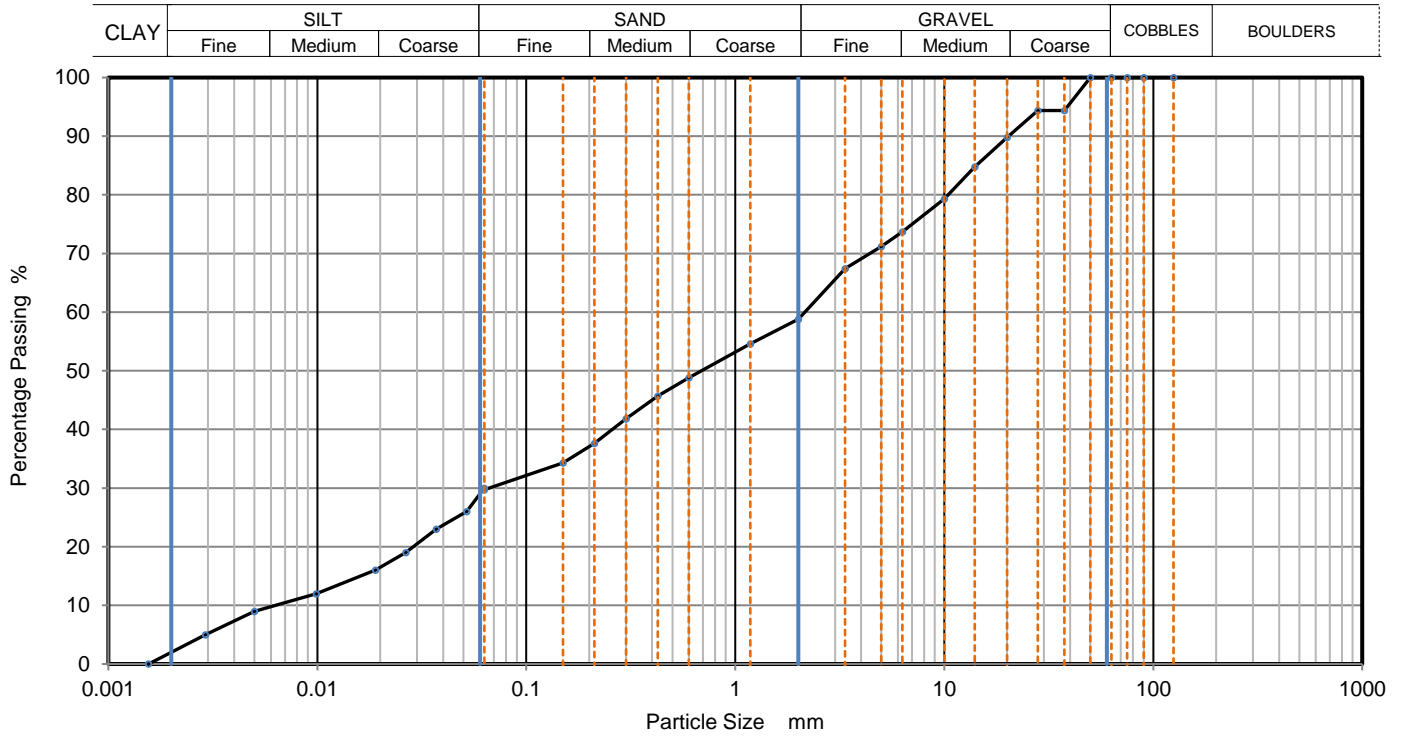
Depth, m **6.00**

Specimen Reference **2** Specimen Depth **6** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clauses 9.2 and 9.5**

KeyLAB ID **Caus2020102257**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	30
90	100	0.05176	26
75	100	0.03702	23
63	100	0.02648	19
50	100	0.01893	16
37.5	94	0.00988	12
28	94	0.00499	9
20	90	0.00291	5
14	85	0.00156	0
10	79		
6.3	74		
5	71		
3.35	67		
2	59		
1.18	55		
0.6	49		
0.425	46	Particle density (assumed) 2.65 Mg/m3	
0.3	42		
0.212	38		
0.15	34		
0.063	30		

Dry Mass of sample, g **2616**

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	41.2
Sand	29.0
Silt	27.7
Clay	2.1

Grading Analysis	
D100	mm
D60	mm
D30	mm
D10	mm
Uniformity Coefficient	340
Curvature Coefficient	0.32

Remarks

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

Approved

Stephen.Watson





PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9CPGS02**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **11**

Soil Description **Greyish brown sandy gravelly silty CLAY.**

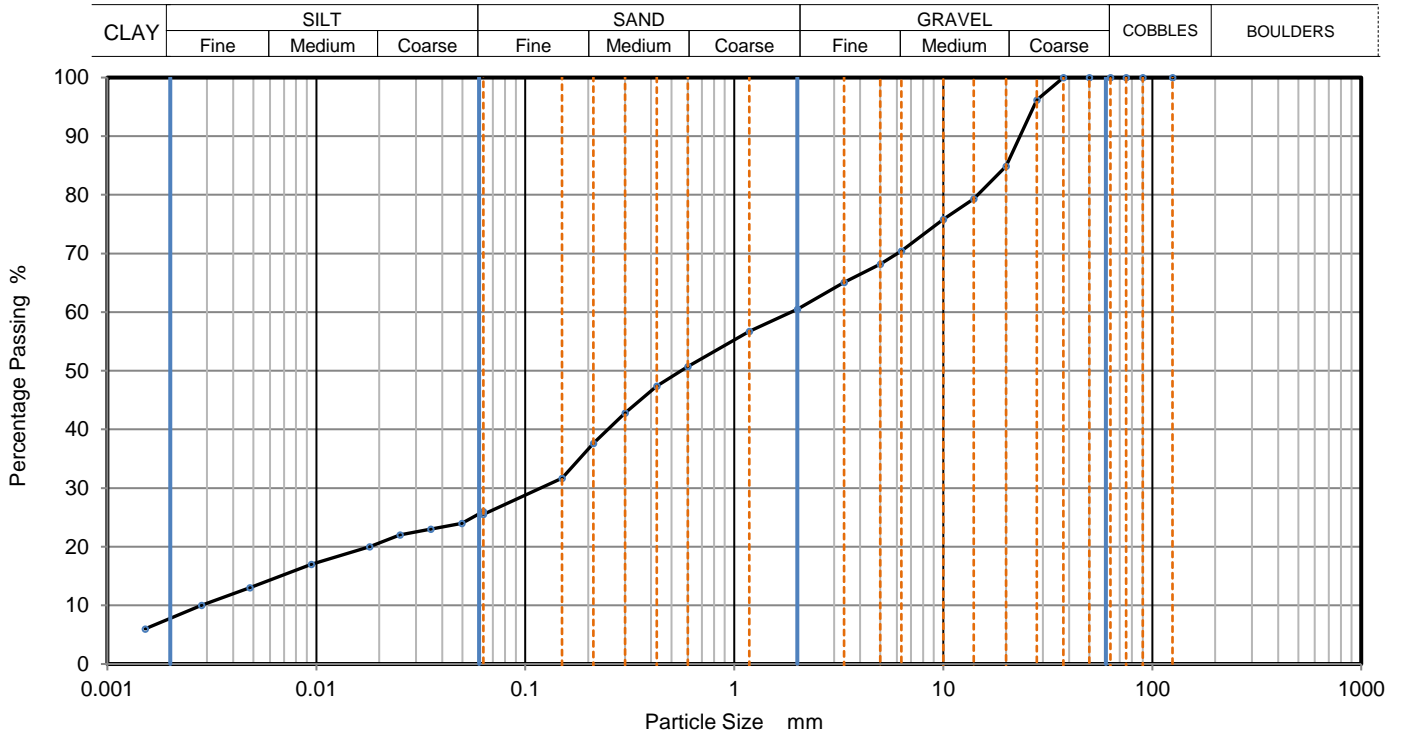
Depth, m **4.00**

Specimen Reference **6** Specimen Depth **4** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clauses 9.2 and 9.5**

KeyLAB ID **Caus2020102260**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	26
90	100	0.04958	24
75	100	0.03528	23
63	100	0.02511	22
50	100	0.01797	20
37.5	100	0.00945	17
28	96	0.00481	13
20	85	0.00282	10
14	79	0.00152	6
10	76		
6.3	70		
5	68		
3.35	65		
2	61		
1.18	57		
0.6	51		
0.425	47	Particle density (assumed) 2.65 Mg/m3	
0.3	43		
0.212	38		
0.15	32		
0.063	26		

Dry Mass of sample, g **2058**

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	39.5
Sand	35.0
Silt	18.0
Clay	7.5

Grading Analysis	
D100	mm
D60	mm
D30	mm
D10	mm
Uniformity Coefficient	660
Curvature Coefficient	2.7

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

Approved

Stephen.Watson





PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9CPGS03**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **9**

Soil Description **Greyish brown slightly sandy slightly gravelly silty CLAY.**

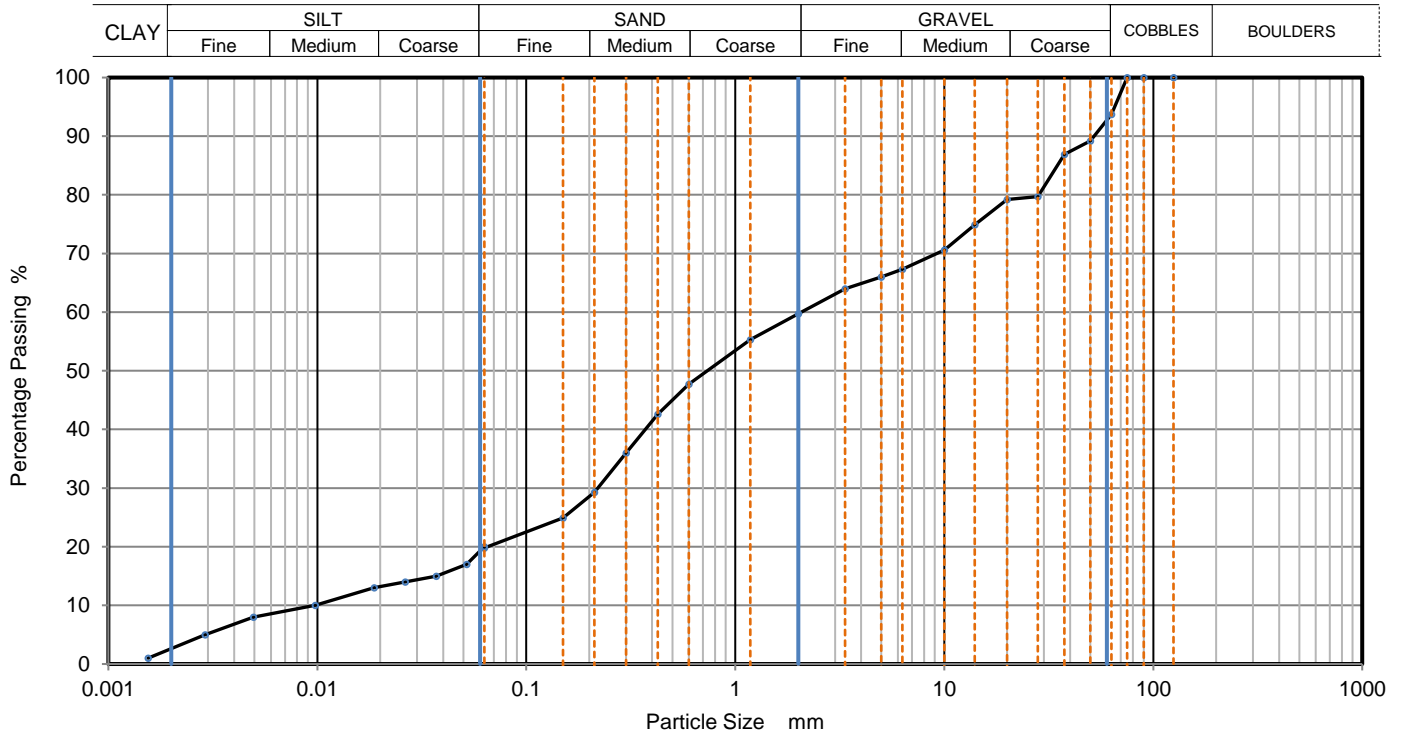
Depth, m **3.00**

Specimen Reference **6** Specimen Depth **3** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clauses 9.2 and 9.5**

KeyLAB ID **Caus2020102264**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	20
90	100	0.05176	17
75	100	0.03702	15
63	94	0.02633	14
50	89	0.01872	13
37.5	87	0.00978	10
28	80	0.00494	8
20	79	0.00290	5
14	75	0.00155	1
10	71		
6.3	67		
5	66		
3.35	64		
2	60		
1.18	55		
0.6	48		
0.425	43	Particle density (assumed) 2.65 Mg/m3	
0.3	36		
0.212	29		
0.15	25		
0.063	20		

Dry Mass of sample, g

13423

Sample Proportions	% dry mass
Cobbles	6.3
Gravel	34.0
Sand	40.0
Silt	17.1
Clay	2.6

Grading Analysis	
D100	mm
D60	mm
D30	mm
D10	mm
Uniformity Coefficient	240
Curvature Coefficient	2.7

Remarks

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

Approved

Stephen.Watson





PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9CPGS03**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **10**

Soil Description **Greyish brown slightly gravelly silty fine to coarse SAND.**

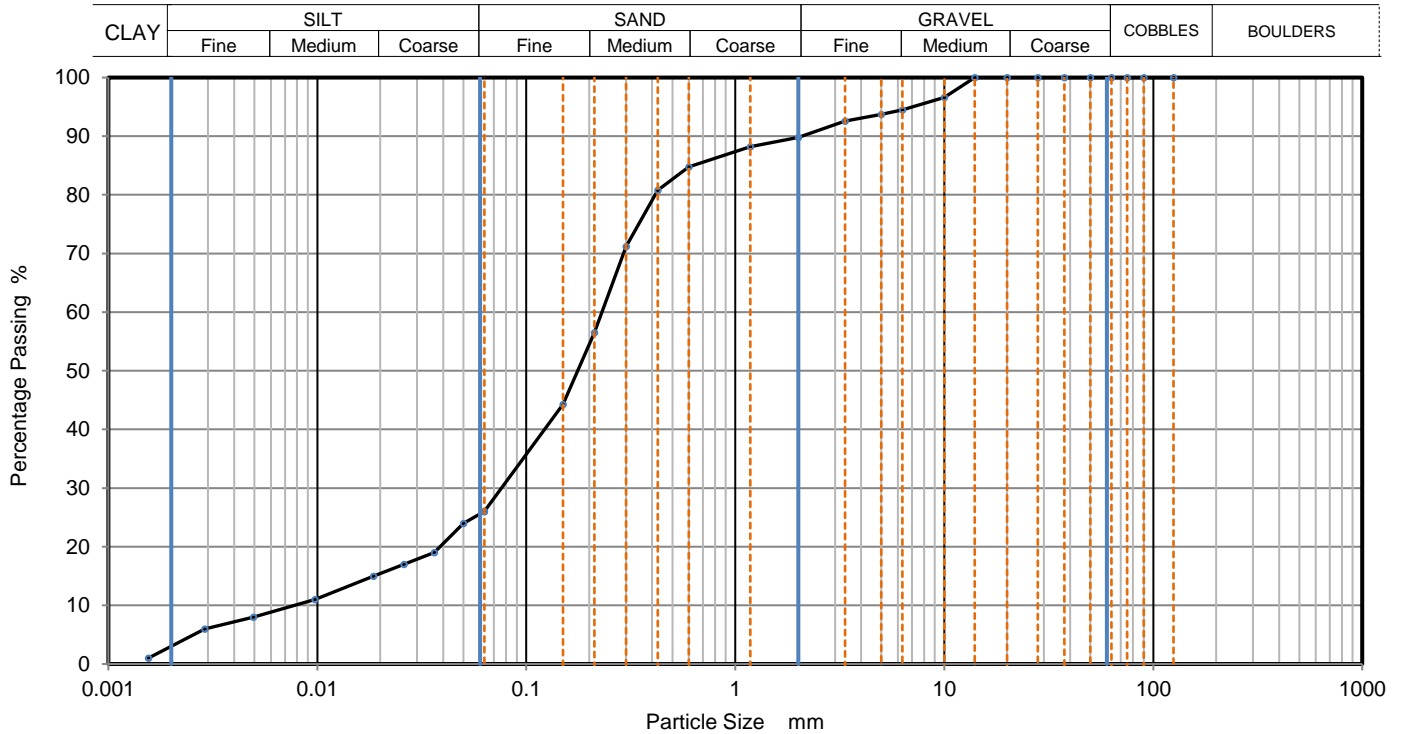
Depth, m **4.00**

Specimen Reference **2** Specimen Depth **4** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clauses 9.2 and 9.5**

KeyLAB ID **Caus2020102266**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	26
90	100	0.05002	24
75	100	0.03625	19
63	100	0.02594	17
50	100	0.01855	15
37.5	100	0.00974	11
28	100	0.00495	8
20	100	0.00289	6
14	100	0.00155	1
10	97		
6.3	95		
5	94		
3.35	93		
2	90		
1.18	88		
0.6	85		
0.425	81	Particle density (assumed) 2.65 Mg/m3	
0.3	71		
0.212	57		
0.15	44		
0.063	26		

Dry Mass of sample, g

505

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	10.2
Sand	63.7
Silt	23.1
Clay	3.0

Grading Analysis	
D100	mm
D60	mm
D30	mm
D10	mm
Uniformity Coefficient	31
Curvature Coefficient	3.3

Remarks

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

Approved

Stephen.Watson

LAB 05R Version 4



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PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9CPGS04**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **10**

Soil Description **Greyish brown sandy gravelly silty CLAY.**

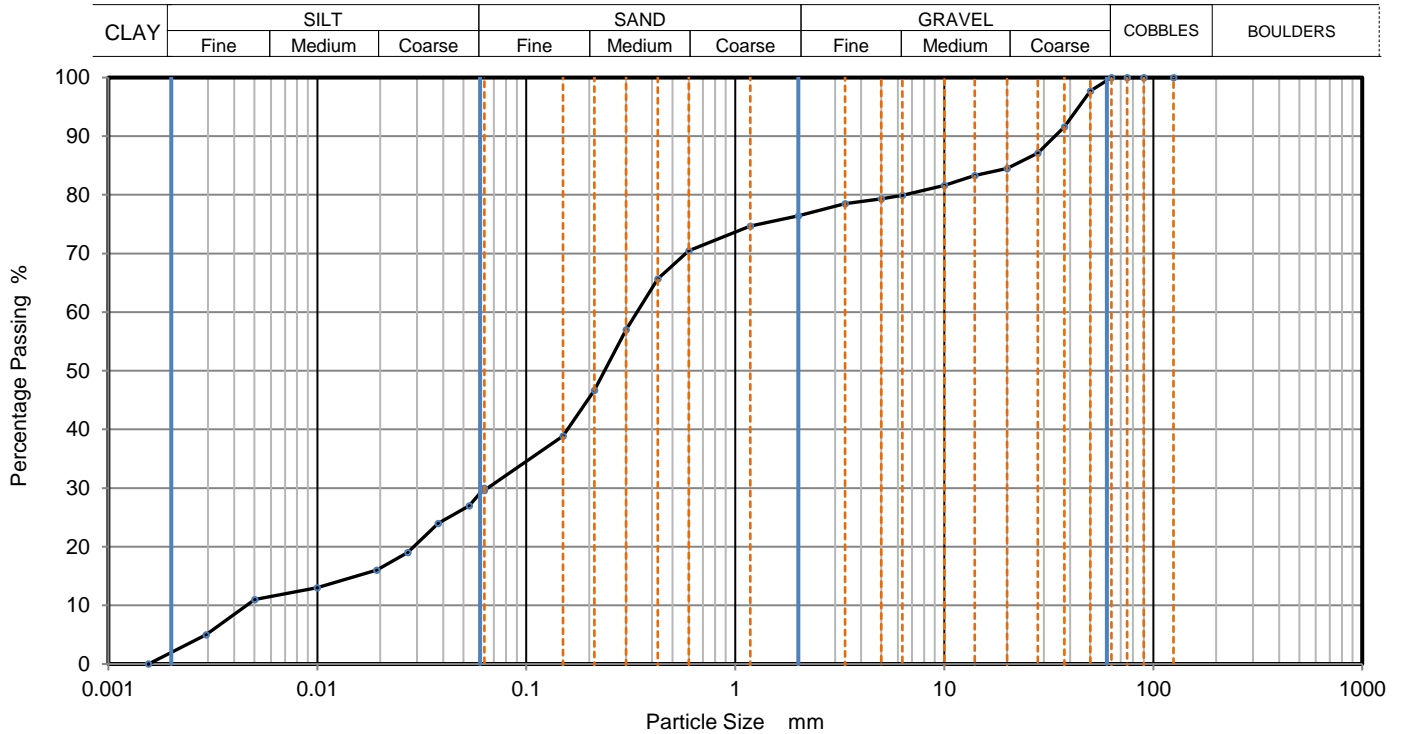
Depth, m **4.00**

Specimen Reference **2** Specimen Depth **4** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clauses 9.2 and 9.5**

KeyLAB ID **Caus2020102268**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	30
90	100	0.05325	27
75	100	0.03787	24
63	100	0.02707	19
50	98	0.01924	16
37.5	92	0.00999	13
28	87	0.00502	11
20	85	0.00293	5
14	83	0.00156	0
10	82		
6.3	80		
5	79		
3.35	79		
2	76		
1.18	75		
0.6	71		
0.425	66	Particle density (assumed) 2.65 Mg/m3	
0.3	57		
0.212	47		
0.15	39		
0.063	30		

Dry Mass of sample, g

14527

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	23.6
Sand	46.8
Silt	27.5
Clay	2.1

Grading Analysis	
D100	mm
D60	mm 0.338
D30	mm 0.0654
D10	mm 0.00465
Uniformity Coefficient	73
Curvature Coefficient	2.7

Remarks

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



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Stephen.Watson

LAB 05R Version 4

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PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9CPGS04**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **12**

Soil Description **Greyish brown sandy gravelly silty CLAY.**

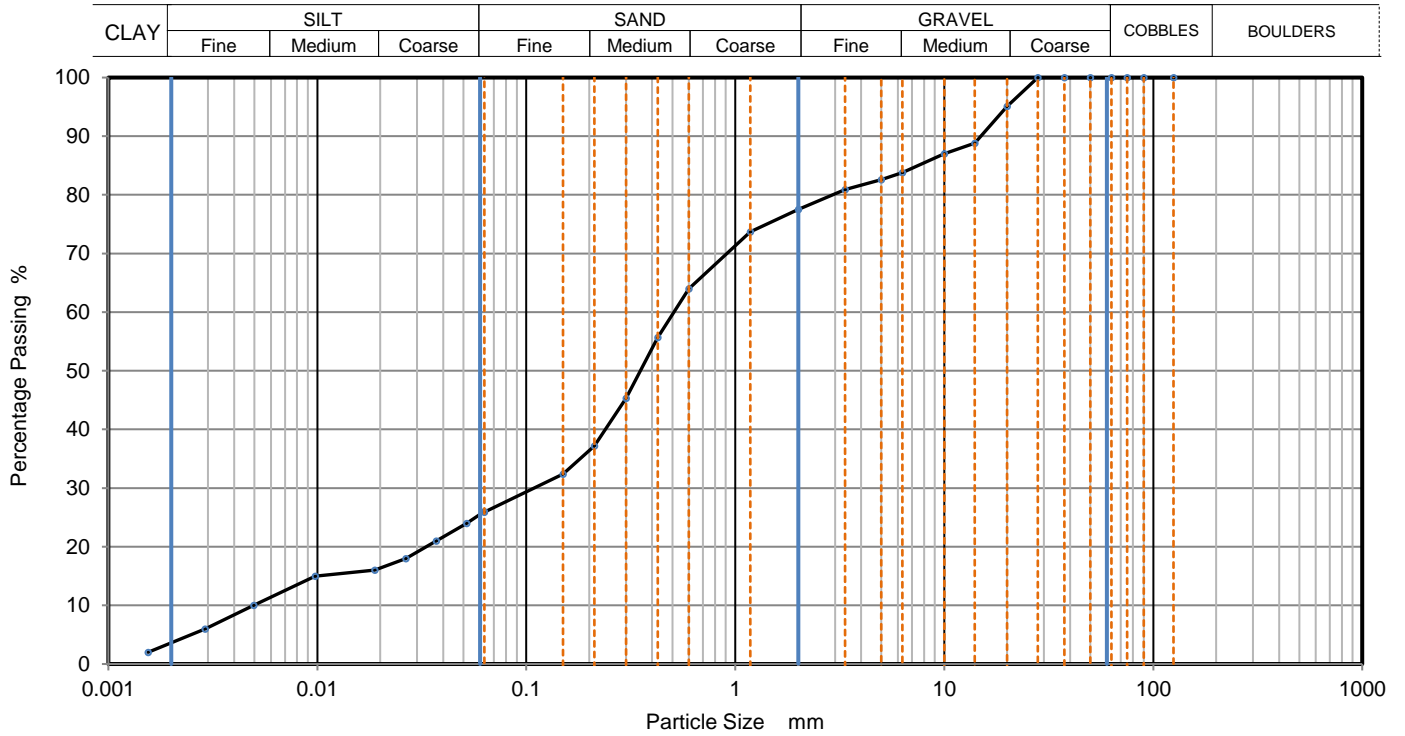
Depth, m **6.00**

Specimen Reference **2** Specimen Depth **6** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clauses 9.2 and 9.5**

KeyLAB ID **Caus2020102269**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	26
90	100	0.05176	24
75	100	0.03702	21
63	100	0.02648	18
50	100	0.01883	16
37.5	100	0.00978	15
28	100	0.00497	10
20	95	0.00290	6
14	89	0.00155	2
10	87		
6.3	84		
5	83		
3.35	81		
2	78		
1.18	74		
0.6	64		
0.425	56	Particle density (assumed) 2.65 Mg/m3	
0.3	45		
0.212	37		
0.15	32		
0.063	26		

Dry Mass of sample, g

3044

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	22.5
Sand	51.6
Silt	22.3
Clay	3.6

Grading Analysis		
D100	mm	
D60	mm	0.508
D30	mm	0.109
D10	mm	0.00517
Uniformity Coefficient		98
Curvature Coefficient		4.5

Remarks

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

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PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9TP05**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **2**

Soil Description **Brown sandy gravelly silty CLAY.**

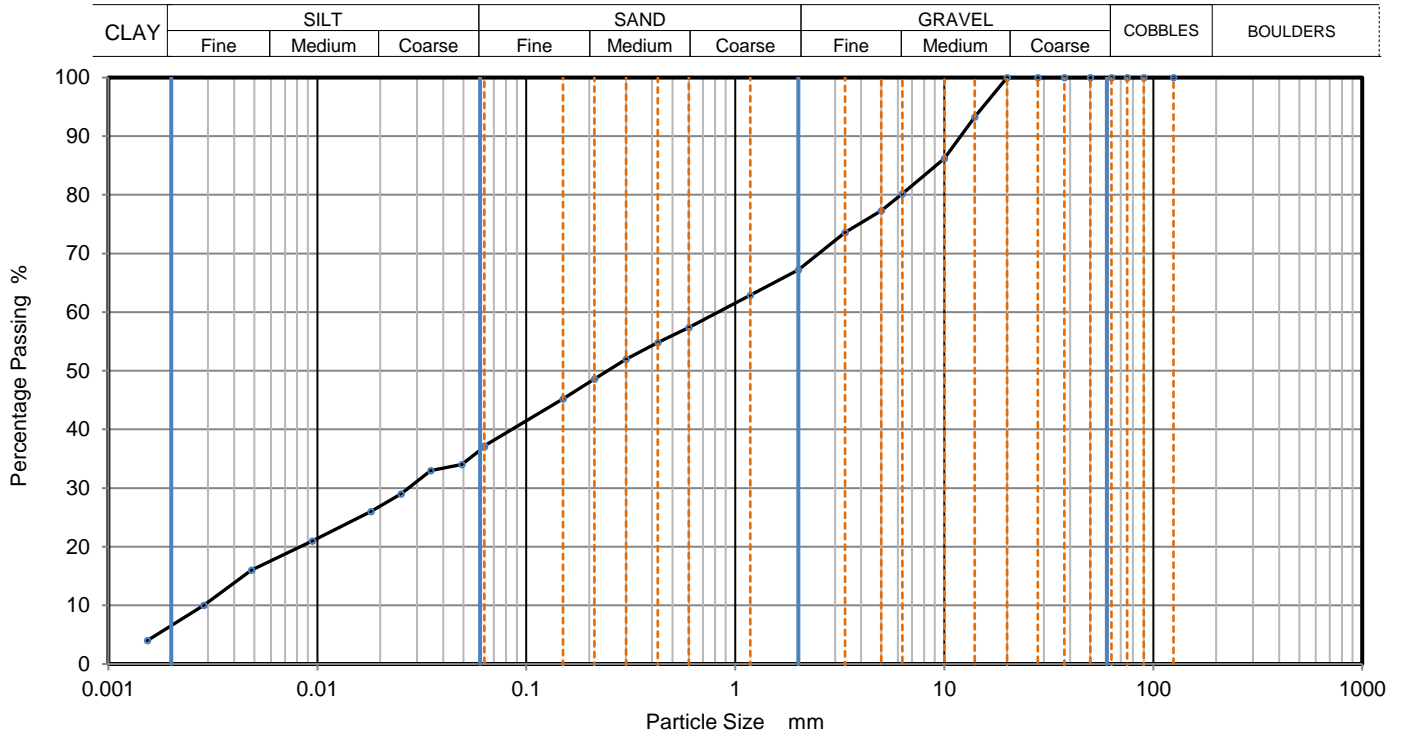
Depth, m **1.00**

Specimen Reference **6** Specimen Depth **1** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clauses 9.2 and 9.5**

KeyLAB ID **Caus2020102273**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	37
90	100	0.04907	34
75	100	0.03492	33
63	100	0.02517	29
50	100	0.01802	26
37.5	100	0.00947	21
28	100	0.00485	16
20	100	0.00286	10
14	93	0.00154	4
10	86		
6.3	80		
5	77		
3.35	74		
2	67		
1.18	63		
0.6	57		
0.425	55	Particle density (assumed) 2.65 Mg/m3	
0.3	52		
0.212	49		
0.15	45		
0.063	37		

Dry Mass of sample, g **512**

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	32.8
Sand	30.0
Silt	30.5
Clay	6.7

Grading Analysis	
D100	mm
D60	mm
D30	mm
D10	mm
Uniformity Coefficient	290
Curvature Coefficient	0.33

Remarks

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

Approved

Stephen.Watson





PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9TP07**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **1**

Soil Description **Brown gravelly clayey fine to coarse SAND.**

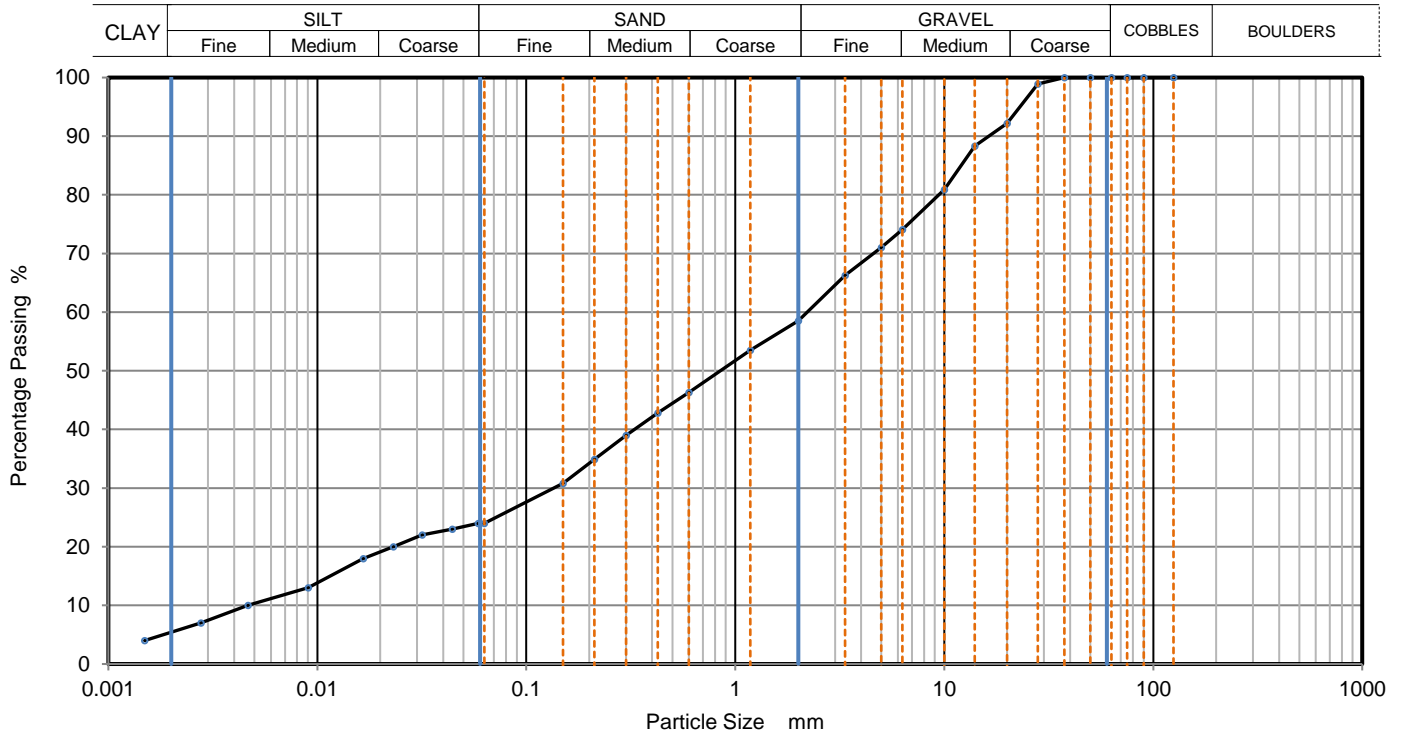
Depth, m **0.50**

Specimen Reference **6** Specimen Depth **0.5** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clauses 9.2 and 9.5**

KeyLAB ID **Caus202011033**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.05889	24
90	100	0.04415	23
75	100	0.03172	22
63	100	0.02312	20
50	100	0.01659	18
37.5	100	0.00904	13
28	99	0.00466	10
20	92	0.00277	7
14	88	0.00149	4
10	81		
6.3	74		
5	71		
3.35	66		
2	59		
1.18	54		
0.6	46		
0.425	43	Particle density (assumed) 2.65 Mg/m3	
0.3	39		
0.212	35		
0.15	31		
0.063	24		

Dry Mass of sample, g

2464

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	41.5
Sand	34.5
Silt	18.4
Clay	5.6

Grading Analysis	
D100	mm
D60	mm
D30	mm
D10	mm
Uniformity Coefficient	480
Curvature Coefficient	1.8

Remarks

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

Approved

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PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9TP07**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **3**

Soil Description **Brown gravelly slightly clayey fine to coarse SAND.**

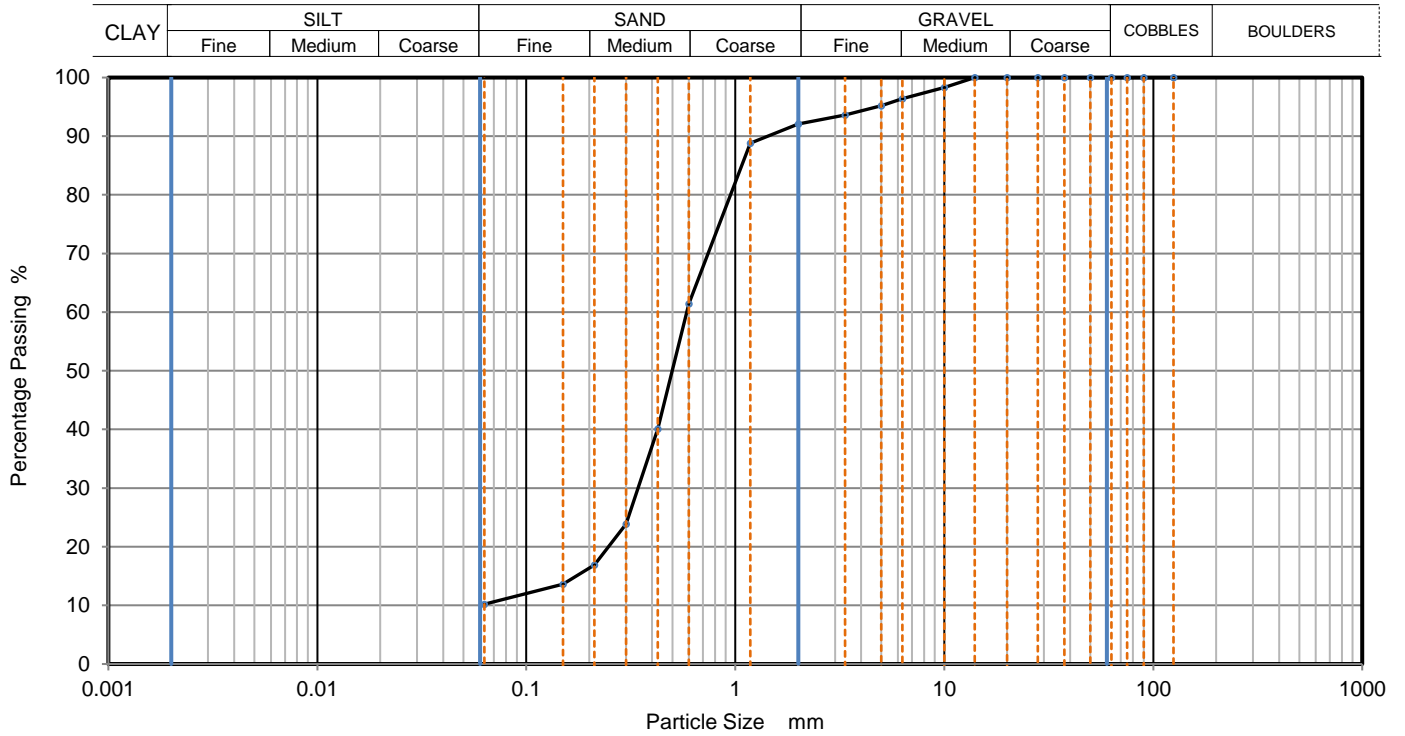
Depth, m **2.00**

Specimen Reference **2** Specimen Depth **2** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clause 9.2**

KeyLAB ID **Caus202011034**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	98		
6.3	96		
5	95		
3.35	94		
2	92		
1.18	89		
0.6	61		
0.425	40		
0.3	24		
0.212	17		
0.15	14		
0.063	10		

Dry Mass of sample, g 530

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	7.9
Sand	81.9
Fines <0.063mm	10.0

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

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

Approved

Stephen.Watson





PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9TP08**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **2**

Soil Description **Brown sandy slightly silty subangular fine to coarse GRAVEL.**

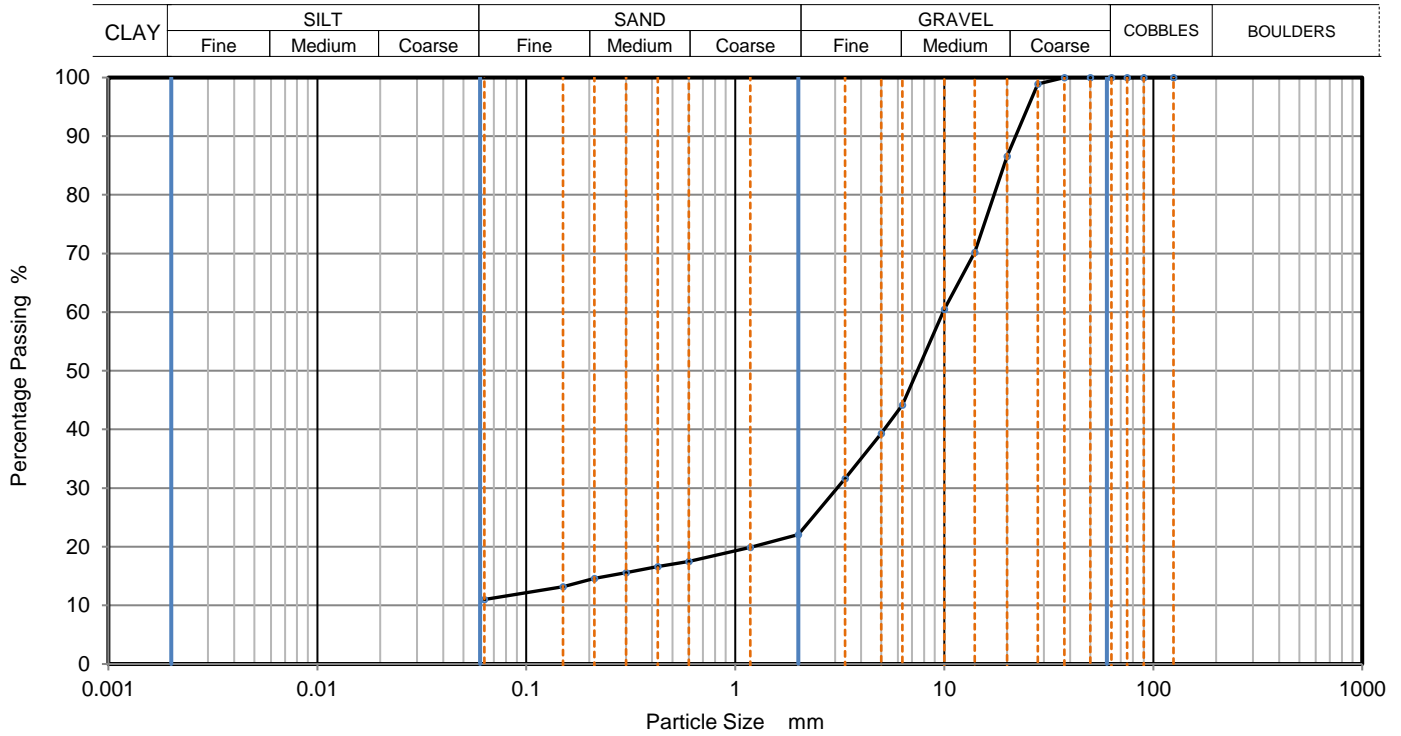
Depth, m **1.00**

Specimen Reference **4** Specimen Depth **1** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clause 9.2**

KeyLAB ID **Caus2020102275**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	99		
20	87		
14	70		
10	61		
6.3	44		
5	39		
3.35	32		
2	22		
1.18	20		
0.6	18		
0.425	17		
0.3	16		
0.212	15		
0.15	13		
0.063	11		

Dry Mass of sample, g

2621

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	77.9
Sand	11.1
Fines <0.063mm	11.0

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

Remarks

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

Approved

Stephen.Watson





PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9TP09**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **6**

Soil Description **Brown sandy slightly silty subangular fine to coarse GRAVEL.**

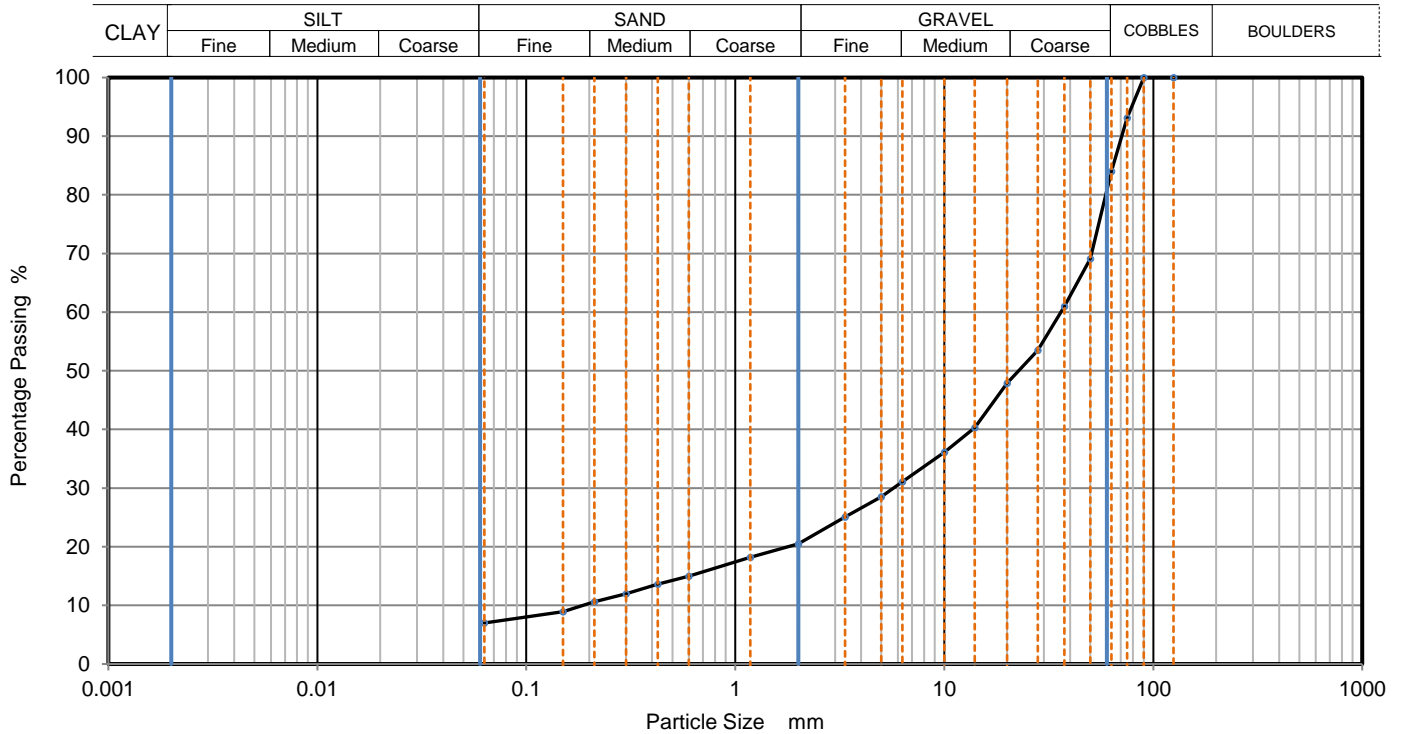
Depth, m **2.50**

Specimen Reference **2** Specimen Depth **2.5** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clause 9.2**

KeyLAB ID **Caus2020102276**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	93		
63	84		
50	69		
37.5	61		
28	54		
20	48		
14	40		
10	36		
6.3	31		
5	29		
3.35	25		
2	21		
1.18	18		
0.6	15		
0.425	14		
0.3	12		
0.212	11		
0.15	9		
0.063	7		

Dry Mass of sample, g

9866

Sample Proportions	% dry mass
Cobbles	16.0
Gravel	63.4
Sand	13.5
Fines <0.063mm	7.0

Grading Analysis	
D100	mm
D60	mm
D30	mm
D10	mm
Uniformity Coefficient	190
Curvature Coefficient	4.9

Remarks

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

Approved

Stephen.Watson

LAB 05R Version 4



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PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9TP10**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **4**

Soil Description **Brown silty fine to coarse SAND.**

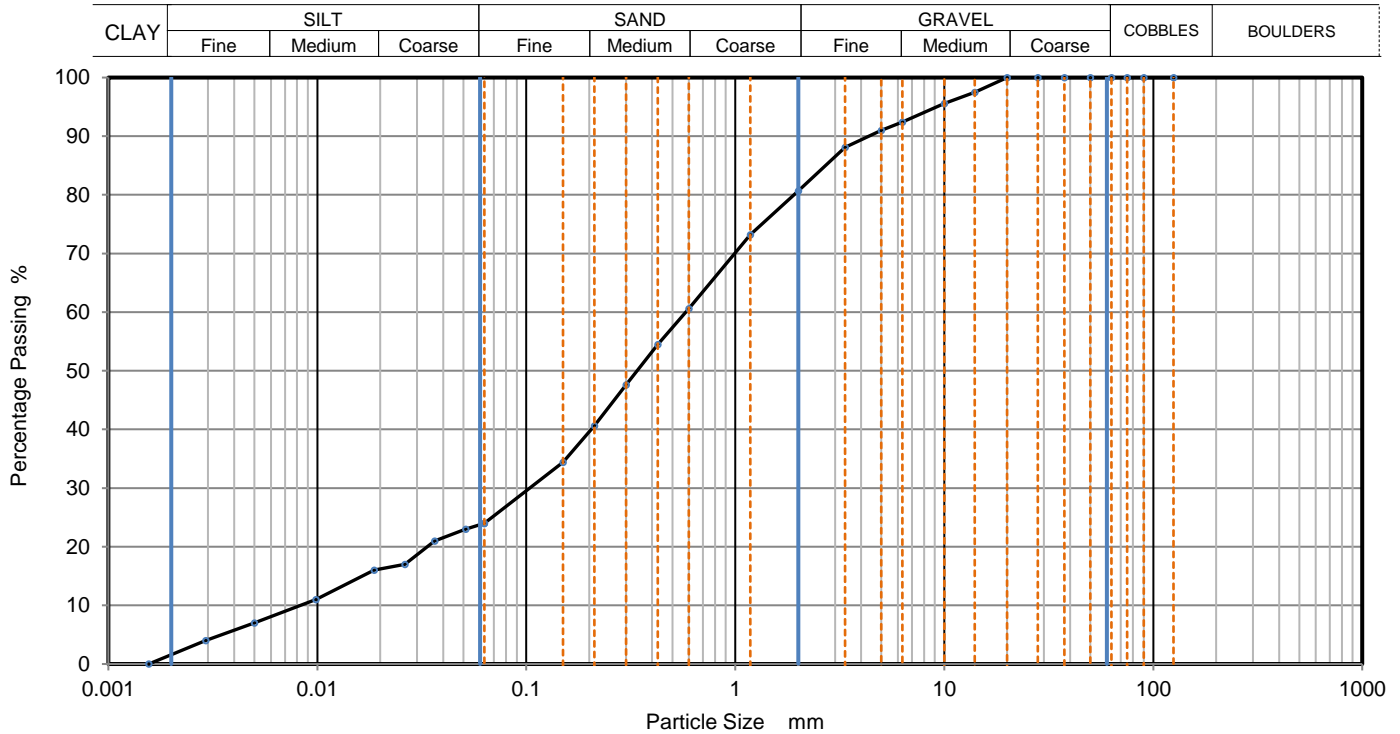
Depth, m **1.00**

Specimen Reference **2** Specimen Depth **1** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clauses 9.2 and 9.5**

KeyLAB ID **Caus2020102277**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	24
90	100	0.05127	23
75	100	0.03647	21
63	100	0.02624	17
50	100	0.01866	16
37.5	100	0.00985	11
28	100	0.00501	7
20	100	0.00292	4
14	98	0.00156	0
10	96		
6.3	92		
5	91		
3.35	88		
2	81		
1.18	73		
0.6	61		
0.425	55	Particle density (assumed)	
0.3	48	2.65 Mg/m3	
0.212	41		
0.15	34		
0.063	24		

Dry Mass of sample, g

507

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	19.3
Sand	56.8
Silt	22.3
Clay	1.6

Grading Analysis	
D100	mm
D60	mm
D30	mm
D10	mm
Uniformity Coefficient	66
Curvature Coefficient	2.1

Remarks

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

Approved

Stephen.Watson

LAB 05R Version 4



10122



PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9TP10**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **6**

Soil Description **Brown slightly sandy silty subangular fine to coarse GRAVEL.**

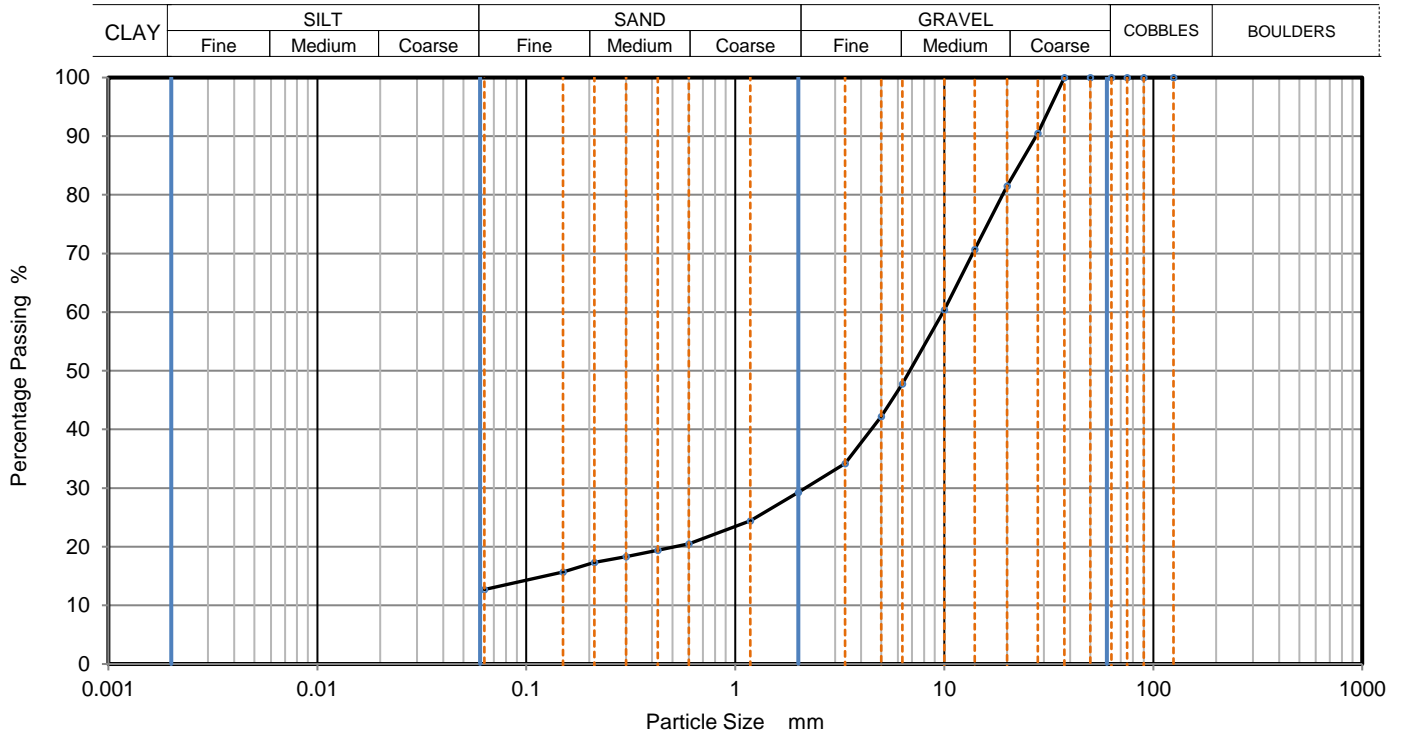
Depth, m **2.00**

Specimen Reference **2** Specimen Depth **2** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clause 9.2**

KeyLAB ID **Caus2020102278**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	91		
20	82		
14	71		
10	60		
6.3	48		
5	42		
3.35	34		
2	29		
1.18	24		
0.6	21		
0.425	19		
0.3	18		
0.212	17		
0.15	16		
0.063	13		

Dry Mass of sample, g

16682

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	70.7
Sand	16.6
Fines <0.063mm	13.0

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

Remarks

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

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PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9TP10**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **9**

Soil Description **Brown sandy silty CLAY.**

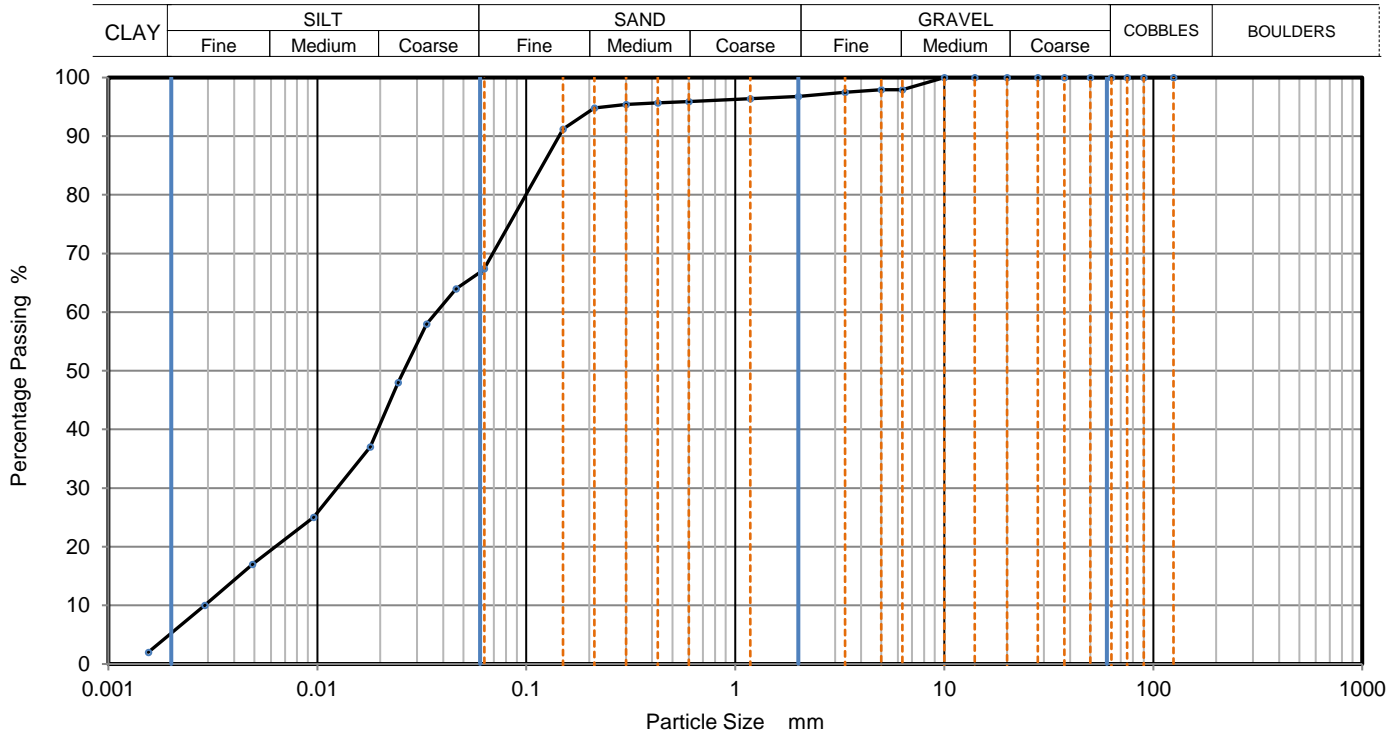
Depth, m **4.00**

Specimen Reference **6** Specimen Depth **4** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clauses 9.2 and 9.5**

KeyLAB ID **Caus2020102279**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06107	67
90	100	0.04609	64
75	100	0.03331	58
63	100	0.02437	48
50	100	0.01791	37
37.5	100	0.00958	25
28	100	0.00490	17
20	100	0.00289	10
14	100	0.00155	2
10	100		
6.3	98		
5	98		
3.35	98		
2	97		
1.18	96		
0.6	96	Particle density (assumed)	
0.425	96	2.65 Mg/m3	
0.3	95		
0.212	95		
0.15	91		
0.063	67		

Dry Mass of sample, g **205**

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	3.2
Sand	29.5
Silt	62.2
Clay	5.1

Grading Analysis		
D100	mm	
D60	mm	0.0378
D30	mm	0.0125
D10	mm	0.00296
Uniformity Coefficient		13
Curvature Coefficient		1.4

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

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Stephen.Watson





PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9TP11**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **2**

Soil Description **Brown sandy slightly gravelly silty CLAY.**

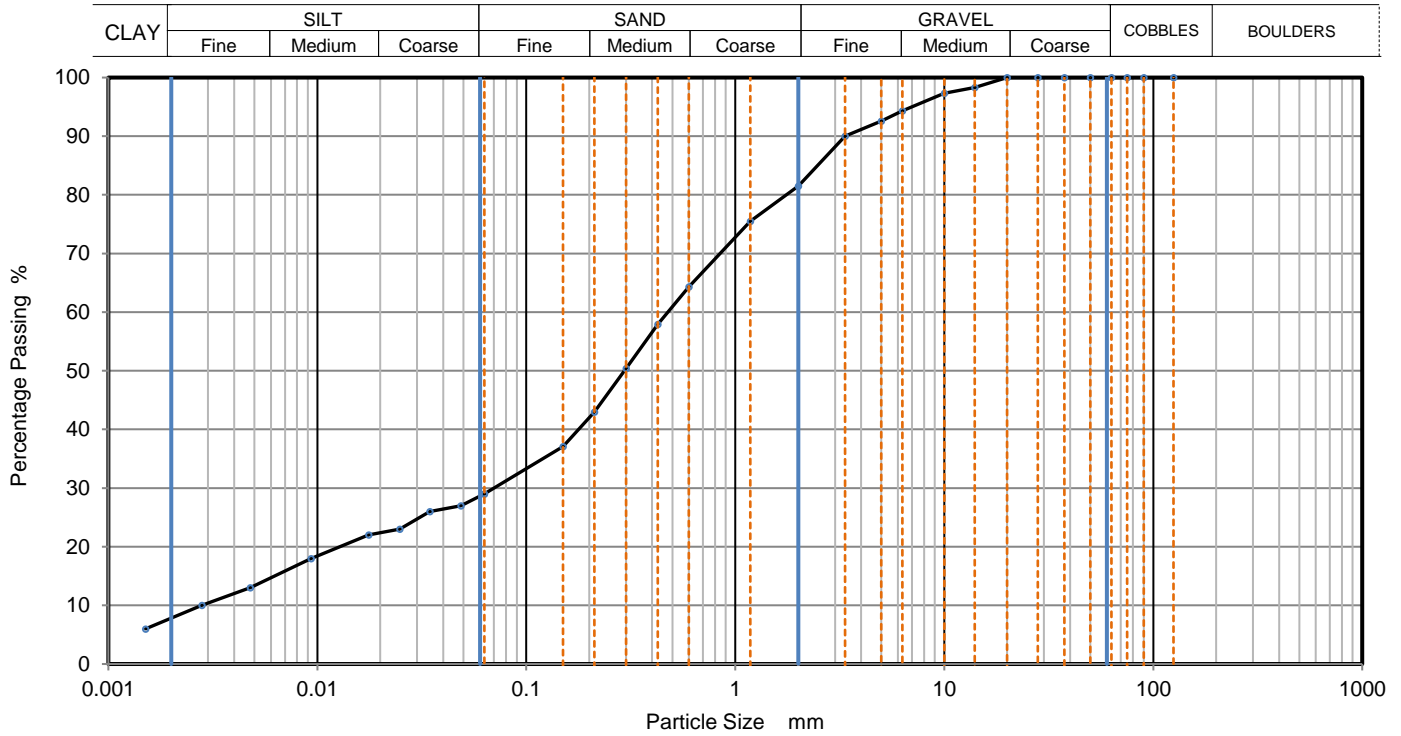
Depth, m **1.00**

Specimen Reference **6** Specimen Depth **1** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clauses 9.2 and 9.5**

KeyLAB ID **Caus2020102280**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	29
90	100	0.04856	27
75	100	0.03457	26
63	100	0.02476	23
50	100	0.01762	22
37.5	100	0.00933	18
28	100	0.00477	13
20	100	0.00280	10
14	98	0.00151	6
10	97		
6.3	94		
5	93		
3.35	90		
2	82		
1.18	76		
0.6	64		
0.425	58	Particle density (assumed)	
0.3	50	2.65 Mg/m3	
0.212	43		
0.15	37		
0.063	29		

Dry Mass of sample, g **522**

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	18.5
Sand	52.5
Silt	21.4
Clay	7.6

Grading Analysis		
D100	mm	
D60	mm	0.477
D30	mm	0.07
D10	mm	0.00279
Uniformity Coefficient		170
Curvature Coefficient		3.7

Remarks

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

Approved

Stephen.Watson





PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399D**

Borehole/Pit No. **R9TP11**

Site Name **Bus Connects Route 9 Tallaght/Clondalkin to City Centre**

Sample No. **5**

Soil Description **Brown slightly sandy silty CLAY.**

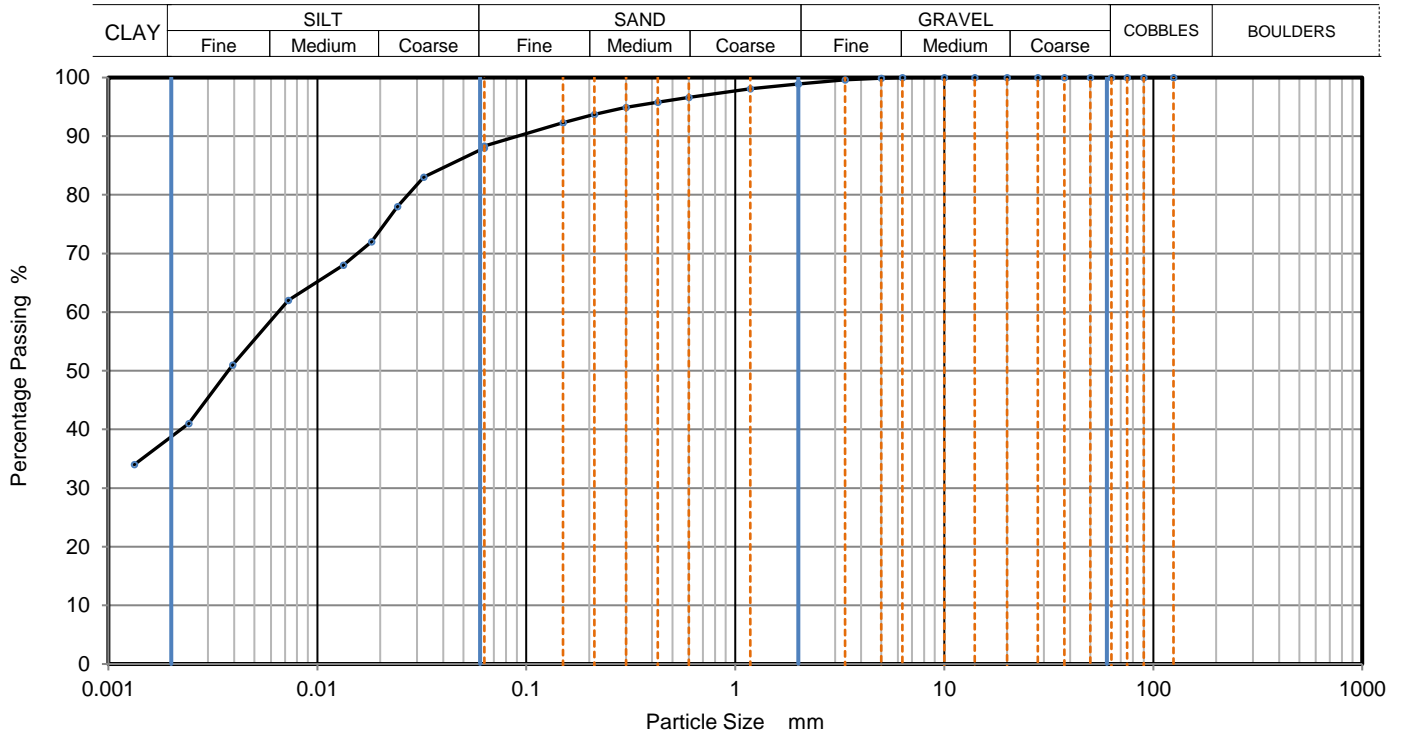
Depth, m **2.00**

Specimen Reference **6** Specimen Depth **2** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clauses 9.2 and 9.5**

KeyLAB ID **Caus2020102281**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	88
90	100	0.03228	83
75	100	0.02417	78
63	100	0.01820	72
50	100	0.01332	68
37.5	100	0.00725	62
28	100	0.00394	51
20	100	0.00242	41
14	100	0.00133	34
10	100		
6.3	100		
5	100		
3.35	100		
2	99		
1.18	98		
0.6	97	Particle density (assumed)	
0.425	96	2.65 Mg/m3	
0.3	95		
0.212	94		
0.15	92		
0.063	88		

Dry Mass of sample, g **213**

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	1.1
Sand	10.6
Silt	49.6
Clay	38.7

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

Remarks

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

Approved

Stephen.Watson





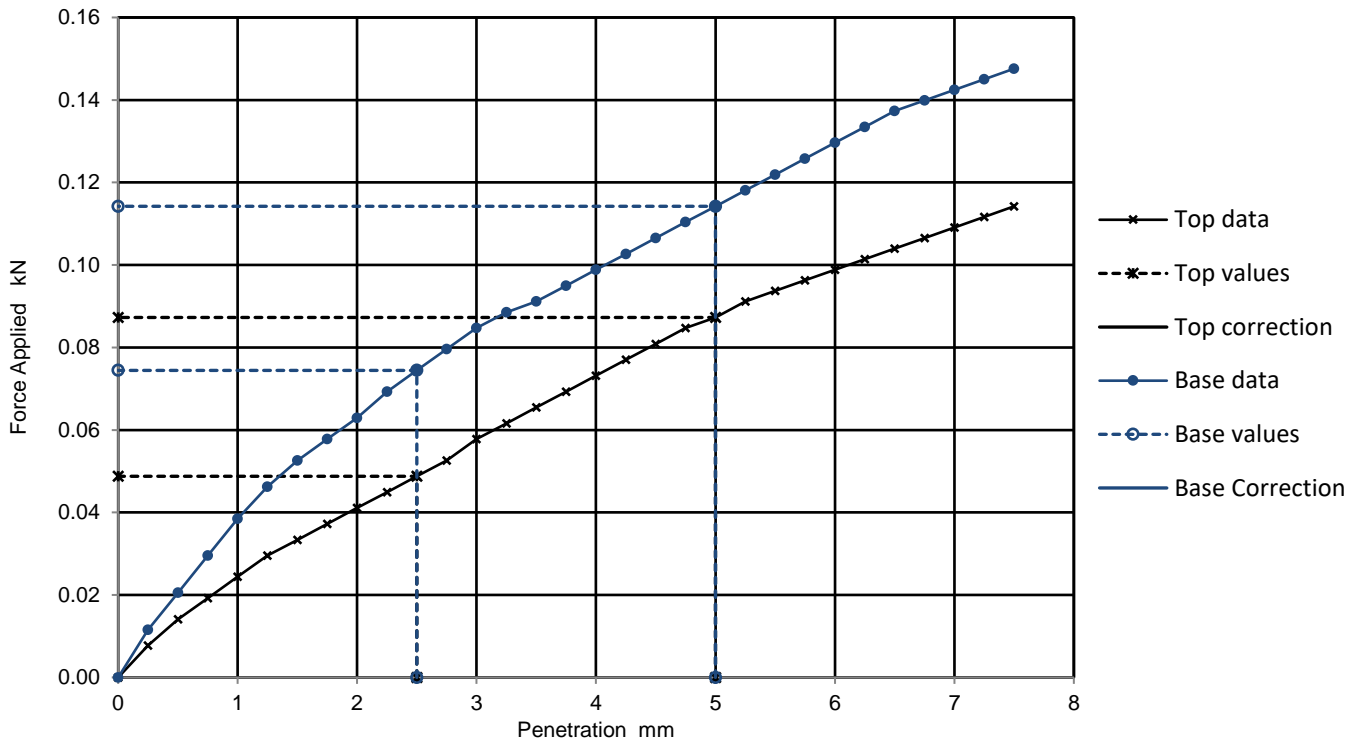
California Bearing Ratio (CBR)

Job Ref	20-0399D
Borehole/Pit No.	R9CP01
Sample No.	5
Depth m	0.50
Sample Type	B
KeyLAB ID	Caus202010220
CBR Test Number	1

Specimen Preparation

Condition	REMOULDED	Soaking details	Not soaked
Details	Recompacted with specified standard effort using 2.5kg rammer	Period of soaking	days
		Time to surface	days
		Amount of swell recorded	mm
Material retained on 20mm sieve removed	3 %	Dry density after soaking	Mg/m3
Initial Specimen details	Bulk density	2.06 Mg/m3	Surcharge applied
	Dry density	1.73 Mg/m3	4.5 kg
	Moisture content	19.4 %	3 kPa

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, %				Moisture Content %
		2.5mm	5mm	Highest	Average	
TOP	No	0	0	0	20	
BASE	No	1	1	1		

General remarks	Test specific remarks	Approved
Tested at natural moisture content.	Average result may be reported if within 10% of the mean CBR value of top and base.	Stephen.Watson





California Bearing Ratio (CBR)

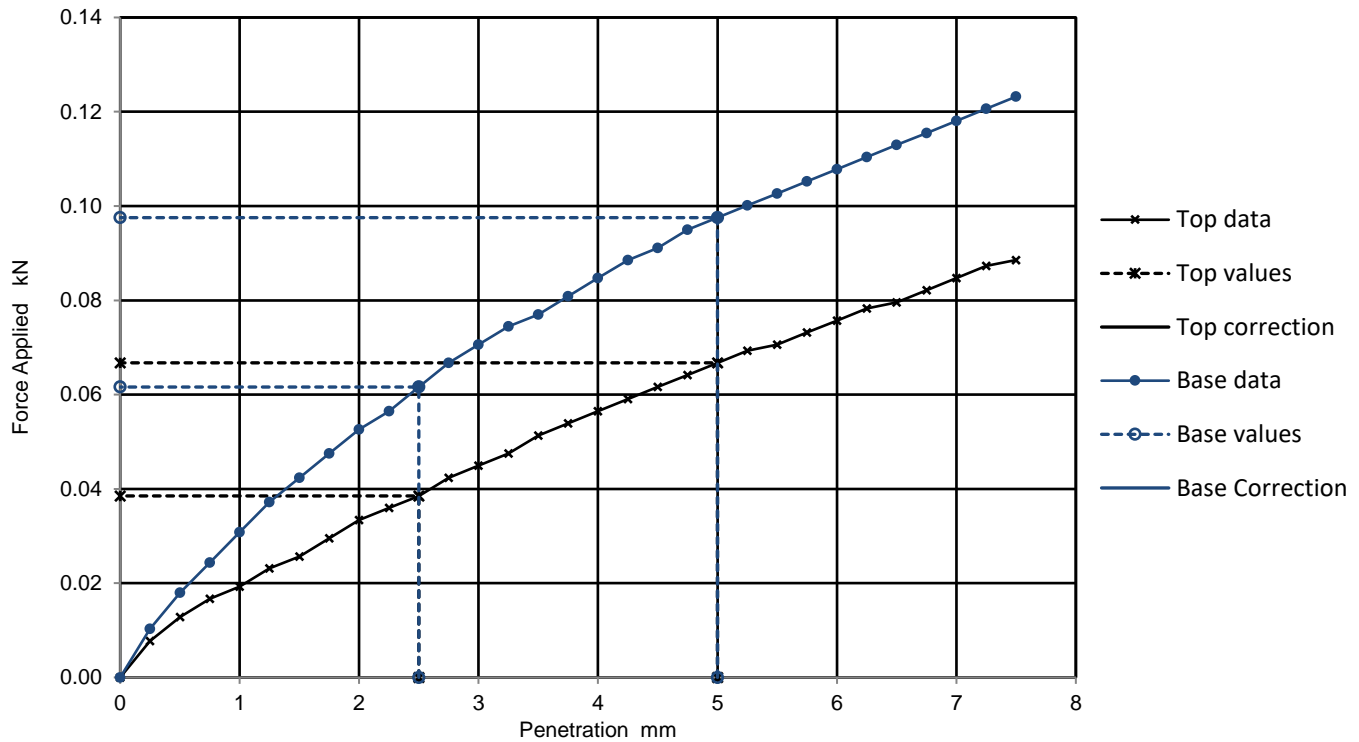
Job Ref	20-0399D
Borehole/Pit No.	R9CP03
Sample No.	11
Depth m	0.50
Sample Type	B
KeyLAB ID	Caus2020102210
CBR Test Number	1

Site Name	Bus Connects Route 9 Tallaght/Clondalkin to City Centre	
Soil Description	Brownish grey sandy gravelly silty CLAY.	
Specimen Reference	Specimen Depth	m
Specimen Description	Brownish grey sandy gravelly silty CLAY.	
Test Method	BS1377 : Part 4 : 1990, clause 7	

Specimen Preparation

Condition	REMOULDED	Soaking details	Not soaked
Details	Recompacted with specified standard effort using 2.5kg rammer	Period of soaking	days
		Time to surface	days
		Amount of swell recorded	mm
Material retained on 20mm sieve removed	1 %	Dry density after soaking	Mg/m3
Initial Specimen details	Bulk density	2.07 Mg/m3	Surcharge applied
	Dry density	1.40 Mg/m3	4.5 kg
	Moisture content	48.0 %	3 kPa

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, %				Moisture Content %
		2.5mm	5mm	Highest	Average	
TOP	No	0	0	0	50	
BASE	No	0	0	0		

General remarks	Test specific remarks	Approved
Tested at natural moisture content.	Average result may be reported if within 10% of the mean CBR value of top and base.	Stephen.Watson






Moisture Condition Value at Natural Moisture Content Summary of Results

Project No. 20-0399D	Project Name Bus Connects Route 9 Tallaght/Clondalkin to City Centre
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Hole No.	Sample				Soil Description	Retained on 20mm sieve %	Moisture Content <20mm %	Moisture Condition Value	Method of Interpretation	Remarks
	Ref	Top	Base	Type						
R9CP01	5	0.50		B	Brown sandy slightly gravelly silty CLAY.	3	20	2.5	Best fit line	
R9CP03	11	0.50		B	Brownish grey sandy gravelly silty CLAY.	1	48	5.7	Best fit line	
R9CP05	11	1.00		B	Brownish grey sandy gravelly silty CLAY.	4	13	10.6	Best fit line	
R9TP08	2	1.00		B	Brown sandy slightly silty subangular fine to coarse GRAVEL.	34	6.3	>18	Best fit line	

LAB 10R Version 5

Key Test performed in accordance with BS1377:Part4:1990, clause 5.4 unless annotated otherwise	Date Printed 18/11/2020	Approved By Stephen.Watson	 10122
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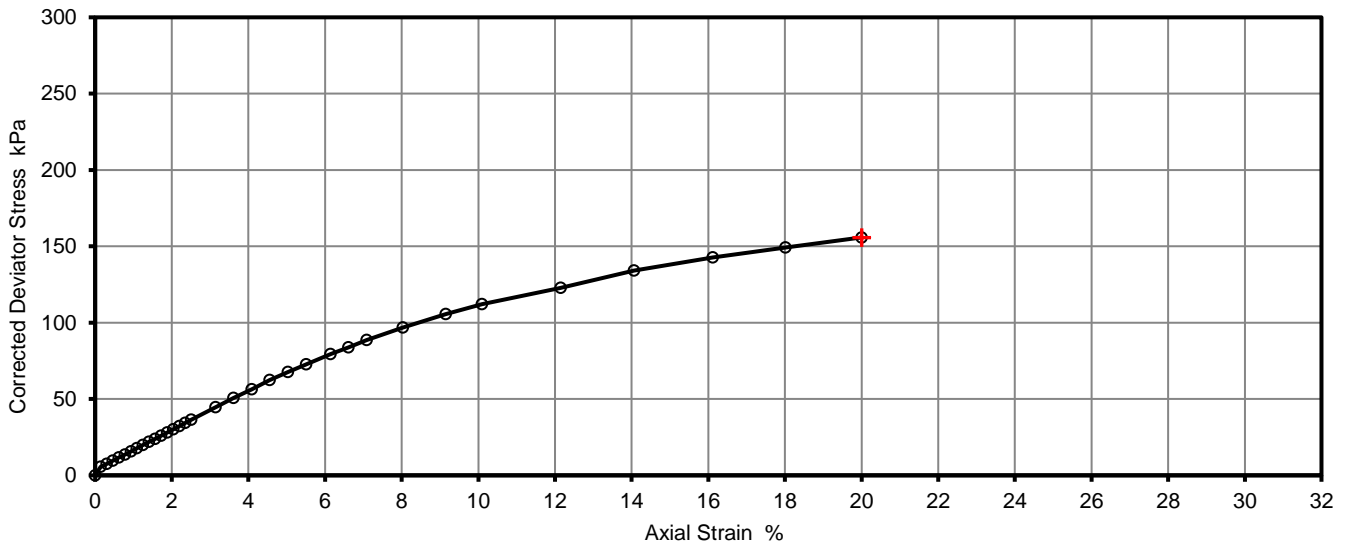
**Unconsolidated Undrained Triaxial
Compression Test without measurement
of pore pressure - single specimen**

Job Ref	20-0399D
Borehole/Pit No.	R9CP01
Sample No.	18
Depth	3.00
Sample Type	U
KeyLAB ID	Caus202010223
Date of test	28/10/2020

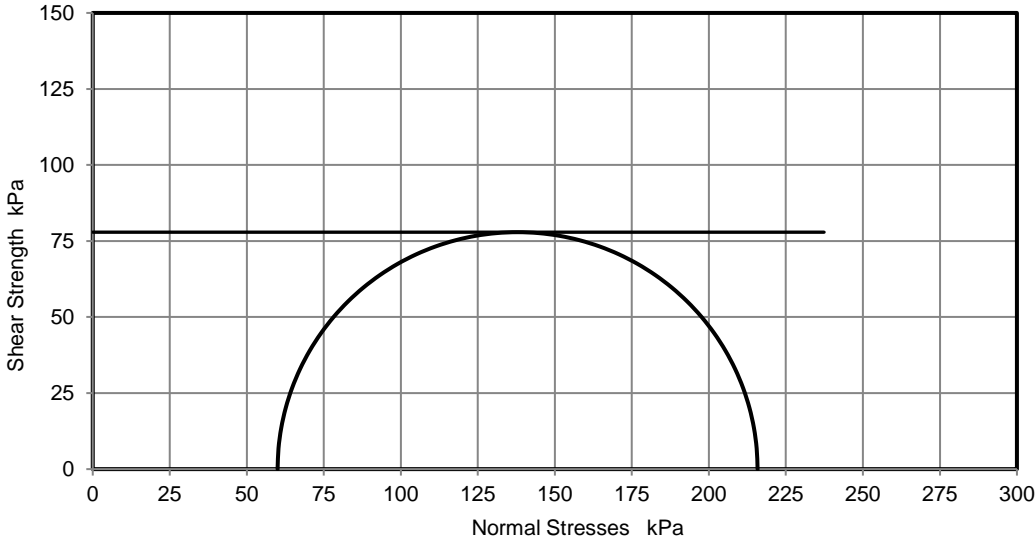
Site Name	Bus Connects Route 9 Tallaght/Clondalkin to City Centre		
Soil Description	Brown sandy slightly gravelly silty CLAY.		
Specimen Reference	4	Specimen Depth	3.05 m
Specimen Description	Stiff brown sandy slightly gravelly silty CLAY.		
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen		

Test Number	1	
Length	209.9	mm
Diameter	105.2	mm
Bulk Density	2.27	Mg/m ³
Moisture Content	15.6	%
Dry Density	1.96	Mg/m ³
Rate of Strain	2.0	%/min
Cell Pressure	60	kPa
At failure	20.0	%
Axial Strain	156	kPa
Deviator Stress, ($\sigma_1 - \sigma_3$) _f	78	kPa $\frac{1}{2}(\sigma_1 - \sigma_3)$
Undrained Shear Strength, c_u		
Mode of Failure		

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects based on Fig 11 BS1377-7:1990

Mohr circles and their interpretation is not covered by BS1377-7. This is provided for information only.

Remarks

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

Approved

Stephen.Watson

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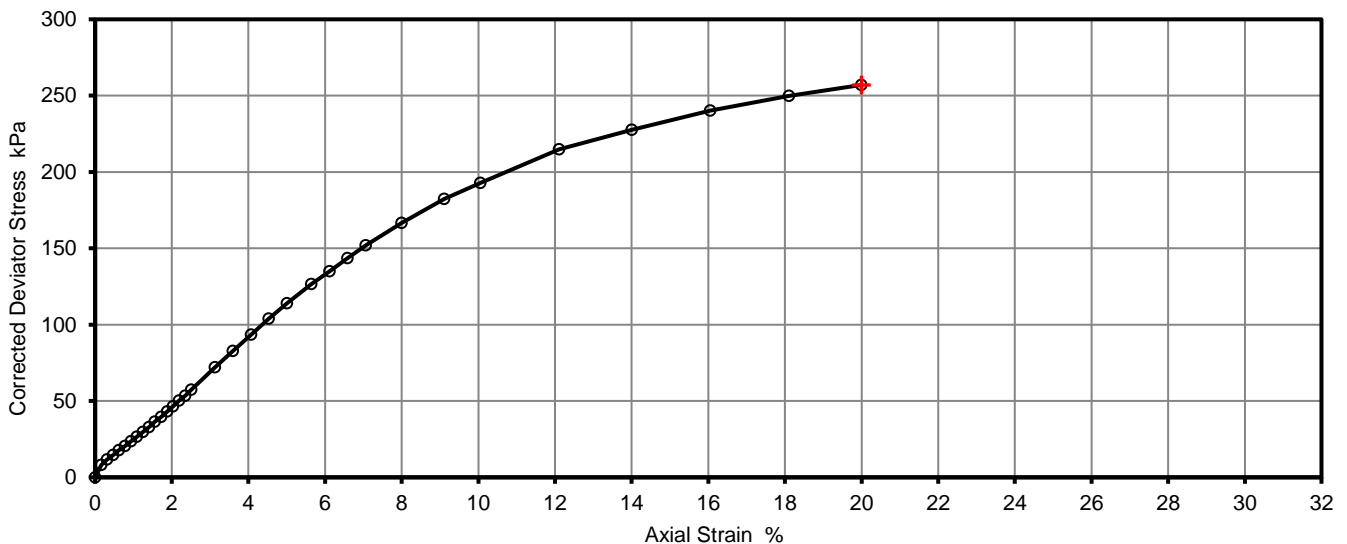
**Unconsolidated Undrained Triaxial
Compression Test without measurement
of pore pressure - single specimen**

Job Ref	20-0399D
Borehole/Pit No.	R9CP01
Sample No.	19
Depth	5.00
Sample Type	U
KeyLAB ID	Caus202010225
Date of test	28/10/2020

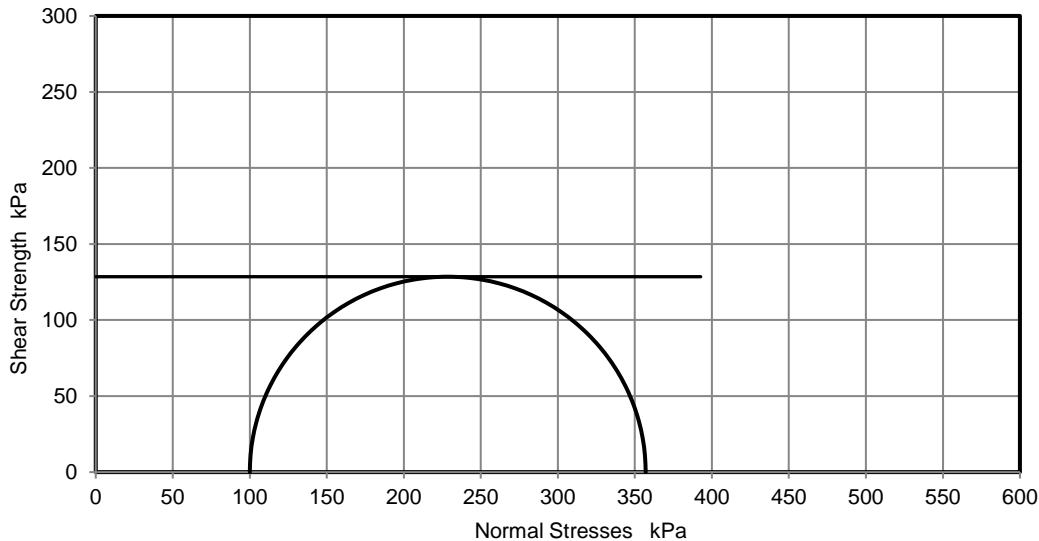
Site Name	Bus Connects Route 9 Tallaght/Clondalkin to City Centre		
Soil Description	Brownish grey sandy slightly gravelly silty CLAY.		
Specimen Reference	4	Specimen Depth	5.05 m
Specimen Description	Stiff brownish grey sandy slightly gravelly silty CLAY.		
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen		

Test Number	1	
Length	210.8	mm
Diameter	105.1	mm
Bulk Density	2.31	Mg/m ³
Moisture Content	12.0	%
Dry Density	2.07	Mg/m ³
Rate of Strain	2.0	%/min
Cell Pressure	100	kPa
At failure	20.0	%
Axial Strain	257	kPa
Deviator Stress, ($\sigma_1 - \sigma_3$) _f	129	kPa $\frac{1}{2}(\sigma_1 - \sigma_3)$
Undrained Shear Strength, c_u		
Mode of Failure		

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects based on Fig 11 BS1377-7:1990

Mohr circles and their interpretation is not covered by BS1377-7. This is provided for information only.

Remarks

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

Approved

Stephen.Watson

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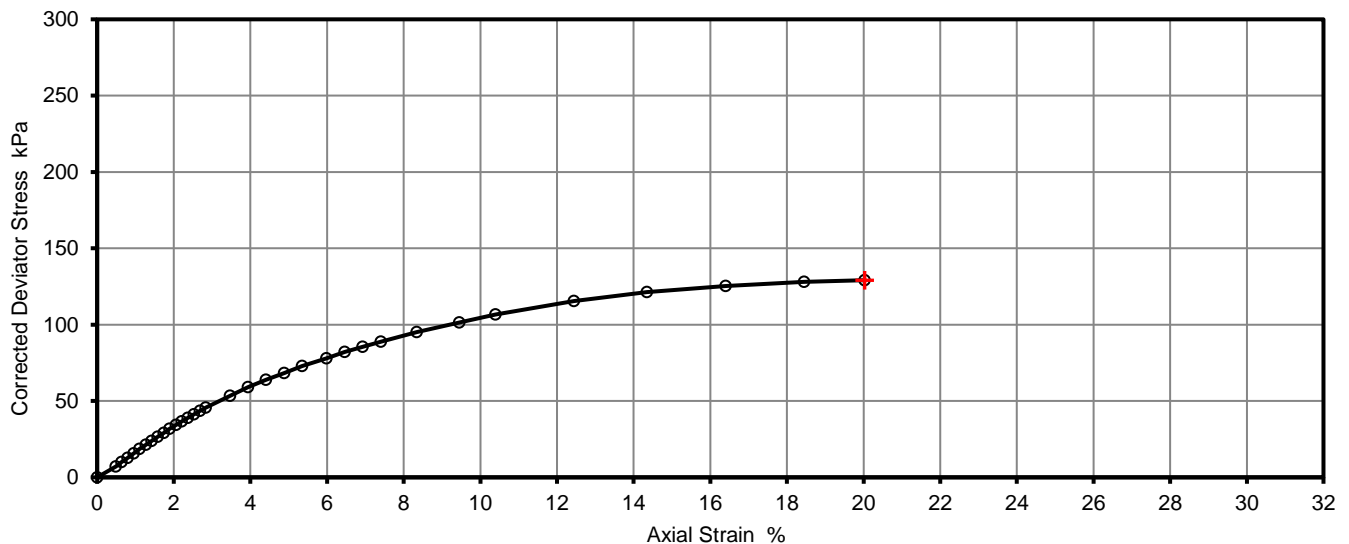
**Unconsolidated Undrained Triaxial
Compression Test without measurement
of pore pressure - single specimen**

Job Ref	20-0399D
Borehole/Pit No.	R9CP03
Sample No.	26
Depth	1.20
Sample Type	U
KeyLAB ID	Caus2020102212
Date of test	29/10/2020

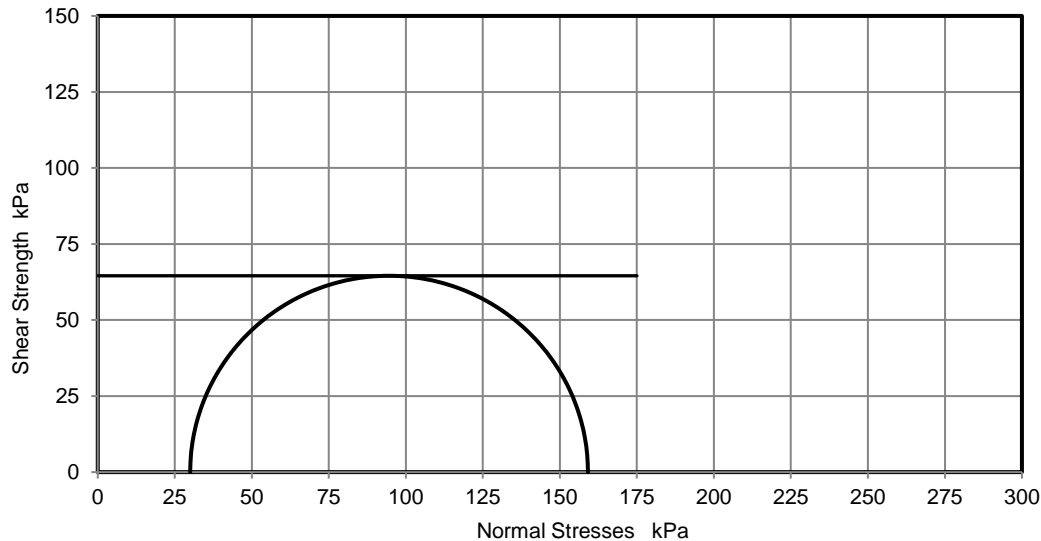
Site Name	Bus Connects Route 9 Tallaght/Clondalkin to City Centre		
Soil Description	Brownish grey sandy gravelly SILT.		
Specimen Reference	4	Specimen Depth	1.25 m
Specimen Description	Firm brownish grey sandy gravelly SILT.		
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen		

Test Number	1	
Length	210.7	mm
Diameter	105.2	mm
Bulk Density	2.28	Mg/m ³
Moisture Content	14.3	%
Dry Density	2.00	Mg/m ³
Rate of Strain	2.0	%/min
Cell Pressure	30	kPa
At failure	20.0	%
Axial Strain	129	kPa
Deviator Stress, ($\sigma_1 - \sigma_3$) _f	65	kPa $\frac{1}{2}(\sigma_1 - \sigma_3)$
Undrained Shear Strength, cu		
Mode of Failure		

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects based on Fig 11 BS1377-7:1990

Mohr circles and their interpretation is not covered by BS1377-7. This is provided for information only.

Remarks

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

Approved

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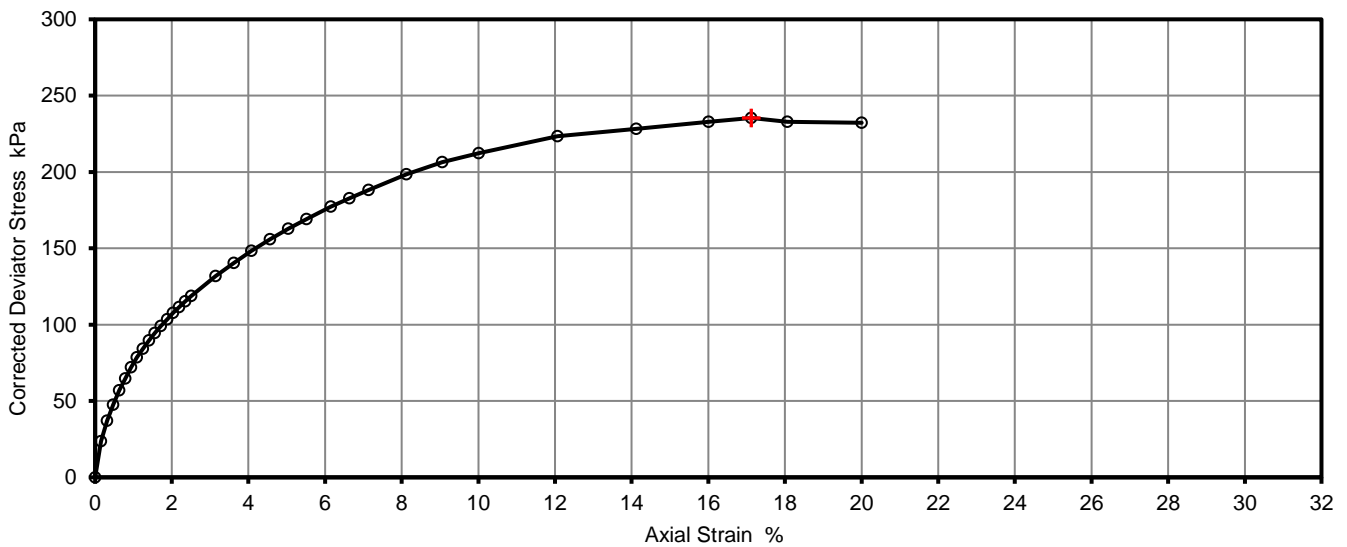
**Unconsolidated Undrained Triaxial
Compression Test without measurement
of pore pressure - single specimen**

Job Ref	20-0399D
Borehole/Pit No.	R9CP05
Sample No.	26
Depth	8.00
Sample Type	U
KeyLAB ID	Caus2020102232
Date of test	29/10/2020

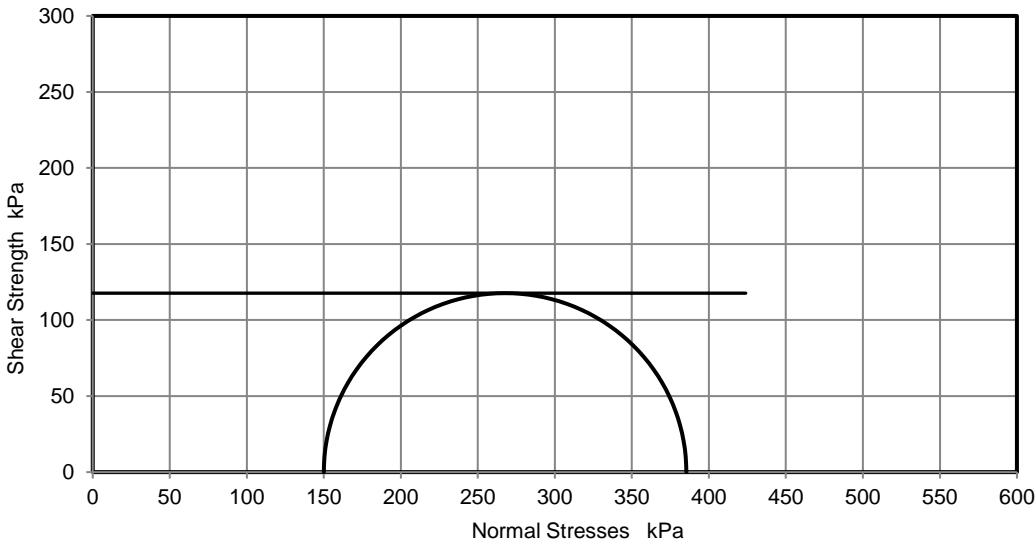
Site Name	Bus Connects Route 9 Tallaght/Clondalkin to City Centre		
Soil Description	Grey sandy slightly gravelly silty CLAY.		
Specimen Reference	4	Specimen Depth	8.05 m
Specimen Description	Stiff grey sandy slightly gravelly silty CLAY.		
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen		

Test Number	1	
Length	210.6	mm
Diameter	104.0	mm
Bulk Density	2.14	Mg/m ³
Moisture Content	9.2	%
Dry Density	1.96	Mg/m ³
Rate of Strain	2.0	%/min
Cell Pressure	150	kPa
At failure	17.1	%
Axial Strain	235	kPa
Deviator Stress, ($\sigma_1 - \sigma_3$) _f	118	kPa $\frac{1}{2}(\sigma_1 - \sigma_3)$
Undrained Shear Strength, <i>c_u</i>	Plastic	
Mode of Failure		

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects based on Fig 11 BS1377-7:1990

Mohr circles and their interpretation is not covered by BS1377-7. This is provided for information only.

Remarks

Approved

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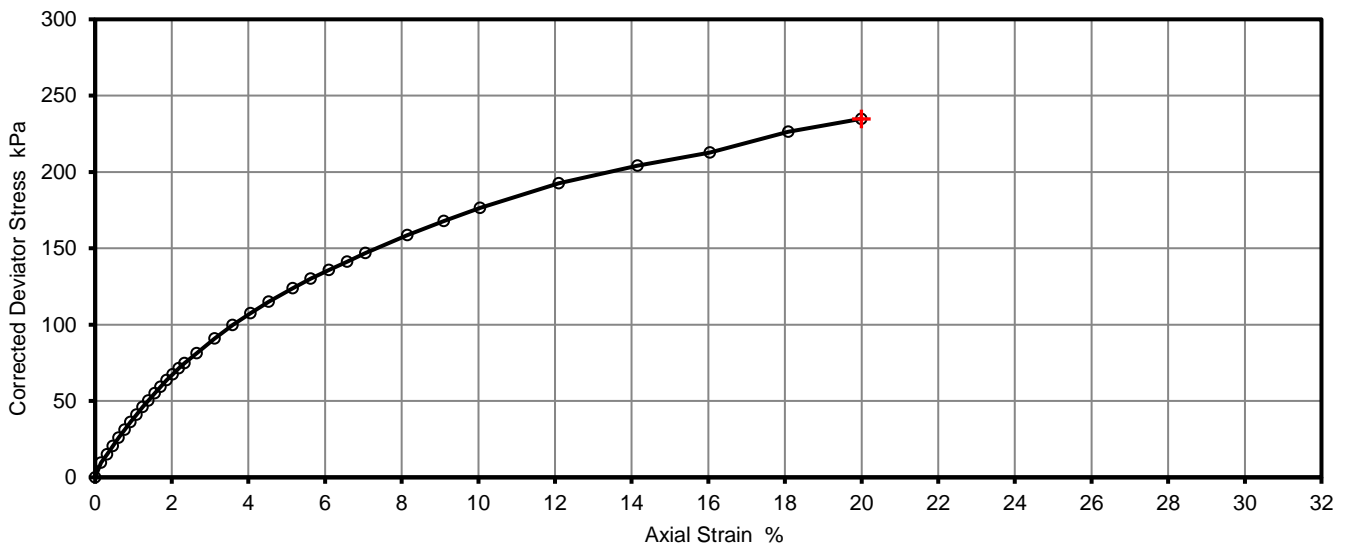
**Unconsolidated Undrained Triaxial
Compression Test without measurement
of pore pressure - single specimen**

Job Ref	20-0399D
Borehole/Pit No.	R9CP08
Sample No.	18
Depth	3.00
Sample Type	U
KeyLAB ID	Caus2020102239
Date of test	29/10/2020

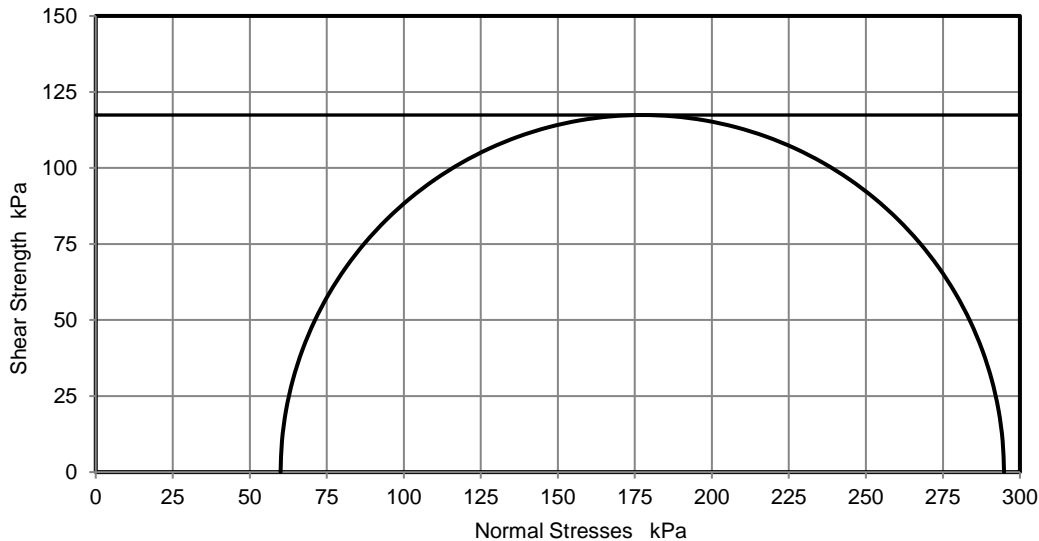
Site Name	Bus Connects Route 9 Tallaght/Clondalkin to City Centre		
Soil Description	Grey slightly sandy slightly gravelly silty CLAY.		
Specimen Reference	4	Specimen Depth	3.05 m
Specimen Description	Stiff grey slightly sandy slightly gravelly silty CLAY.		
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen		

Test Number	1	
Length	210.8	mm
Diameter	104.9	mm
Bulk Density	2.22	Mg/m ³
Moisture Content	14.0	%
Dry Density	1.95	Mg/m ³
Rate of Strain	2.0	%/min
Cell Pressure	60	kPa
At failure	20.0	%
Axial Strain	235	kPa
Deviator Stress, ($\sigma_1 - \sigma_3$) _f	117	kPa $\frac{1}{2}(\sigma_1 - \sigma_3)$
Undrained Shear Strength, c_u		
Mode of Failure		

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects based on Fig 11 BS1377-7:1990

Mohr circles and their interpretation is not covered by BS1377-7. This is provided for information only.

Remarks

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

Approved

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**Unconsolidated Undrained Triaxial
Compression Test without measurement
of pore pressure - single specimen**

Job Ref	20-0399D
Borehole/Pit No.	R9CPGS02
Sample No.	17
Depth	2.00
Sample Type	U
KeyLAB ID	Caus2020102258
Date of test	29/10/2020

Site Name	Bus Connects Route 9 Tallaght/Clondalkin to City Centre		
Soil Description	Greyish brown slightly sandy silty CLAY.		
Specimen Reference	4	Specimen Depth	2.05 m
Specimen Description	Stiff greyish brown slightly sandy silty CLAY.		
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen		

Test Number
Length
Diameter
Bulk Density
Moisture Content
Dry Density

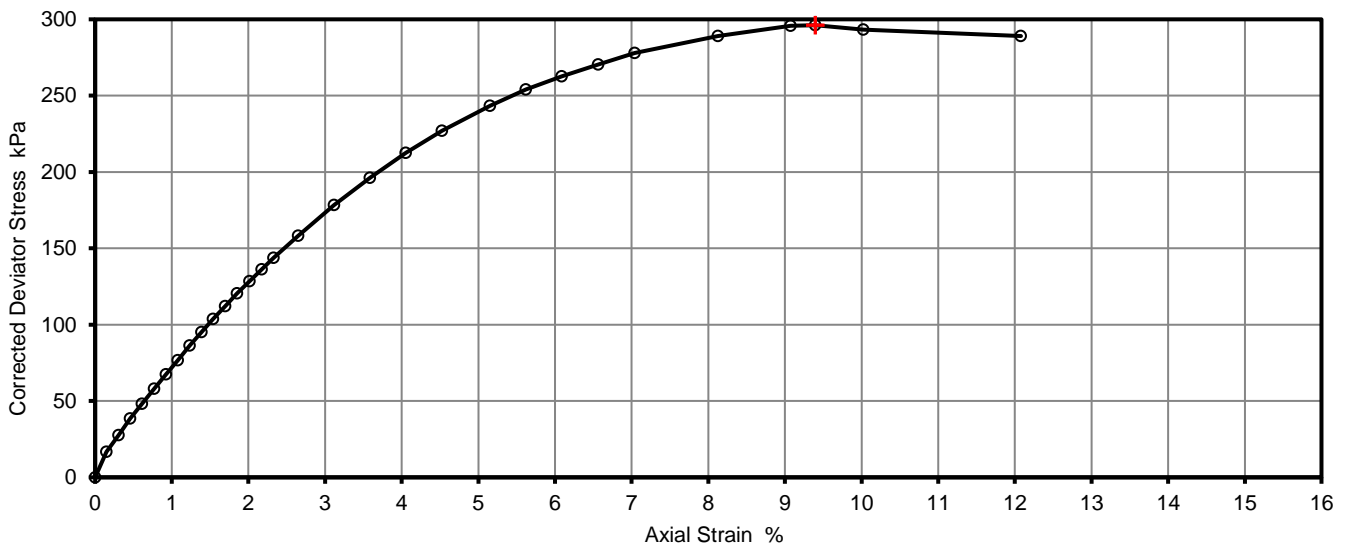
1	
210.7	mm
104.9	mm
2.11	Mg/m3
15.7	%
1.82	Mg/m3

Rate of Strain
Cell Pressure
At failure

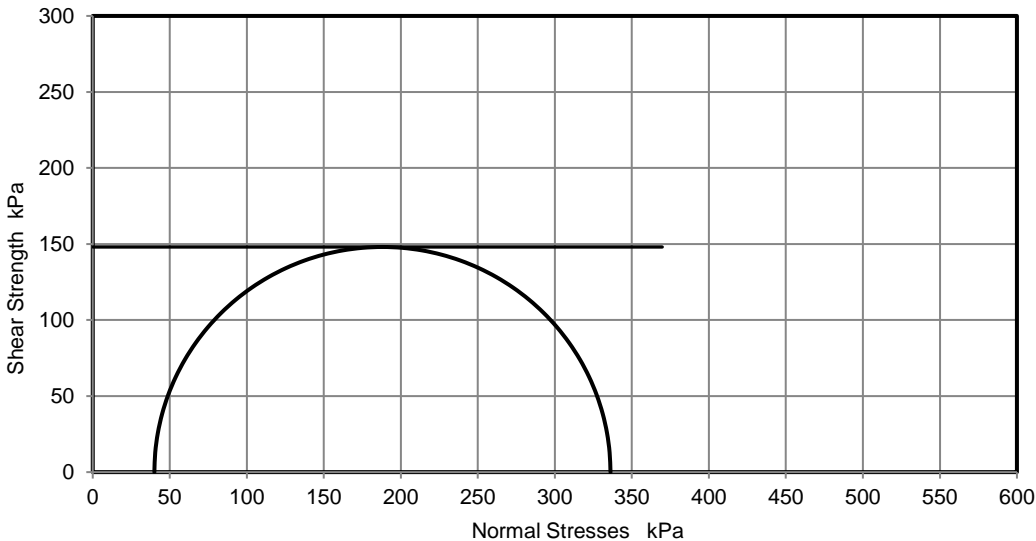
2.0	%/min
40	kPa
9.4	%
296	kPa
148	kPa $\frac{1}{2}(\sigma_1 - \sigma_3)_f$
Brittle	

Axial Strain
Deviator Stress, $(\sigma_1 - \sigma_3)_f$
Undrained Shear Strength, c_u
Mode of Failure

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects based on Fig 11 BS1377-7:1990

Mohr circles and their interpretation is not covered by BS1377-7. This is provided for information only.

Remarks

Approved

Stephen.Watson

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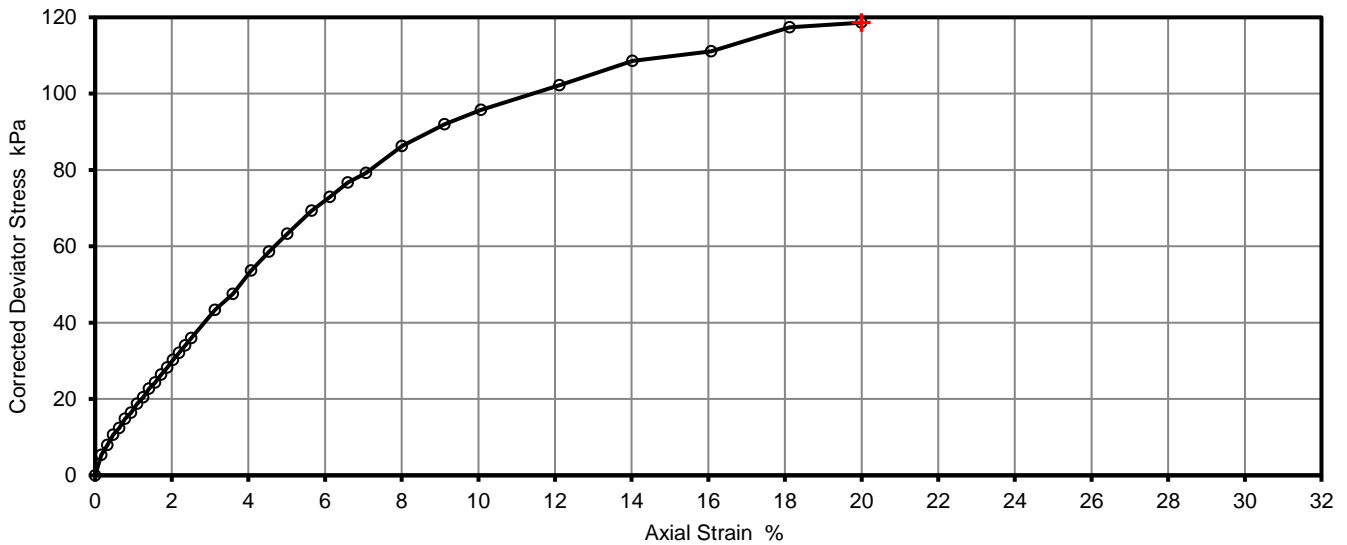
Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen

Job Ref	20-0399D
Borehole/Pit No.	R9CPGS02
Sample No.	11
Depth	12.00
Sample Type	C
KeyLAB ID	Caus2020102262
Date of test	28/10/2020

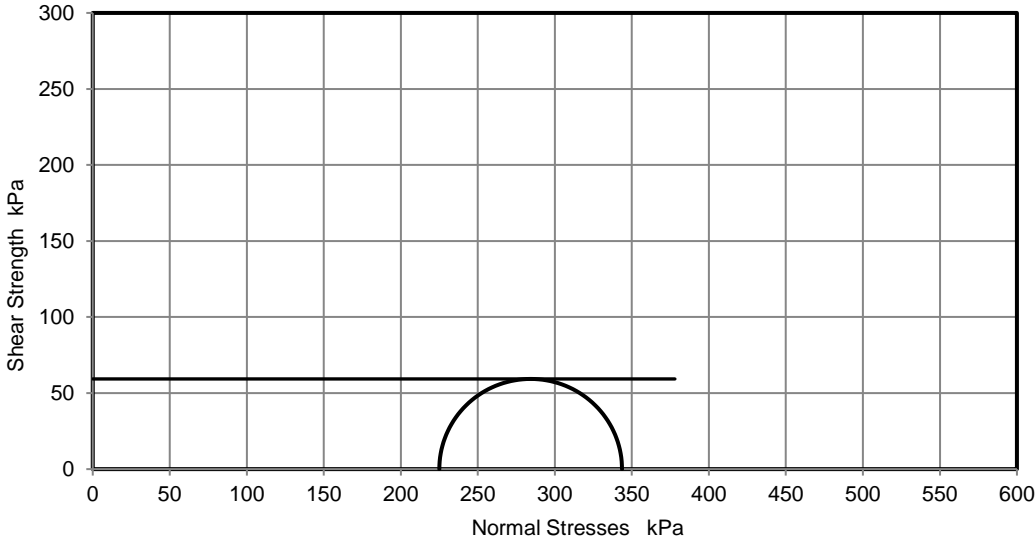
Site Name	Bus Connects Route 9 Tallaght/Clondalkin to City Centre		
Soil Description	Greyish brown sandy gravelly silty CLAY.		
Specimen Reference	4	Specimen Depth	12.05 m
Specimen Description	Firm greyish brown sandy gravelly silty CLAY.		
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen		

Test Number	1	
Length	210.7	mm
Diameter	105.3	mm
Bulk Density	2.25	Mg/m ³
Moisture Content	12.8	%
Dry Density	2.00	Mg/m ³
Rate of Strain	2.0	%/min
Cell Pressure	225	kPa
At failure	20.0	%
Axial Strain	119	kPa
Deviator Stress, ($\sigma_1 - \sigma_3$) _f	59	kPa $\frac{1}{2}(\sigma_1 - \sigma_3)$
Undrained Shear Strength, c_u		
Mode of Failure		

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects based on Fig 11 BS1377-7:1990

Mohr circles and their interpretation is not covered by BS1377-7. This is provided for information only.

Remarks

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

Approved

Stephen.Watson

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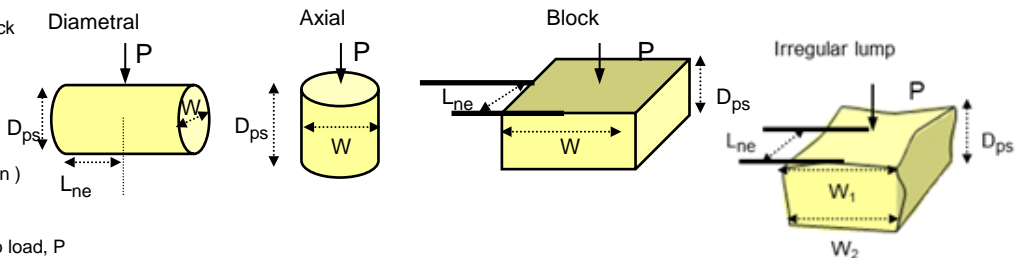
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Point Load Strength Index Tests Summary of Results

Project No. 20-0399D	Project Name Bus Connects Route 9 Tallaght/Clondalkin to City Centre
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Borehole No.	Sample			Specimen		Rock Type	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P kN	Equivalent diameter, De mm	Point Load Strength Index		Remarks (including water content if measured)
	Depth m	Ref.	Type	Ref.	Depth m		Type (D, A, I, B)	Direction (L, P or U)		Lne mm	W mm	Dps mm	Dps' mm			Is MPa	Is(50) MPa	
R9CPGS01	12.30		C	2	12.30	LIMESTONE	D	U	NO	87.5	101.3	101.3	96.0	8.2	98.6	0.8	1.1	
R9CPGS01	12.55		C	2	12.55	LIMESTONE	A	U	NO		101.4	68.0	66.0	6.1	92.3	0.7	0.9	
R9CPGS01	12.80		C	2	12.80	LIMESTONE	D	U	NO	81.2	101.4	101.4	98.0	9.6	99.7	1.0	1.3	
R9CPGS01	13.20		C	2	13.20	LIMESTONE	A	U	YES		101.6	57.0	54.0	4.7	83.6	0.7	0.8	
R9CPGS01	13.75		C	2	13.75	LIMESTONE	D	U	NO	79.6	101.3	101.3	98.0	7.5	99.6	0.8	1.0	
R9CPGS01	14.00		C	2	14.00	LIMESTONE	D	U	YES	80.5	101.5	101.5	96.0	9.0	98.7	0.9	1.3	
R9CPGS01	14.15		C	2	14.15	LIMESTONE	A	U	NO		101.9	90.0	88.0	5.8	106.9	0.5	0.7	
R9CPGS01	14.50		C	2	14.50	LIMESTONE	A	U	NO		101.6	65.0	63.0	2.0	90.3	0.2	0.3	
R9CPGS01	15.35		C	2	15.35	LIMESTONE	D	U	NO	76.6	101.6	101.6	97.0	6.5	99.3	0.7	0.9	
R9CPGS01	15.85		C	2	15.85	LIMESTONE	A	U	NO		101.8	60.0	56.0	4.4	85.2	0.6	0.8	
R9CPGS01	17.20		C	2	17.20	LIMESTONE	D	U	NO	79.2	101.6	101.6	98.0	10.1	99.8	1.0	1.4	
R9CPGS01	17.40		C	2	17.40	LIMESTONE	D	U	NO	88.2	101.4	101.4	98.0	8.6	99.7	0.9	1.2	
R9CPGS02	13.35		C	2	13.35	LIMESTONE	A	U	NO		101.5	51.0	48.0	8.0	78.8	1.3	1.6	
R9CPGS02	13.70		C	2	13.70	LIMESTONE	D	U	YES	75.1	101.4	101.4	94.0	2.4	97.6	0.3	0.3	
R9CPGS02	13.90		C	2	13.90	LIMESTONE	A	U	NO		101.3	47.0	42.0	7.3	73.6	1.3	1.6	
R9CPGS02	14.10		C	2	14.10	LIMESTONE	A	U	NO		101.4	50.0	41.0	5.7	72.8	1.1	1.3	
R9CPGS02	14.65		C	2	14.65	LIMESTONE	D	U	YES	66.3	101.4	101.4	95.0	6.4	98.1	0.7	0.9	
R9CPGS02	15.10		C	2	15.10	LIMESTONE	D	U	NO	88.6	101.6	101.6	96.0	9.2	98.8	0.9	1.3	

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
16/11/2020

Approved By
Stephen.Watson

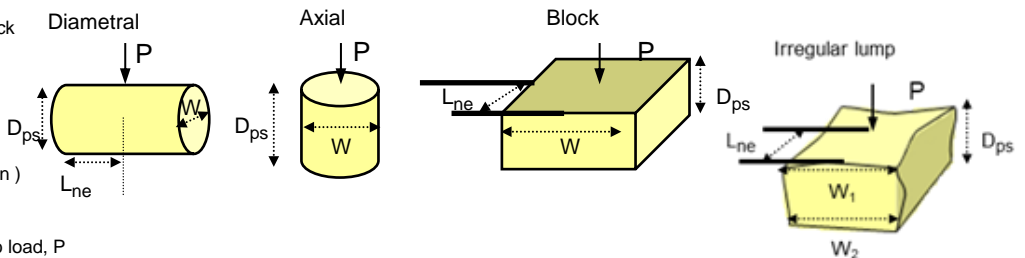


Point Load Strength Index Tests Summary of Results

Project No. 20-0399D	Project Name Bus Connects Route 9 Tallaght/Clondalkin to City Centre
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Borehole No.	Sample			Specimen		Rock Type	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P kN	Equivalent diameter, De mm	Point Load Strength Index		Remarks (including water content if measured)
	Depth m	Ref.	Type	Ref.	Depth m		Type (D, A, I, B)	Direction (L, P or U)		Lne mm	W mm	Dps mm	Dps' mm			Is MPa	Is(50) MPa	
R9CPGS02	15.40		C	2	15.40	LIMESTONE	D	U	YES	90.2	101.9	101.9	91.0	11.6	96.3	1.3	1.7	
R9CPGS02	15.70		C	2	15.70	LIMESTONE	A	U	NO		101.5	50.0	42.0	4.1	73.7	0.8	0.9	
R9CPGS02	16.10		C	2	16.10	LIMESTONE	A	U	NO		101.8	93.0	74.0	7.4	97.9	0.8	1.0	
R9CPGS02	16.75		C	2	16.75	LIMESTONE	D	U	NO	55.6	101.6	101.6	98.0	6.9	99.8	0.7	0.9	
R9CPGS02	17.05		C	2	17.05	LIMESTONE	D	U	NO	77.2	101.4	101.4	98.0	9.7	99.7	1.0	1.3	
R9CPGS03	11.50		C	3	11.50	LIMESTONE	D	U	YES	92.3	101.3	101.3	89.2	24.6	95.1	2.7	3.6	
R9CPGS03	11.50		C	4	11.55	LIMESTONE	A	U	YES		101.3	57.0	54.0	13.2	83.5	1.9	2.4	
R9CPGS03	12.00		C	2	12.00	LIMESTONE	A	U	NO		101.4	58.0	55.0	11.5	84.3	1.6	2.0	
R9CPGS03	12.40		C	2	12.40	LIMESTONE	A	U	NO		101.8	71.0	69.0	8.9	94.6	1.0	1.3	
R9CPGS03	12.70		C	2	12.70	LIMESTONE	D	U	YES	85.0	101.6	101.6	97.0	8.5	99.3	0.9	1.2	
R9CPGS03	12.95		C	2	12.95	LIMESTONE	A	U	YES		101.5	101.5	97.0	5.5	112.0	0.4	0.6	
R9CPGS03	13.80		C	2	13.80	LIMESTONE	D	U	YES	66.0	101.6	101.6	98.0	3.7	99.8	0.4	0.5	
R9CPGS03	14.10		C	2	14.10	LIMESTONE	A	U	NO		101.6	96.0	94.0	0.5	110.3	0.0	0.1	
R9CPGS03	14.55		C	2	14.55	LIMESTONE	A	U	NO		101.4	101.0	97.2	4.9	112.0	0.4	0.6	
R9CPGS03	14.65		C	2	14.65	LIMESTONE	D	U	YES	81.0	101.6	101.6	91.0	21.4	96.2	2.3	3.1	
R9CPGS03	15.40		C	2	15.40	LIMESTONE	A	U	YES		101.3	60.0	56.0	9.6	85.0	1.3	1.7	
R9CPGS03	15.60		C	2	15.60	LIMESTONE	D	U	NO	71.0	101.4	101.4	98.0	11.7	99.7	1.2	1.6	
R9CPGS04	11.15		C	2	11.15	LIMESTONE	D	U	NO	85.2	101.6	101.6	99.0	12.1	100.3	1.2	1.6	

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
16/11/2020

Approved By

Stephen.Watson





Final Report

Report No.: 20-29098-1
Initial Date of Issue: 02-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
Gabiella 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 20-0399D Bus Connects Route 9
Tallaght/Clondalkin to City Centre

Quotation No.:		Date Received:	28-Oct-2020
Order No.:		Date Instructed:	28-Oct-2020
No. of Samples:	16		
Turnaround (Wkdays):	5	Results Due:	03-Nov-2020
Date Approved:	02-Nov-2020		

Approved By:



Details: Glynn Harvey, Technical Manager

Results - Soil

Project: 20-0399D Bus Connects Route 9 Tallaght/Clondalkin to City Centre

Client: Causeway Geotech Ltd		Chemtest Job No.:		20-29098	20-29098	20-29098	20-29098	20-29098	20-29098	20-29098	20-29098	20-29098	
Quotation No.:	Chemtest Sample ID.:	1087486	1087487	1087488	1087489	1087490	1087491	1087492	1087493	1087494			
Order No.:	Client Sample Ref.:	6	6	22	6	20	10	12	8	9			
	Sample Location:	R9CP01	R9CP02	R9CP03	R9CP04	R9CP05	R9CPGS01	R9CPGS01	R9CPGS02	R9CPGS02			
	Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL			
	Top Depth (m):	1.00	1.00	5.00	1.00	2.00	2.00	4.00	1.00	2.00			
	Date Sampled:	27-Oct-2020	27-Oct-2020	27-Oct-2020	27-Oct-2020	27-Oct-2020	27-Oct-2020	27-Oct-2020	27-Oct-2020	27-Oct-2020			
Determinand	Accred.	SOP	Units	LOD									
Moisture	N	2030	%	0.020	11	16	9.5	13	16	12	14	11	8.4
pH	U	2010		4.0	8.6	8.5	8.6	8.6	8.4	8.8	8.8	8.7	8.4
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	0.12	< 0.010	0.057	< 0.010	1.5	< 0.010	< 0.010	< 0.010	0.12
Total Sulphur	U	2175	%	0.010					0.77	0.030		0.041	
Sulphate (Acid Soluble)	U	2430	%	0.010					1.9	0.050		0.039	

Results - Soil

Project: 20-0399D Bus Connects Route 9 Tallaght/Clondalkin to City Centre

Client: Causeway Geotech Ltd		Chemtest Job No.:		20-29098	20-29098	20-29098	20-29098	20-29098	20-29098	20-29098	
Quotation No.:	Chemtest Sample ID.:	1087495	1087496	1087497	1087498	1087499	1087500	1087501			
Order No.:	Client Sample Ref.:	12	8	10	7	11	2	2			
	Sample Location:	R9CPGS02	R9CPGS03	R9CPGS03	R9CPGS04	R9CPGS04	R9TP04	R9TP05			
	Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL			
	Top Depth (m):	5.00	2.00	4.00	1.00	5.00	1.00	1.00			
	Date Sampled:	27-Oct-2020	27-Oct-2020	27-Oct-2020	27-Oct-2020	27-Oct-2020	27-Oct-2020	27-Oct-2020			
Determinand	Accred.	SOP	Units	LOD							
Moisture	N	2030	%	0.020	5.5	10	12	13	6.7	13	10
pH	U	2010		4.0	11.3	10.1	8.7	9.1	9.0	8.7	8.5
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	0.65	0.010	< 0.010	0.013	< 0.010	< 0.010	0.095
Total Sulphur	U	2175	%	0.010		0.065		0.013		0.028	0.25
Sulphate (Acid Soluble)	U	2430	%	0.010		0.055		0.041		0.067	0.087

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
2175	Total Sulphur in Soils	Total Sulphur	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2430	Total Sulphate in soils	Total Sulphate	Acid digestion followed by determination of sulphate in extract by 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



Final Report

Report No.: 20-30004-1
Initial Date of Issue: 10-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
Gabiella 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 20-0399D Bus Connects Route 9

Quotation No.: **Date Received:** 05-Nov-2020

Order No.: **Date Instructed:** 05-Nov-2020

No. of Samples: 4

Turnaround (Wkdays): 5 **Results Due:** 11-Nov-2020

Date Approved: 10-Nov-2020

Approved By:

Details: Glynn Harvey, Technical Manager

Results - Soil

Project: 20-0399D Bus Connects Route 9

Client: Causeway Geotech Ltd		Chemtest Job No.:		20-30004	20-30004	20-30004	20-30004	
Quotation No.:		Chemtest Sample ID.:		1092175	1092176	1092177	1092178	
		Sample Location:		R9CPGS01	R9CPGS02	R9CPGS03	R9CPGS04	
		Sample Type:		SOIL	SOIL	SOIL	SOIL	
		Top Depth (m):		12.0	12.0	10.5	10.5	
		Bottom Depth (m):		13.5	13.5	12.0	12.0	
		Date Sampled:		04-Nov-2020	04-Nov-2020	04-Nov-2020	04-Nov-2020	
Determinand	Accred.	SOP	Units	LOD				
Moisture	N	2030	%	0.020	3.7	2.0	1.7	2.0
pH	U	2010		4.0	9.1	8.9	9.2	8.8
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	< 0.010	< 0.010	< 0.010	0.090

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
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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
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I/S	Insufficient Sample
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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



Final Report

Report No.: 20-30603-1
Initial Date of Issue: 16-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
Gabiella 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 20-0399D ROUTE 9 Tallaght/
Clondalkin to City Centre

Quotation No.:		Date Received:	11-Nov-2020
Order No.:		Date Instructed:	11-Nov-2020
No. of Samples:	1		
Turnaround (Wkdays):	5	Results Due:	17-Nov-2020
Date Approved:	16-Nov-2020		

Approved By:

Details: Glynn Harvey, Technical Manager

Results - Soil

Project: 20-0399D ROUTE 9 Tallaght/Clondalkin to City Centre

Client: Causeway Geotech Ltd	Chemtest Job No.:	20-30603			
Quotation No.:	Chemtest Sample ID.:	1095074			
Order No.:	Client Sample Ref.:	2			
	Sample Location:	R9CP06			
	Sample Type:	SOIL			
	Top Depth (m):	1.00			
	Date Sampled:	09-Nov-2020			
Determinand	Accred.	SOP	Units	LOD	
Moisture	N	2030	%	0.020	11
pH	U	2010		4.0	8.8
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	< 0.010
Total Sulphur	U	2175	%	0.010	0.024
Sulphate (Acid Soluble)	U	2430	%	0.010	0.019

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
2175	Total Sulphur in Soils	Total Sulphur	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2430	Total Sulphate in soils	Total Sulphate	Acid digestion followed by determination of sulphate in extract by 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	20-0399D	To	Sean Ross
Project Name	Bus Connects Route 9 - Tallaght/Clondalkin to City Centre	Position	Project Manager
TR reference	20-0399D / 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			
R9CP GS02		10.50	C	UU Triaxial	Insufficient intact material to obtain test specimen	CANCEL

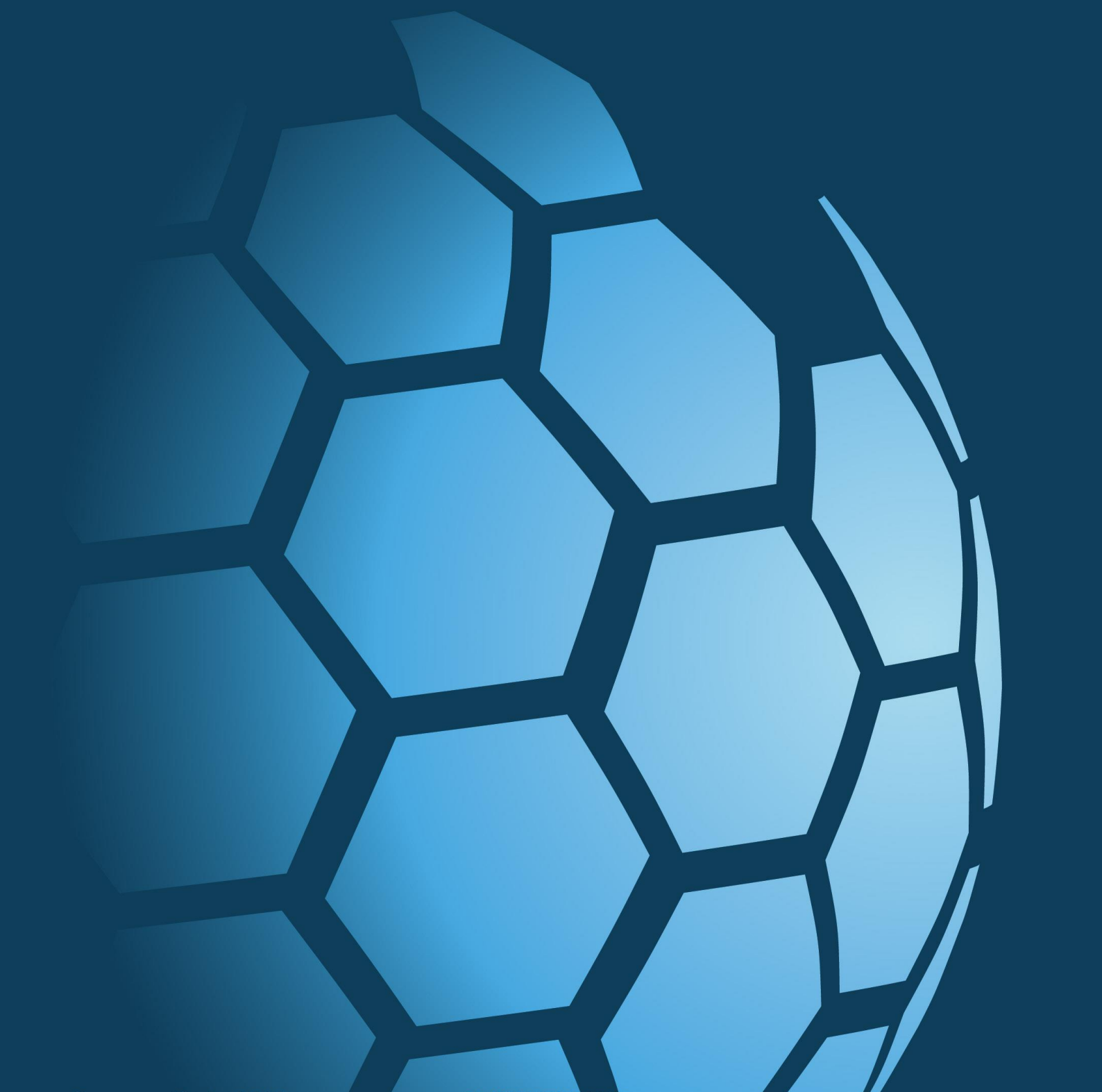
For electronic reporting a form of electronic signature or printed name is acceptable

Laboratory Signature Joseph Nicholl	Project Manager Signature Sean Ross
Date 04 November 2020	Date



CAUSEWAY
— GEOTECH

APPENDIX H
ENVIRONMENTAL LABORATORY TEST RESULTS





Final Report

Report No.: 20-26467-1
Initial Date of Issue: 12-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
Gabiella 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 20-0399D Bus Connects-Greenhills

Quotation No.: Q20-21063 **Date Received:** 01-Oct-2020

Order No.: **Date Instructed:** 05-Oct-2020

No. of Samples: 1

Turnaround (Wkdays): 5 **Results Due:** 09-Oct-2020

Date Approved: 12-Oct-2020

Approved By:

Details: Glynn Harvey, Technical Manager

Results - Leachate

Project: 20-0399D Bus Connects-Greenhills

Client: Causeway Geotech Ltd	Chemtest Job No.: 20-26467				
Quotation No.: Q20-21063	Chemtest Sample ID.: 1073480				
	Sample Location: R9CP01				
	Sample Type: SOIL				
	Top Depth (m): 0.50				
	Date Sampled: 29-Sep-2020				
Determinand	Accred.	SOP	Type	Units	LOD
Ammonium	U	1220	10:1	mg/l	0.050
Ammonium	N	1220	10:1	mg/kg	0.10

Results - Soil

Project: 20-0399D Bus Connects-Greenhills

Client: Causeway Geotech Ltd		Chemtest Job No.:		20-26467	
Quotation No.: Q20-21063		Chemtest Sample ID.:		1073480	
		Sample Location:		R9CP01	
		Sample Type:		SOIL	
		Top Depth (m):		0.50	
		Date Sampled:		29-Sep-2020	
		Asbestos Lab:		COVENTRY	
Determinand	Accred.	SOP	Units	LOD	
ACM Type	U	2192		N/A	-
Asbestos Identification	U	2192		N/A	No Asbestos Detected
ACM Detection Stage	U	2192		N/A	-
Moisture	N	2030	%	0.020	10
pH	M	2010		4.0	8.9
Boron (Hot Water Soluble)	M	2120	mg/kg	0.40	< 0.40
Sulphur (Elemental)	M	2180	mg/kg	1.0	1.5
Cyanide (Total)	M	2300	mg/kg	0.50	< 0.50
Sulphide (Easily Liberatable)	N	2325	mg/kg	0.50	8.7
Sulphate (Total)	M	2430	%	0.010	0.024
Arsenic	M	2450	mg/kg	1.0	5.4
Barium	M	2450	mg/kg	10	22
Cadmium	M	2450	mg/kg	0.10	0.85
Chromium	M	2450	mg/kg	1.0	7.1
Molybdenum	M	2450	mg/kg	2.0	< 2.0
Antimony	N	2450	mg/kg	2.0	< 2.0
Copper	M	2450	mg/kg	0.50	12
Mercury	M	2450	mg/kg	0.10	< 0.10
Nickel	M	2450	mg/kg	0.50	20
Lead	M	2450	mg/kg	0.50	8.7
Selenium	M	2450	mg/kg	0.20	0.22
Zinc	M	2450	mg/kg	0.50	35
Chromium (Trivalent)	N	2490	mg/kg	1.0	7.1
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50
Total Organic Carbon	M	2625	%	0.20	0.49
Mineral Oil	N	2670	mg/kg	10	< 10
Aliphatic TPH >C5-C6	N	2680	mg/kg	1.0	< 1.0
Aliphatic TPH >C6-C8	N	2680	mg/kg	1.0	< 1.0
Aliphatic TPH >C8-C10	M	2680	mg/kg	1.0	< 1.0
Aliphatic TPH >C10-C12	M	2680	mg/kg	1.0	< 1.0
Aliphatic TPH >C12-C16	M	2680	mg/kg	1.0	< 1.0
Aliphatic TPH >C16-C21	M	2680	mg/kg	1.0	< 1.0
Aliphatic TPH >C21-C35	M	2680	mg/kg	1.0	< 1.0
Aliphatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0
Total Aliphatic Hydrocarbons	N	2680	mg/kg	5.0	< 5.0
Aromatic TPH >C5-C7	N	2680	mg/kg	1.0	< 1.0
Aromatic TPH >C7-C8	N	2680	mg/kg	1.0	< 1.0
Aromatic TPH >C8-C10	M	2680	mg/kg	1.0	< 1.0

Results - Soil

Project: 20-0399D Bus Connects-Greenhills

Client: Causeway Geotech Ltd		Chemtest Job No.:		20-26467	
Quotation No.: Q20-21063		Chemtest Sample ID.:		1073480	
		Sample Location:		R9CP01	
		Sample Type:		SOIL	
		Top Depth (m):		0.50	
		Date Sampled:		29-Sep-2020	
		Asbestos Lab:		COVENTRY	
Determinand	Accred.	SOP	Units	LOD	
Aromatic TPH >C10-C12	M	2680	mg/kg	1.0	< 1.0
Aromatic TPH >C12-C16	M	2680	mg/kg	1.0	< 1.0
Aromatic TPH >C16-C21	U	2680	mg/kg	1.0	< 1.0
Aromatic TPH >C21-C35	M	2680	mg/kg	1.0	< 1.0
Aromatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0
Total Aromatic Hydrocarbons	N	2680	mg/kg	5.0	< 5.0
Total Petroleum Hydrocarbons	N	2680	mg/kg	10.0	< 10
Benzene	M	2760	µg/kg	1.0	< 1.0
Toluene	M	2760	µg/kg	1.0	< 1.0
Ethylbenzene	M	2760	µg/kg	1.0	< 1.0
m & p-Xylene	M	2760	µg/kg	1.0	< 1.0
o-Xylene	M	2760	µg/kg	1.0	< 1.0
Methyl Tert-Butyl Ether	M	2760	µg/kg	1.0	< 1.0
Naphthalene	M	2800	mg/kg	0.10	< 0.10
Acenaphthylene	N	2800	mg/kg	0.10	< 0.10
Acenaphthene	M	2800	mg/kg	0.10	< 0.10
Fluorene	M	2800	mg/kg	0.10	< 0.10
Phenanthrene	M	2800	mg/kg	0.10	< 0.10
Anthracene	M	2800	mg/kg	0.10	< 0.10
Fluoranthene	M	2800	mg/kg	0.10	< 0.10
Pyrene	M	2800	mg/kg	0.10	< 0.10
Benzo[a]anthracene	M	2800	mg/kg	0.10	< 0.10
Chrysene	M	2800	mg/kg	0.10	< 0.10
Benzo[b]fluoranthene	M	2800	mg/kg	0.10	< 0.10
Benzo[k]fluoranthene	M	2800	mg/kg	0.10	< 0.10
Benzo[a]pyrene	M	2800	mg/kg	0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	M	2800	mg/kg	0.10	< 0.10
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10	< 0.10
Benzo[g,h,i]perylene	M	2800	mg/kg	0.10	< 0.10
Coronene	N	2800	mg/kg	0.10	< 0.10
Total Of 17 PAH's	N	2800	mg/kg	2.0	< 2.0
PCB 28	U	2815	mg/kg	0.010	< 0.010
PCB 52	U	2815	mg/kg	0.010	< 0.010
PCB 90+101	U	2815	mg/kg	0.010	< 0.010
PCB 118	U	2815	mg/kg	0.010	< 0.010
PCB 153	U	2815	mg/kg	0.010	< 0.010
PCB 138	U	2815	mg/kg	0.010	< 0.010
PCB 180	U	2815	mg/kg	0.010	< 0.010
Total PCBs (7 Congeners)	U	2815	mg/kg	0.10	< 0.10

Results - Soil

Project: 20-0399D Bus Connects-Greenhills

Client: Causeway Geotech Ltd	Chemtest Job No.: 20-26467				
Quotation No.: Q20-21063	Chemtest Sample ID.: 1073480				
	Sample Location:		R9CP01		
	Sample Type:		SOIL		
	Top Depth (m):		0.50		
	Date Sampled:		29-Sep-2020		
	Asbestos Lab:		COVENTRY		
Determinand	Accred.	SOP	Units	LOD	
Total Phenols	M	2920	mg/kg	0.30	< 0.30

Results - Single Stage WAC

Project: 20-0399D Bus Connects-Greenhills

Chemtest Job No: 20-26467				Landfill Waste Acceptance Criteria Limits			
Chemtest Sample ID: 1073480							
Sample Ref:							
Sample ID:							
Sample Location: R9CP01							
Top Depth(m): 0.50							
Bottom Depth(m):				Inert Waste Landfill	Stable, Non-reactive hazardous waste in non-hazardous Landfill	Hazardous Waste Landfill	
Sampling Date: 29-Sep-2020							
Determinand	SOP	Accred.	Units				
Total Organic Carbon	2625	M	%	0.49	3	5	6
Loss On Ignition	2610	M	%	2.7	--	--	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	2800	N	mg/kg	< 2.0	100	--	--
pH	2010	M		8.9	--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg	0.13	--	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	0.0054	< 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	< 0.0010	< 0.050	2	50	100
Mercury	1450	U	< 0.00050	< 0.0050	0.01	0.2	2
Molybdenum	1450	U	0.0036	< 0.050	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	< 0.0010	< 0.010	0.1	0.5	7
Zinc	1450	U	< 0.0010	< 0.50	4	50	200
Chloride	1220	U	< 1.0	< 10	800	15000	25000
Fluoride	1220	U	< 0.050	< 1.0	10	150	500
Sulphate	1220	U	< 1.0	< 10	1000	20000	50000
Total Dissolved Solids	1020	N	290	2900	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	U	3.7	< 50	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.

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.
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
2015	Acid Neutralisation Capacity	Acid Reserve	Titration
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
2180	Sulphur (Elemental) in Soils by HPLC	Sulphur	Dichloromethane extraction / HPLC with UV detection
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2300	Cyanides & Thiocyanate in Soils	Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Alkaline extraction followed by colorimetric determination using Automated Flow Injection Analyser.
2325	Sulphide in Soils	Sulphide	Steam distillation with sulphuric acid / analysis by 'Aquakem 600' Discrete Analyser, using N,N-dimethyl-p-phenylenediamine.
2430	Total Sulphate in soils	Total Sulphate	Acid digestion followed by determination of sulphate in extract by ICP-OES.
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.
2490	Hexavalent Chromium in Soils	Chromium [VI]	Soil extracts are prepared by extracting dried and ground soil samples into boiling water. Chromium [VI] is determined by 'Aquakem 600' Discrete Analyser using 1,5-diphenylcarbazide.
2610	Loss on Ignition	loss on ignition (LOI)	Determination of the proportion by mass that is lost from a soil by ignition at 550°C.
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
2680	TPH A/A Split	Aliphatics: >C5–C6, >C6–C8, >C8–C10, >C10–C12, >C12–C16, >C16–C21, >C21–C35, >C35–C44 Aromatics: >C5–C7, >C7–C8, >C8–C10, >C10–C12, >C12–C16, >C16–C21, >C21–C35, >C35–C44	Dichloromethane extraction / GCxGC FID detection

Test Methods

SOP	Title	Parameters included	Method summary
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.
2800	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil 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*	Dichloromethane extraction / GC-MS
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
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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



Final Report

Report No.: 20-26886-1
Initial Date of Issue: 14-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
Gabiella 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 20-0399D Bus Connects Route 9

Quotation No.: Q20-21063

Date Received: 06-Oct-2020

Order No.:

Date Instructed: 08-Oct-2020

No. of Samples: 1

Turnaround (Wkdays): 5

Results Due: 14-Oct-2020

Date Approved: 14-Oct-2020

Approved By:

Details: Glynn Harvey, Technical Manager

Results - Soil

Project: 20-0399D Bus Connects Route 9

Client: Causeway Geotech Ltd		Chemtest Job No.:		20-26886	
Quotation No.: Q20-21063		Chemtest Sample ID.:		1075650	
		Sample Location:		R9-CPGS02	
		Sample Type:		SOIL	
		Top Depth (m):		2.00	
		Date Sampled:		03-Oct-2020	
		Asbestos Lab:		COVENTRY	
Determinand	Accred.	SOP	Units	LOD	
ACM Type	U	2192		N/A	-
Asbestos Identification	U	2192		N/A	No Asbestos Detected
ACM Detection Stage	U	2192		N/A	-
Moisture	N	2030	%	0.020	9.9
pH	U	2010		4.0	8.6
Boron (Hot Water Soluble)	U	2120	mg/kg	0.40	< 0.40
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	< 0.010
Cyanide (Total)	U	2300	mg/kg	0.50	< 0.50
Arsenic	U	2450	mg/kg	1.0	24
Cadmium	U	2450	mg/kg	0.10	1.7
Chromium	U	2450	mg/kg	1.0	15
Copper	U	2450	mg/kg	0.50	25
Mercury	U	2450	mg/kg	0.10	0.22
Nickel	U	2450	mg/kg	0.50	60
Lead	U	2450	mg/kg	0.50	37
Zinc	U	2450	mg/kg	0.50	83
Organic Matter	U	2625	%	0.40	< 0.40
Total TPH >C6-C40	U	2670	mg/kg	10	< 10
Naphthalene	U	2700	mg/kg	0.10	< 0.10
Acenaphthylene	U	2700	mg/kg	0.10	< 0.10
Acenaphthene	U	2700	mg/kg	0.10	< 0.10
Fluorene	U	2700	mg/kg	0.10	< 0.10
Phenanthrene	U	2700	mg/kg	0.10	< 0.10
Anthracene	U	2700	mg/kg	0.10	< 0.10
Fluoranthene	U	2700	mg/kg	0.10	< 0.10
Pyrene	U	2700	mg/kg	0.10	< 0.10
Benzo[a]anthracene	U	2700	mg/kg	0.10	< 0.10
Chrysene	U	2700	mg/kg	0.10	< 0.10
Benzo[b]fluoranthene	U	2700	mg/kg	0.10	< 0.10
Benzo[k]fluoranthene	U	2700	mg/kg	0.10	< 0.10
Benzo[a]pyrene	U	2700	mg/kg	0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	U	2700	mg/kg	0.10	< 0.10
Dibenz(a,h)Anthracene	U	2700	mg/kg	0.10	< 0.10
Benzo[g,h,i]perylene	U	2700	mg/kg	0.10	< 0.10
Coronene	N	2700	mg/kg	0.10	< 0.10
Total Of 17 PAH's	N	2700	mg/kg	2.0	< 2.0
Total Phenols	U	2920	mg/kg	0.30	< 0.30

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
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2300	Cyanides & Thiocyanate in Soils	Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Alkaline 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)
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.

Report Information

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U	UKAS accredited
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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



Final Report

Report No.: 20-27122-1
Initial Date of Issue: 15-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
Gabiella 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 20-0399D Bus Connects Route 9

Quotation No.: Q20-21063

Date Received: 08-Oct-2020

Order No.:

Date Instructed: 09-Oct-2020

No. of Samples: 1

Turnaround (Wkdays): 5

Results Due: 15-Oct-2020

Date Approved: 15-Oct-2020

Approved By:

Details: Glynn Harvey, Technical Manager

Results - Soil

Project: 20-0399D Bus Connects Route 9

Client: Causeway Geotech Ltd		Chemtest Job No.:		20-27122	
Quotation No.: Q20-21063		Chemtest Sample ID.:		1077012	
		Sample Location:		R9-CP04	
		Sample Type:		SOIL	
		Top Depth (m):		1.50	
		Date Sampled:		05-Oct-2020	
		Asbestos Lab:		COVENTRY	
Determinand	Accred.	SOP	Units	LOD	
ACM Type	U	2192		N/A	-
Asbestos Identification	U	2192		N/A	No Asbestos Detected
ACM Detection Stage	U	2192		N/A	-
Moisture	N	2030	%	0.020	19
pH	U	2010		4.0	8.3
Boron (Hot Water Soluble)	U	2120	mg/kg	0.40	1.2
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	0.10
Cyanide (Total)	U	2300	mg/kg	0.50	< 0.50
Arsenic	U	2450	mg/kg	1.0	25
Cadmium	U	2450	mg/kg	0.10	1.8
Chromium	U	2450	mg/kg	1.0	23
Copper	U	2450	mg/kg	0.50	65
Mercury	U	2450	mg/kg	0.10	0.24
Nickel	U	2450	mg/kg	0.50	60
Lead	U	2450	mg/kg	0.50	87
Zinc	U	2450	mg/kg	0.50	140
Organic Matter	U	2625	%	0.40	2.2
Total TPH >C6-C40	U	2670	mg/kg	10	< 10
Naphthalene	U	2700	mg/kg	0.10	< 0.10
Acenaphthylene	U	2700	mg/kg	0.10	< 0.10
Acenaphthene	U	2700	mg/kg	0.10	< 0.10
Fluorene	U	2700	mg/kg	0.10	< 0.10
Phenanthrene	U	2700	mg/kg	0.10	< 0.10
Anthracene	U	2700	mg/kg	0.10	< 0.10
Fluoranthene	U	2700	mg/kg	0.10	< 0.10
Pyrene	U	2700	mg/kg	0.10	< 0.10
Benzo[a]anthracene	U	2700	mg/kg	0.10	< 0.10
Chrysene	U	2700	mg/kg	0.10	< 0.10
Benzo[b]fluoranthene	U	2700	mg/kg	0.10	< 0.10
Benzo[k]fluoranthene	U	2700	mg/kg	0.10	< 0.10
Benzo[a]pyrene	U	2700	mg/kg	0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	U	2700	mg/kg	0.10	< 0.10
Dibenz(a,h)Anthracene	U	2700	mg/kg	0.10	< 0.10
Benzo[g,h,i]perylene	U	2700	mg/kg	0.10	< 0.10
Coronene	N	2700	mg/kg	0.10	< 0.10
Total Of 17 PAH's	N	2700	mg/kg	2.0	< 2.0
Total Phenols	U	2920	mg/kg	0.30	< 0.30

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
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2300	Cyanides & Thiocyanate in Soils	Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Alkaline 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)
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.

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



Final Report

Report No.: 20-27377-1
Initial Date of Issue: 19-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
Gabiella 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 20-0399D Bus Connects Route 9

Quotation No.: Q20-21063

Date Received: 09-Oct-2020

Order No.:

Date Instructed: 13-Oct-2020

No. of Samples: 1

Turnaround (Wkdays): 5

Results Due: 19-Oct-2020

Date Approved: 19-Oct-2020

Approved By:

Details: Glynn Harvey, Technical Manager

Results - Soil

Project: 20-0399D Bus Connects Route 9

Client: Causeway Geotech Ltd	Chemtest Job No.:				20-27377
Quotation No.: Q20-21063	Chemtest Sample ID.:				1078413
	Sample Location:				R9-CP08
	Sample Type:				SOIL
	Top Depth (m):				1.50
	Date Sampled:				07-Oct-2020
	Asbestos Lab:				COVENTRY
Determinand	Accred.	SOP	Units	LOD	
ACM Type	U	2192		N/A	-
Asbestos Identification	U	2192		N/A	No Asbestos Detected
ACM Detection Stage	U	2192		N/A	-
Moisture	N	2030	%	0.020	11
pH	U	2010		4.0	8.6
Boron (Hot Water Soluble)	U	2120	mg/kg	0.40	1.7
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	0.13
Cyanide (Total)	U	2300	mg/kg	0.50	< 0.50
Arsenic	U	2450	mg/kg	1.0	25
Cadmium	U	2450	mg/kg	0.10	2.5
Chromium	U	2450	mg/kg	1.0	19
Copper	U	2450	mg/kg	0.50	32
Mercury	U	2450	mg/kg	0.10	< 0.10
Nickel	U	2450	mg/kg	0.50	60
Lead	U	2450	mg/kg	0.50	54
Zinc	U	2450	mg/kg	0.50	86
Organic Matter	U	2625	%	0.40	0.67
Total TPH >C6-C40	U	2670	mg/kg	10	< 10
Naphthalene	U	2700	mg/kg	0.10	< 0.10
Acenaphthylene	U	2700	mg/kg	0.10	< 0.10
Acenaphthene	U	2700	mg/kg	0.10	< 0.10
Fluorene	U	2700	mg/kg	0.10	< 0.10
Phenanthrene	U	2700	mg/kg	0.10	< 0.10
Anthracene	U	2700	mg/kg	0.10	< 0.10
Fluoranthene	U	2700	mg/kg	0.10	< 0.10
Pyrene	U	2700	mg/kg	0.10	< 0.10
Benzo[a]anthracene	U	2700	mg/kg	0.10	< 0.10
Chrysene	U	2700	mg/kg	0.10	< 0.10
Benzo[b]fluoranthene	U	2700	mg/kg	0.10	< 0.10
Benzo[k]fluoranthene	U	2700	mg/kg	0.10	< 0.10
Benzo[a]pyrene	U	2700	mg/kg	0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	U	2700	mg/kg	0.10	< 0.10
Dibenz(a,h)Anthracene	U	2700	mg/kg	0.10	< 0.10
Benzo[g,h,i]perylene	U	2700	mg/kg	0.10	< 0.10
Coronene	N	2700	mg/kg	0.10	< 0.10
Total Of 17 PAH's	N	2700	mg/kg	2.0	< 2.0
Total Phenols	U	2920	mg/kg	0.30	< 0.30

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
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2300	Cyanides & Thiocyanate in Soils	Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Alkaline extraction followed by colorimetric determination using Automated Flow Injection Analyser.
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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)
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.

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customerservices@chemtest.com



Final Report

Report No.: 20-27524-1
Initial Date of Issue: 19-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
Gabiella 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 20-0399D Bus Connects Route 9

Quotation No.: Q20-21063 **Date Received:** 12-Oct-2020

Order No.: **Date Instructed:** 13-Oct-2020

No. of Samples: 6

Turnaround (Wkdays): 5 **Results Due:** 19-Oct-2020

Date Approved: 19-Oct-2020

Approved By:

Details: Glynn Harvey, Technical Manager

Results - Leachate

Project: 20-0399D Bus Connects Route 9

Client: Causeway Geotech Ltd	Chemtest Job No.:					20-27524	20-27524
Quotation No.: Q20-21063	Chemtest Sample ID.:					1079225	1079230
	Sample Location:					TP05	TP09
	Sample Type:					SOIL	SOIL
	Top Depth (m):					1.00	1.00
	Date Sampled:					08-Oct-2020	09-Oct-2020
Determinand	Accred.	SOP	Type	Units	LOD		
Ammonium	U	1220	10:1	mg/l	0.050	0.056	0.066
Ammonium	N	1220	10:1	mg/kg	0.10	0.71	0.78

Results - Soil

Project: 20-0399D Bus Connects Route 9

Client: Causeway Geotech Ltd	Chemtest Job No.:		20-27524	20-27524	20-27524	20-27524	20-27524	20-27524	20-27524
Quotation No.: Q20-21063	Chemtest Sample ID.:		1079222	1079225	1079227	1079230	1079232	1079240	
	Sample Location:		TP04	TP05	TP06	TP09	TP09	TP11	
	Sample Type:		SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
	Top Depth (m):		1.50	1.00	0.50	1.00	2.00	1.00	
	Date Sampled:		08-Oct-2020	08-Oct-2020	08-Oct-2020	09-Oct-2020	09-Oct-2020	08-Oct-2020	
	Asbestos Lab:		COVENTRY	COVENTRY	COVENTRY	DURHAM	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	No Asbestos Detected	No Asbestos Detected
ACM Detection Stage	U	2192		N/A	-	-	-	-	-
Moisture	N	2030	%	0.020	10	13	9.5	10	23
pH	M	2010		4.0	8.7	8.6	8.5	8.8	8.3
Boron (Hot Water Soluble)	M	2120	mg/kg	0.40	0.67	0.44	0.48	0.72	1.5
Sulphate (2:1 Water Soluble) as SO4	M	2120	g/l	0.010	< 0.010		0.13		0.24
Sulphur (Elemental)	M	2180	mg/kg	1.0		3.7		7.3	
Cyanide (Total)	M	2300	mg/kg	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Sulphide (Easily Liberatable)	N	2325	mg/kg	0.50		13		9.9	
Sulphate (Total)	M	2430	%	0.010		0.071		0.13	
Arsenic	M	2450	mg/kg	1.0	14	18	35	25	86
Barium	M	2450	mg/kg	10		80		350	
Cadmium	M	2450	mg/kg	0.10	2.2	1.4	1.8	1.4	1.2
Chromium	M	2450	mg/kg	1.0	18	17	21	17	81
Molybdenum	M	2450	mg/kg	2.0		2.1		4.6	
Antimony	N	2450	mg/kg	2.0		< 2.0		3.8	
Copper	M	2450	mg/kg	0.50	25	30	38	61	280
Mercury	M	2450	mg/kg	0.10	< 0.10	0.20	0.25	0.43	0.51
Nickel	M	2450	mg/kg	0.50	40	37	46	44	120
Lead	M	2450	mg/kg	0.50	36	92	90	130	710
Selenium	M	2450	mg/kg	0.20		0.36		0.34	
Zinc	M	2450	mg/kg	0.50	95	85	280	340	570
Chromium (Trivalent)	N	2490	mg/kg	1.0		17		17	
Chromium (Hexavalent)	N	2490	mg/kg	0.50		< 0.50		< 0.50	
Organic Matter	M	2625	%	0.40	1.7		2.8		19
Total Organic Carbon	M	2625	%	0.20		1.9		3.3	
Mineral Oil	N	2670	mg/kg	10		< 10		24	
Total TPH >C6-C40	M	2670	mg/kg	10	< 10		55		860
Aliphatic TPH >C5-C6	N	2680	mg/kg	1.0		< 1.0		< 1.0	
Aliphatic TPH >C6-C8	N	2680	mg/kg	1.0		< 1.0		< 1.0	
Aliphatic TPH >C8-C10	M	2680	mg/kg	1.0		< 1.0		6.2	
Aliphatic TPH >C10-C12	M	2680	mg/kg	1.0		< 1.0		2.3	
Aliphatic TPH >C12-C16	M	2680	mg/kg	1.0		< 1.0		1.4	
Aliphatic TPH >C16-C21	M	2680	mg/kg	1.0		< 1.0		1.2	
Aliphatic TPH >C21-C35	M	2680	mg/kg	1.0		< 1.0		11	
Aliphatic TPH >C35-C44	N	2680	mg/kg	1.0		< 1.0		1.9	
Total Aliphatic Hydrocarbons	N	2680	mg/kg	5.0		< 5.0		24	

Results - Soil

Project: 20-0399D Bus Connects Route 9

Client: Causeway Geotech Ltd	Chemtest Job No.:		20-27524	20-27524	20-27524	20-27524	20-27524	20-27524
Quotation No.: Q20-21063	Chemtest Sample ID.:		1079222	1079225	1079227	1079230	1079232	1079240
	Sample Location:		TP04	TP05	TP06	TP09	TP09	TP11
	Sample Type:		SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
	Top Depth (m):		1.50	1.00	0.50	1.00	2.00	1.00
	Date Sampled:		08-Oct-2020	08-Oct-2020	08-Oct-2020	09-Oct-2020	09-Oct-2020	08-Oct-2020
	Asbestos Lab:		COVENTRY	COVENTRY	COVENTRY	DURHAM	COVENTRY	COVENTRY
Determinand	Accred.	SOP	Units	LOD				
Aromatic TPH >C5-C7	N	2680	mg/kg	1.0		< 1.0	< 1.0	
Aromatic TPH >C7-C8	N	2680	mg/kg	1.0		< 1.0	< 1.0	
Aromatic TPH >C8-C10	M	2680	mg/kg	1.0		< 1.0	1.2	
Aromatic TPH >C10-C12	M	2680	mg/kg	1.0		< 1.0	1.3	
Aromatic TPH >C12-C16	M	2680	mg/kg	1.0		< 1.0	2.2	
Aromatic TPH >C16-C21	U	2680	mg/kg	1.0		< 1.0	5.3	
Aromatic TPH >C21-C35	M	2680	mg/kg	1.0		< 1.0	57	
Aromatic TPH >C35-C44	N	2680	mg/kg	1.0		< 1.0	3.7	
Total Aromatic Hydrocarbons	N	2680	mg/kg	5.0		< 5.0	71	
Total Petroleum Hydrocarbons	N	2680	mg/kg	10.0		< 10	94	
Naphthalene	M	2700	mg/kg	0.10	< 0.10		0.32	< 0.10
Acenaphthylene	M	2700	mg/kg	0.10	< 0.10		0.33	< 0.10
Acenaphthene	M	2700	mg/kg	0.10	< 0.10		1.3	< 0.10
Fluorene	M	2700	mg/kg	0.10	< 0.10		1.4	< 0.10
Phenanthrene	M	2700	mg/kg	0.10	< 0.10		7.7	< 0.10
Anthracene	M	2700	mg/kg	0.10	< 0.10		2.7	< 0.10
Fluoranthene	M	2700	mg/kg	0.10	< 0.10		11	1.6
Pyrene	M	2700	mg/kg	0.10	< 0.10		10	2.8
Benzo[a]anthracene	M	2700	mg/kg	0.10	< 0.10		4.9	1.6
Chrysene	M	2700	mg/kg	0.10	< 0.10		4.3	1.5
Benzo[b]fluoranthene	M	2700	mg/kg	0.10	< 0.10		6.2	3.7
Benzo[k]fluoranthene	M	2700	mg/kg	0.10	< 0.10		2.8	1.8
Benzo[a]pyrene	M	2700	mg/kg	0.10	< 0.10		5.3	3.0
Indeno(1,2,3-c,d)Pyrene	M	2700	mg/kg	0.10	< 0.10		3.1	2.2
Dibenz(a,h)Anthracene	M	2700	mg/kg	0.10	< 0.10		1.9	1.9
Benzo[g,h,i]perylene	M	2700	mg/kg	0.10	< 0.10		3.1	2.6
Coronene	N	2700	mg/kg	0.10	< 0.10		< 0.10	< 0.10
Total Of 17 PAH's	N	2700	mg/kg	2.0	< 2.0		66	23
Benzene	M	2760	µg/kg	1.0		< 1.0		< 1.0
Toluene	M	2760	µg/kg	1.0		< 1.0		< 1.0
Ethylbenzene	M	2760	µg/kg	1.0		< 1.0		< 1.0
m & p-Xylene	M	2760	µg/kg	1.0		< 1.0		< 1.0
o-Xylene	M	2760	µg/kg	1.0		< 1.0		< 1.0
Methyl Tert-Butyl Ether	M	2760	µg/kg	1.0		< 1.0		< 1.0
Naphthalene	M	2800	mg/kg	0.10		< 0.10		0.16
Acenaphthylene	N	2800	mg/kg	0.10		< 0.10		0.10
Acenaphthene	M	2800	mg/kg	0.10		< 0.10		0.11
Fluorene	M	2800	mg/kg	0.10		< 0.10		0.13
Phenanthrene	M	2800	mg/kg	0.10		< 0.10		1.4

Results - Soil

Project: 20-0399D Bus Connects Route 9

Client: Causeway Geotech Ltd		Chemtest Job No.:		20-27524	20-27524	20-27524	20-27524	20-27524	20-27524
Quotation No.: Q20-21063		Chemtest Sample ID.:		1079222	1079225	1079227	1079230	1079232	1079240
Sample Location:		TP04	TP05	TP06	TP09	TP09	TP11		
Sample Type:		SOIL	SOIL	SOIL	SOIL	SOIL	SOIL		
Top Depth (m):		1.50	1.00	0.50	1.00	2.00	1.00		
Date Sampled:		08-Oct-2020	08-Oct-2020	08-Oct-2020	09-Oct-2020	09-Oct-2020	08-Oct-2020		
Asbestos Lab:		COVENTRY	COVENTRY	COVENTRY	DURHAM	COVENTRY	COVENTRY		
Determinand	Accred.	SOP	Units	LOD					
Anthracene	M	2800	mg/kg	0.10		< 0.10		0.34	
Fluoranthene	M	2800	mg/kg	0.10		0.19		3.7	
Pyrene	M	2800	mg/kg	0.10		0.17		3.3	
Benzo[a]anthracene	M	2800	mg/kg	0.10		0.18		2.4	
Chrysene	M	2800	mg/kg	0.10		0.18		2.1	
Benzo[b]fluoranthene	M	2800	mg/kg	0.10		0.27		3.3	
Benzo[k]fluoranthene	M	2800	mg/kg	0.10		0.19		1.4	
Benzo[a]pyrene	M	2800	mg/kg	0.10		0.26		3.2	
Indeno(1,2,3-c,d)Pyrene	M	2800	mg/kg	0.10		0.43		3.2	
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10		0.41		0.67	
Benzo[g,h,i]perylene	M	2800	mg/kg	0.10		0.43		2.6	
Coronene	N	2800	mg/kg	0.10		< 0.10		< 0.10	
Total Of 17 PAH's	N	2800	mg/kg	2.0		2.7		28	
PCB 28	U	2815	mg/kg	0.010		< 0.010		< 0.010	
PCB 52	U	2815	mg/kg	0.010		< 0.010		< 0.010	
PCB 90+101	U	2815	mg/kg	0.010		< 0.010		< 0.010	
PCB 118	U	2815	mg/kg	0.010		< 0.010		< 0.010	
PCB 153	U	2815	mg/kg	0.010		< 0.010		< 0.010	
PCB 138	U	2815	mg/kg	0.010		< 0.010		< 0.010	
PCB 180	U	2815	mg/kg	0.010		< 0.010		< 0.010	
Total PCBs (7 Congeners)	U	2815	mg/kg	0.10		< 0.10		< 0.10	
Total Phenols	M	2920	mg/kg	0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30

Results - Single Stage WAC

Project: 20-0399D Bus Connects Route 9

Chemtest Job No: 20-27524					Landfill Waste Acceptance Criteria Limits		
Chemtest Sample ID: 1079225					Inert Waste Landfill	Stable, Non-reactive hazardous waste in non-hazardous Landfill	Hazardous Waste Landfill
Sample Ref:							
Sample ID:							
Sample Location: TP05							
Top Depth(m): 1.00							
Bottom Depth(m):							
Sampling Date: 08-Oct-2020							
Determinand	SOP	Accred.	Units				
Total Organic Carbon	2625	M	%	1.9	3	5	6
Loss On Ignition	2610	M	%	5.3	--	--	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	2800	N	mg/kg	2.7	100	--	--
pH	2010	M		8.6	--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg	0.018	--	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	0.0082	< 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	0.0014	< 0.050	2	50	100
Mercury	1450	U	< 0.00050	< 0.0050	0.01	0.2	2
Molybdenum	1450	U	0.0021	< 0.050	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	< 0.0010	< 0.010	0.1	0.5	7
Zinc	1450	U	< 0.0010	< 0.50	4	50	200
Chloride	1220	U	< 1.0	< 10	800	15000	25000
Fluoride	1220	U	0.29	2.9	10	150	500
Sulphate	1220	U	3.1	31	1000	20000	50000
Total Dissolved Solids	1020	N	150	1500	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	U	6.2	62	500	800	1000

Solid Information

Dry mass of test portion/kg	0.090
Moisture (%)	13

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: 20-0399D Bus Connects Route 9

Chemtest Job No: 20-27524				Landfill Waste Acceptance Criteria Limits			
Chemtest Sample ID: 1079230							
Sample Ref:							
Sample ID:							
Sample Location: TP09							
Top Depth(m): 1.00				Inert Waste Landfill	Stable, Non-reactive hazardous waste in non-hazardous Landfill	Hazardous Waste Landfill	
Bottom Depth(m):							
Sampling Date: 09-Oct-2020							
Determinand	SOP	Accred.	Units				
Total Organic Carbon	2625	M	%	3.3	3	5	6
Loss On Ignition	2610	M	%	6.4	--	--	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	94	500	--	--
Total (Of 17) PAH's	2800	N	mg/kg	28	100	--	--
pH	2010	M		8.8	--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg	0.012	--	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	0.033	< 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	0.0013	< 0.050	2	50	100
Mercury	1450	U	< 0.00050	< 0.0050	0.01	0.2	2
Molybdenum	1450	U	0.012	0.12	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	0.0019	0.019	0.06	0.7	5
Selenium	1450	U	< 0.0010	< 0.010	0.1	0.5	7
Zinc	1450	U	0.0067	< 0.50	4	50	200
Chloride	1220	U	< 1.0	< 10	800	15000	25000
Fluoride	1220	U	0.28	2.8	10	150	500
Sulphate	1220	U	5.6	56	1000	20000	50000
Total Dissolved Solids	1020	N	150	1500	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	U	4.4	< 50	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.

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.
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
2015	Acid Neutralisation Capacity	Acid Reserve	Titration
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
2180	Sulphur (Elemental) in Soils by HPLC	Sulphur	Dichloromethane extraction / HPLC with UV detection
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2300	Cyanides & Thiocyanate in Soils	Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Alkaline extraction followed by colorimetric determination using Automated Flow Injection Analyser.
2325	Sulphide in Soils	Sulphide	Steam distillation with sulphuric acid / analysis by 'Aquakem 600' Discrete Analyser, using N,N-dimethyl-p-phenylenediamine.
2430	Total Sulphate in soils	Total Sulphate	Acid digestion followed by determination of sulphate in extract by ICP-OES.
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.
2490	Hexavalent Chromium in Soils	Chromium [VI]	Soil extracts are prepared by extracting dried and ground soil samples into boiling water. Chromium [VI] is determined by 'Aquakem 600' Discrete Analyser using 1,5-diphenylcarbazide.
2610	Loss on Ignition	loss on ignition (LOI)	Determination of the proportion by mass that is lost from a soil by ignition at 550°C.
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
2680	TPH A/A Split	Aliphatics: >C5–C6, >C6–C8,>C8–C10, >C10–C12, >C12–C16, >C16–C21, >C21–C35, >C35– C44Aromatics: >C5–C7, >C7–C8, >C8– C10, >C10–C12, >C12–C16, >C16– C21, >C21– C35, >C35– C44	Dichloromethane extraction / GCxGC FID detection

Test Methods

SOP	Title	Parameters included	Method summary
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.
2800	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil 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*	Dichloromethane extraction / GC-MS
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



Final Report

Report No.: 20-27739-1

Initial Date of Issue: 02-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
Gabiella 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 20-0399D Bus Connects Route 9

Quotation No.: Q20-21063	Date Received: 14-Oct-2020
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Order No.: R8765/0005	Date Instructed: 28-Oct-2020
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No. of Samples: 1

Turnaround (Wkdays): 5	Results Due: 03-Nov-2020
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Date Approved: 02-Nov-2020

Approved By:

Details: Glynn Harvey, Technical Manager

Results - Leachate

Project: 20-0399D Bus Connects Route 9

Client: Causeway Geotech Ltd	Chemtest Job No.: 20-27739				
Quotation No.: Q20-21063	Chemtest Sample ID.: 1080543				
	Sample Location: R9-CP05				
	Sample Type: SOIL				
	Top Depth (m): 1.50				
	Date Sampled: 12-Oct-2020				
Determinand	Accred.	SOP	Type	Units	LOD
Ammonium	U	1220	10:1	mg/l	0.050
Ammonium	N	1220	10:1	mg/kg	0.10

Results - Soil

Project: 20-0399D Bus Connects Route 9

Client: Causeway Geotech Ltd		Chemtest Job No.:		20-27739	
Quotation No.: Q20-21063		Chemtest Sample ID.:		1080543	
		Sample Location:		R9-CP05	
		Sample Type:		SOIL	
		Top Depth (m):		1.50	
		Date Sampled:		12-Oct-2020	
		Asbestos Lab:		COVENTRY	
Determinand	Accred.	SOP	Units	LOD	
ACM Type	U	2192		N/A	-
Asbestos Identification	U	2192		N/A	No Asbestos Detected
ACM Detection Stage	U	2192		N/A	-
Moisture	N	2030	%	0.020	11
pH	M	2010		4.0	9.3
Boron (Hot Water Soluble)	M	2120	mg/kg	0.40	0.42
Sulphur (Elemental)	M	2180	mg/kg	1.0	1.9
Cyanide (Total)	M	2300	mg/kg	0.50	[B] < 0.50
Sulphide (Easily Liberatable)	N	2325	mg/kg	0.50	7.9
Sulphate (Total)	M	2430	%	0.010	0.089
Arsenic	M	2450	mg/kg	1.0	20
Barium	M	2450	mg/kg	10	53
Cadmium	M	2450	mg/kg	0.10	1.9
Chromium	M	2450	mg/kg	1.0	15
Molybdenum	M	2450	mg/kg	2.0	3.6
Antimony	N	2450	mg/kg	2.0	< 2.0
Copper	M	2450	mg/kg	0.50	28
Mercury	M	2450	mg/kg	0.10	< 0.10
Nickel	M	2450	mg/kg	0.50	48
Lead	M	2450	mg/kg	0.50	19
Selenium	M	2450	mg/kg	0.20	0.41
Zinc	M	2450	mg/kg	0.50	76
Chromium (Trivalent)	N	2490	mg/kg	1.0	15
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50
Total Organic Carbon	M	2625	%	0.20	0.51
Mineral Oil	N	2670	mg/kg	10	< 10
Aliphatic TPH >C5-C6	N	2680	mg/kg	1.0	[B] < 1.0
Aliphatic TPH >C6-C8	N	2680	mg/kg	1.0	[B] < 1.0
Aliphatic TPH >C8-C10	M	2680	mg/kg	1.0	[B] < 1.0
Aliphatic TPH >C10-C12	M	2680	mg/kg	1.0	[B] < 1.0
Aliphatic TPH >C12-C16	M	2680	mg/kg	1.0	[B] < 1.0
Aliphatic TPH >C16-C21	M	2680	mg/kg	1.0	[B] < 1.0
Aliphatic TPH >C21-C35	M	2680	mg/kg	1.0	[B] < 1.0
Aliphatic TPH >C35-C44	N	2680	mg/kg	1.0	[B] < 1.0
Total Aliphatic Hydrocarbons	N	2680	mg/kg	5.0	[B] < 5.0
Aromatic TPH >C5-C7	N	2680	mg/kg	1.0	[B] < 1.0
Aromatic TPH >C7-C8	N	2680	mg/kg	1.0	[B] < 1.0
Aromatic TPH >C8-C10	M	2680	mg/kg	1.0	[B] < 1.0

Results - Soil

Project: 20-0399D Bus Connects Route 9

Client: Causeway Geotech Ltd		Chemtest Job No.:		20-27739	
Quotation No.: Q20-21063		Chemtest Sample ID.:		1080543	
		Sample Location:		R9-CP05	
		Sample Type:		SOIL	
		Top Depth (m):		1.50	
		Date Sampled:		12-Oct-2020	
		Asbestos Lab:		COVENTRY	
Determinand	Accred.	SOP	Units	LOD	
Aromatic TPH >C10-C12	M	2680	mg/kg	1.0	[B] < 1.0
Aromatic TPH >C12-C16	M	2680	mg/kg	1.0	[B] < 1.0
Aromatic TPH >C16-C21	U	2680	mg/kg	1.0	[B] < 1.0
Aromatic TPH >C21-C35	M	2680	mg/kg	1.0	[B] < 1.0
Aromatic TPH >C35-C44	N	2680	mg/kg	1.0	[B] < 1.0
Total Aromatic Hydrocarbons	N	2680	mg/kg	5.0	[B] < 5.0
Total Petroleum Hydrocarbons	N	2680	mg/kg	10.0	[B] < 10
Benzene	M	2760	µg/kg	1.0	[B] < 1.0
Toluene	M	2760	µg/kg	1.0	[B] < 1.0
Ethylbenzene	M	2760	µg/kg	1.0	[B] < 1.0
m & p-Xylene	M	2760	µg/kg	1.0	[B] < 1.0
o-Xylene	M	2760	µg/kg	1.0	[B] < 1.0
Methyl Tert-Butyl Ether	M	2760	µg/kg	1.0	[B] < 1.0
Naphthalene	M	2800	mg/kg	0.10	< 0.10
Acenaphthylene	N	2800	mg/kg	0.10	< 0.10
Acenaphthene	M	2800	mg/kg	0.10	< 0.10
Fluorene	M	2800	mg/kg	0.10	< 0.10
Phenanthrene	M	2800	mg/kg	0.10	< 0.10
Anthracene	M	2800	mg/kg	0.10	< 0.10
Fluoranthene	M	2800	mg/kg	0.10	< 0.10
Pyrene	M	2800	mg/kg	0.10	< 0.10
Benzo[a]anthracene	M	2800	mg/kg	0.10	< 0.10
Chrysene	M	2800	mg/kg	0.10	< 0.10
Benzo[b]fluoranthene	M	2800	mg/kg	0.10	< 0.10
Benzo[k]fluoranthene	M	2800	mg/kg	0.10	< 0.10
Benzo[a]pyrene	M	2800	mg/kg	0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	M	2800	mg/kg	0.10	< 0.10
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10	< 0.10
Benzo[g,h,i]perylene	M	2800	mg/kg	0.10	< 0.10
Coronene	N	2800	mg/kg	0.10	< 0.10
Total Of 17 PAH's	N	2800	mg/kg	2.0	< 2.0
PCB 28	U	2815	mg/kg	0.010	< 0.010
PCB 52	U	2815	mg/kg	0.010	< 0.010
PCB 90+101	U	2815	mg/kg	0.010	< 0.010
PCB 118	U	2815	mg/kg	0.010	< 0.010
PCB 153	U	2815	mg/kg	0.010	< 0.010
PCB 138	U	2815	mg/kg	0.010	< 0.010
PCB 180	U	2815	mg/kg	0.010	< 0.010
Total PCBs (7 Congeners)	U	2815	mg/kg	0.10	< 0.10

Results - Soil

Project: 20-0399D Bus Connects Route 9

Client: Causeway Geotech Ltd	Chemtest Job No.: 20-27739				
Quotation No.: Q20-21063	Chemtest Sample ID.: 1080543				
	Sample Location:		R9-CP05		
	Sample Type:		SOIL		
	Top Depth (m):		1.50		
	Date Sampled:		12-Oct-2020		
	Asbestos Lab:		COVENTRY		
Determinand	Accred.	SOP	Units	LOD	
Total Phenols	M	2920	mg/kg	0.30	< 0.30

Results - Single Stage WAC

Project: 20-0399D Bus Connects Route 9

Chemtest Job No: 20-27739 Chemtest Sample ID: 1080543 Sample Ref: Sample ID: Sample Location: R9-CP05 Top Depth(m): 1.50 Bottom Depth(m): Sampling Date: 12-Oct-2020				Landfill Waste Acceptance Criteria			
				Limits			
				Inert Waste Landfill	Stable, Non-reactive hazardous waste in non-hazardous Landfill	Hazardous Waste Landfill	
Determinand	SOP	Accred.	Units				
Total Organic Carbon	2625	M	%	0.51	3	5	6
Loss On Ignition	2610	M	%	2.1	--	--	10
Total BTEX	2760	M	mg/kg	[B] < 0.010	6	--	--
Total PCBs (7 Congeners)	2815	M	mg/kg	< 0.10	1	--	--
TPH Total WAC (Mineral Oil)	2670	M	mg/kg	[B] < 10	500	--	--
Total (Of 17) PAH's	2800	N	mg/kg	< 2.0	100	--	--
pH	2010	M		9.3	--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg	0.049	--	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	0.0010	< 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	< 0.0010	< 0.050	2	50	100
Mercury	1450	U	< 0.00050	< 0.0050	0.01	0.2	2
Molybdenum	1450	U	0.0057	0.057	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	< 0.0010	< 0.010	0.1	0.5	7
Zinc	1450	U	< 0.0010	< 0.50	4	50	200
Chloride	1220	U	< 1.0	< 10	800	15000	25000
Fluoride	1220	U	0.32	3.2	10	150	500
Sulphate	1220	U	11	110	1000	20000	50000
Total Dissolved Solids	1020	N	72	710	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	U	4.2	< 50	500	800	1000

Solid Information

Dry mass of test portion/kg	0.090
Moisture (%)	11

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.

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:
1080543			R9-CP05	12-Oct-2020	B	Amber Glass 250ml
1080543			R9-CP05	12-Oct-2020	B	Amber Glass 60ml
1080543			R9-CP05	12-Oct-2020	B	Plastic Tub 500g

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.
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
2015	Acid Neutralisation Capacity	Acid Reserve	Titration
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
2180	Sulphur (Elemental) in Soils by HPLC	Sulphur	Dichloromethane extraction / HPLC with UV detection
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2300	Cyanides & Thiocyanate in Soils	Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Alkaline extraction followed by colorimetric determination using Automated Flow Injection Analyser.
2325	Sulphide in Soils	Sulphide	Steam distillation with sulphuric acid / analysis by 'Aquakem 600' Discrete Analyser, using N,N-dimethyl-p-phenylenediamine.
2430	Total Sulphate in soils	Total Sulphate	Acid digestion followed by determination of sulphate in extract by ICP-OES.
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.
2490	Hexavalent Chromium in Soils	Chromium [VI]	Soil extracts are prepared by extracting dried and ground soil samples into boiling water. Chromium [VI] is determined by 'Aquakem 600' Discrete Analyser using 1,5-diphenylcarbazide.
2610	Loss on Ignition	loss on ignition (LOI)	Determination of the proportion by mass that is lost from a soil by ignition at 550°C.
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
2680	TPH A/A Split	Aliphatics: >C5–C6, >C6–C8,>C8–C10, >C10–C12, >C12–C16, >C16–C21, >C21–C35, >C35– C44Aromatics: >C5–C7, >C7–C8, >C8– C10, >C10–C12, >C12–C16, >C16– C21, >C21– C35, >C35– C44	Dichloromethane extraction / GCxGC FID detection

Test Methods

SOP	Title	Parameters included	Method summary
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.
2800	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil 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*	Dichloromethane extraction / GC-MS
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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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



Final Report

Report No.: 20-27893-1
Initial Date of Issue: 20-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
Gabiella 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 20-0399D Bus Connects Route 9

Quotation No.: Q20-21063

Date Received: 15-Oct-2020

Order No.:

Date Instructed: 15-Oct-2020

No. of Samples: 1

Turnaround (Wkdays): 5

Results Due: 21-Oct-2020

Date Approved: 20-Oct-2020

Approved By:

Details: Glynn Harvey, Technical Manager

Results - Soil

Project: 20-0399D Bus Connects Route 9

Client: Causeway Geotech Ltd		Chemtest Job No.:		20-27893	
Quotation No.: Q20-21063		Chemtest Sample ID.:		1081298	
		Sample Location:		TP08	
		Sample Type:		SOIL	
		Top Depth (m):		0.50	
		Date Sampled:		08-Oct-2020	
		Asbestos Lab:		COVENTRY	
Determinand	Accred.	SOP	Units	LOD	
ACM Type	U	2192		N/A	-
Asbestos Identification	U	2192		N/A	No Asbestos Detected
ACM Detection Stage	U	2192		N/A	-
Moisture	N	2030	%	0.020	7.1
pH	U	2010		4.0	8.8
Boron (Hot Water Soluble)	U	2120	mg/kg	0.40	0.52
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	< 0.010
Cyanide (Total)	U	2300	mg/kg	0.50	< 0.50
Arsenic	U	2450	mg/kg	1.0	23
Cadmium	U	2450	mg/kg	0.10	1.3
Chromium	U	2450	mg/kg	1.0	30
Copper	U	2450	mg/kg	0.50	36
Mercury	U	2450	mg/kg	0.10	< 0.10
Nickel	U	2450	mg/kg	0.50	47
Lead	U	2450	mg/kg	0.50	51
Zinc	U	2450	mg/kg	0.50	110
Organic Matter	U	2625	%	0.40	1.0
Total TPH >C6-C40	U	2670	mg/kg	10	< 10
Naphthalene	U	2700	mg/kg	0.10	< 0.10
Acenaphthylene	U	2700	mg/kg	0.10	< 0.10
Acenaphthene	U	2700	mg/kg	0.10	< 0.10
Fluorene	U	2700	mg/kg	0.10	< 0.10
Phenanthrene	U	2700	mg/kg	0.10	< 0.10
Anthracene	U	2700	mg/kg	0.10	< 0.10
Fluoranthene	U	2700	mg/kg	0.10	0.28
Pyrene	U	2700	mg/kg	0.10	0.31
Benzo[a]anthracene	U	2700	mg/kg	0.10	< 0.10
Chrysene	U	2700	mg/kg	0.10	< 0.10
Benzo[b]fluoranthene	U	2700	mg/kg	0.10	< 0.10
Benzo[k]fluoranthene	U	2700	mg/kg	0.10	< 0.10
Benzo[a]pyrene	U	2700	mg/kg	0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	U	2700	mg/kg	0.10	< 0.10
Dibenz(a,h)Anthracene	U	2700	mg/kg	0.10	< 0.10
Benzo[g,h,i]perylene	U	2700	mg/kg	0.10	< 0.10
Coronene	N	2700	mg/kg	0.10	< 0.10
Total Of 17 PAH's	N	2700	mg/kg	2.0	< 2.0
Total Phenols	U	2920	mg/kg	0.30	< 0.30

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
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2300	Cyanides & Thiocyanate in Soils	Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Alkaline 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)
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.

Report Information

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M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
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>	"greater than"

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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

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- A - Date of sampling not supplied
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- 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

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

customerservices@chemtest.com



Final Report

Report No.: 20-29281-1

Initial Date of Issue: 04-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
Gabiella 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 20-0399D Bus Connects Route 9

Quotation No.: Q20-21063

Date Received: 29-Oct-2020

Order No.:

Date Instructed: 29-Oct-2020

No. of Samples: 1

Turnaround (Wkdays): 5

Results Due: 04-Nov-2020

Date Approved: 04-Nov-2020

Approved By:

Details: Glynn Harvey, Technical Manager

Results - Leachate

Project: 20-0399D Bus Connects Route 9

Client: Causeway Geotech Ltd	Chemtest Job No.: 20-29281				
Quotation No.: Q20-21063	Chemtest Sample ID.: 1088392				
	Sample Location: TP07				
	Sample Type: SOIL				
	Top Depth (m): 0.50				
	Date Sampled: 26-Oct-2020				
Determinand	Accred.	SOP	Type	Units	LOD
Ammonium	U	1220	10:1	mg/l	0.050
Ammonium	N	1220	10:1	mg/kg	0.10

Results - Soil

Project: 20-0399D Bus Connects Route 9

Client: Causeway Geotech Ltd		Chemtest Job No.:		20-29281	
Quotation No.: Q20-21063		Chemtest Sample ID.:		1088392	
		Sample Location:		TP07	
		Sample Type:		SOIL	
		Top Depth (m):		0.50	
		Date Sampled:		26-Oct-2020	
		Asbestos Lab:		COVENTRY	
Determinand	Accred.	SOP	Units	LOD	
ACM Type	U	2192		N/A	-
Asbestos Identification	U	2192		N/A	No Asbestos Detected
ACM Detection Stage	U	2192		N/A	-
Moisture	N	2030	%	0.020	8.5
pH	M	2010		4.0	8.9
Boron (Hot Water Soluble)	M	2120	mg/kg	0.40	0.62
Sulphur (Elemental)	M	2180	mg/kg	1.0	6.0
Cyanide (Total)	M	2300	mg/kg	0.50	< 0.50
Sulphide (Easily Liberatable)	N	2325	mg/kg	0.50	12
Sulphate (Total)	M	2430	%	0.010	0.22
Arsenic	M	2450	mg/kg	1.0	19
Barium	M	2450	mg/kg	10	88
Cadmium	M	2450	mg/kg	0.10	1.4
Chromium	M	2450	mg/kg	1.0	16
Molybdenum	M	2450	mg/kg	2.0	3.4
Antimony	N	2450	mg/kg	2.0	2.4
Copper	M	2450	mg/kg	0.50	44
Mercury	M	2450	mg/kg	0.10	0.27
Nickel	M	2450	mg/kg	0.50	38
Lead	M	2450	mg/kg	0.50	110
Selenium	M	2450	mg/kg	0.20	0.54
Zinc	M	2450	mg/kg	0.50	120
Chromium (Trivalent)	N	2490	mg/kg	1.0	16
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50
Total Organic Carbon	M	2625	%	0.20	1.6
Mineral Oil	N	2670	mg/kg	10	< 10
Aliphatic TPH >C5-C6	N	2680	mg/kg	1.0	< 1.0
Aliphatic TPH >C6-C8	N	2680	mg/kg	1.0	< 1.0
Aliphatic TPH >C8-C10	M	2680	mg/kg	1.0	< 1.0
Aliphatic TPH >C10-C12	M	2680	mg/kg	1.0	< 1.0
Aliphatic TPH >C12-C16	M	2680	mg/kg	1.0	< 1.0
Aliphatic TPH >C16-C21	M	2680	mg/kg	1.0	< 1.0
Aliphatic TPH >C21-C35	M	2680	mg/kg	1.0	< 1.0
Aliphatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0
Total Aliphatic Hydrocarbons	N	2680	mg/kg	5.0	< 5.0
Aromatic TPH >C5-C7	N	2680	mg/kg	1.0	< 1.0
Aromatic TPH >C7-C8	N	2680	mg/kg	1.0	< 1.0
Aromatic TPH >C8-C10	M	2680	mg/kg	1.0	< 1.0

Results - Soil

Project: 20-0399D Bus Connects Route 9

Client: Causeway Geotech Ltd		Chemtest Job No.:		20-29281	
Quotation No.: Q20-21063		Chemtest Sample ID.:		1088392	
		Sample Location:		TP07	
		Sample Type:		SOIL	
		Top Depth (m):		0.50	
		Date Sampled:		26-Oct-2020	
		Asbestos Lab:		COVENTRY	
Determinand	Accred.	SOP	Units	LOD	
Aromatic TPH >C10-C12	M	2680	mg/kg	1.0	< 1.0
Aromatic TPH >C12-C16	M	2680	mg/kg	1.0	< 1.0
Aromatic TPH >C16-C21	U	2680	mg/kg	1.0	< 1.0
Aromatic TPH >C21-C35	M	2680	mg/kg	1.0	< 1.0
Aromatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0
Total Aromatic Hydrocarbons	N	2680	mg/kg	5.0	< 5.0
Total Petroleum Hydrocarbons	N	2680	mg/kg	10.0	< 10
Benzene	M	2760	µg/kg	1.0	< 1.0
Toluene	M	2760	µg/kg	1.0	< 1.0
Ethylbenzene	M	2760	µg/kg	1.0	< 1.0
m & p-Xylene	M	2760	µg/kg	1.0	< 1.0
o-Xylene	M	2760	µg/kg	1.0	< 1.0
Methyl Tert-Butyl Ether	M	2760	µg/kg	1.0	< 1.0
Naphthalene	M	2800	mg/kg	0.10	< 0.10
Acenaphthylene	N	2800	mg/kg	0.10	< 0.10
Acenaphthene	M	2800	mg/kg	0.10	< 0.10
Fluorene	M	2800	mg/kg	0.10	< 0.10
Phenanthrene	M	2800	mg/kg	0.10	0.64
Anthracene	M	2800	mg/kg	0.10	0.13
Fluoranthene	M	2800	mg/kg	0.10	1.5
Pyrene	M	2800	mg/kg	0.10	1.3
Benzo[a]anthracene	M	2800	mg/kg	0.10	< 0.10
Chrysene	M	2800	mg/kg	0.10	< 0.10
Benzo[b]fluoranthene	M	2800	mg/kg	0.10	< 0.10
Benzo[k]fluoranthene	M	2800	mg/kg	0.10	< 0.10
Benzo[a]pyrene	M	2800	mg/kg	0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	M	2800	mg/kg	0.10	< 0.10
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10	< 0.10
Benzo[g,h,i]perylene	M	2800	mg/kg	0.10	< 0.10
Coronene	N	2800	mg/kg	0.10	< 0.10
Total Of 17 PAH's	N	2800	mg/kg	2.0	3.6
PCB 28	U	2815	mg/kg	0.010	< 0.010
PCB 52	U	2815	mg/kg	0.010	< 0.010
PCB 90+101	U	2815	mg/kg	0.010	< 0.010
PCB 118	U	2815	mg/kg	0.010	< 0.010
PCB 153	U	2815	mg/kg	0.010	< 0.010
PCB 138	U	2815	mg/kg	0.010	< 0.010
PCB 180	U	2815	mg/kg	0.010	< 0.010
Total PCBs (7 Congeners)	U	2815	mg/kg	0.10	< 0.10

Results - Soil

Project: 20-0399D Bus Connects Route 9

Client: Causeway Geotech Ltd	Chemtest Job No.: 20-29281				
Quotation No.: Q20-21063	Chemtest Sample ID.: 1088392				
	Sample Location:		TP07		
	Sample Type:		SOIL		
	Top Depth (m):		0.50		
	Date Sampled:		26-Oct-2020		
	Asbestos Lab:		COVENTRY		
Determinand	Accred.	SOP	Units	LOD	
Total Phenols	M	2920	mg/kg	0.30	< 0.30

Results - Single Stage WAC

Project: 20-0399D Bus Connects Route 9

Chemtest Job No: 20-29281					Landfill Waste Acceptance Criteria Limits		
Chemtest Sample ID: 1088392					Inert Waste Landfill	Stable, Non-reactive hazardous waste in non-hazardous Landfill	Hazardous Waste Landfill
Sample Ref:							
Sample ID:							
Sample Location: TP07							
Top Depth(m): 0.50							
Bottom Depth(m):							
Sampling Date: 26-Oct-2020							
Determinand	SOP	Accred.	Units				
Total Organic Carbon	2625	M	%	1.6	3	5	6
Loss On Ignition	2610	M	%	3.9	--	--	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	2800	N	mg/kg	3.6	100	--	--
pH	2010	M		8.9	--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg	0.042	--	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	0.010	< 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	< 0.0010	< 0.050	2	50	100
Mercury	1450	U	< 0.00050	< 0.0050	0.01	0.2	2
Molybdenum	1450	U	0.010	0.10	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	< 0.0010	< 0.010	0.1	0.5	7
Zinc	1450	U	< 0.0010	< 0.50	4	50	200
Chloride	1220	U	< 1.0	< 10	800	15000	25000
Fluoride	1220	U	0.34	3.4	10	150	500
Sulphate	1220	U	3.9	39	1000	20000	50000
Total Dissolved Solids	1020	N	91	910	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	U	5.5	55	500	800	1000

Solid Information	
Dry mass of test portion/kg	0.090
Moisture (%)	8.5

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
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.
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
2015	Acid Neutralisation Capacity	Acid Reserve	Titration
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
2180	Sulphur (Elemental) in Soils by HPLC	Sulphur	Dichloromethane extraction / HPLC with UV detection
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2300	Cyanides & Thiocyanate in Soils	Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Alkaline extraction followed by colorimetric determination using Automated Flow Injection Analyser.
2325	Sulphide in Soils	Sulphide	Steam distillation with sulphuric acid / analysis by 'Aquakem 600' Discrete Analyser, using N,N-dimethyl-p-phenylenediamine.
2430	Total Sulphate in soils	Total Sulphate	Acid digestion followed by determination of sulphate in extract by ICP-OES.
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.
2490	Hexavalent Chromium in Soils	Chromium [VI]	Soil extracts are prepared by extracting dried and ground soil samples into boiling water. Chromium [VI] is determined by 'Aquakem 600' Discrete Analyser using 1,5-diphenylcarbazide.
2610	Loss on Ignition	loss on ignition (LOI)	Determination of the proportion by mass that is lost from a soil by ignition at 550°C.
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
2680	TPH A/A Split	Aliphatics: >C5–C6, >C6–C8,>C8–C10, >C10–C12, >C12–C16, >C16–C21, >C21–C35, >C35– C44Aromatics: >C5–C7, >C7–C8, >C8– C10, >C10–C12, >C12–C16, >C16– C21, >C21– C35, >C35– C44	Dichloromethane extraction / GCxGC FID detection

Test Methods

SOP	Title	Parameters included	Method summary
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.
2800	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil 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*	Dichloromethane extraction / GC-MS
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
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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



Final Report

Report No.: 20-29604-1
Initial Date of Issue: 06-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
Gabiella 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

Quotation No.:	Q20-21063	Date Received:	02-Nov-2020
Order No.:	20-0399D Bus Connects Route 9	Date Instructed:	02-Nov-2020
No. of Samples:	1		
Turnaround (Wkdays):	5	Results Due:	06-Nov-2020
Date Approved:	06-Nov-2020		

Approved By:

Details: Glynn Harvey, Technical Manager

Results - Soil

Project:

Client: Causeway Geotech Ltd	Chemtest Job No.: 20-29604				
Quotation No.: Q20-21063	Chemtest Sample ID.: 1090019				
	Sample Location:		R9-CP06		
	Sample Type:		SOIL		
	Top Depth (m):		1.00		
	Date Sampled:		29-Oct-2020		
	Asbestos Lab:		LIVERPOOL		
Determinand	Accred.	SOP	Units	LOD	
ACM Type	U	2192		N/A	-
Asbestos Identification	U	2192		N/A	No Asbestos Detected
ACM Detection Stage	U	2192		N/A	-
Moisture	N	2030	%	0.020	6.5
pH	U	2010		4.0	8.2
Boron (Hot Water Soluble)	U	2120	mg/kg	0.40	< 0.40
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	1.2
Cyanide (Total)	U	2300	mg/kg	0.50	< 0.50
Arsenic	U	2450	mg/kg	1.0	20
Cadmium	U	2450	mg/kg	0.10	0.68
Chromium	U	2450	mg/kg	1.0	6.8
Copper	U	2450	mg/kg	0.50	17
Mercury	U	2450	mg/kg	0.10	< 0.10
Nickel	U	2450	mg/kg	0.50	27
Lead	U	2450	mg/kg	0.50	24
Zinc	U	2450	mg/kg	0.50	49
Organic Matter	U	2625	%	0.40	2.4
Total TPH >C6-C40	U	2670	mg/kg	10	< 10
Naphthalene	U	2700	mg/kg	0.10	< 0.10
Acenaphthylene	U	2700	mg/kg	0.10	< 0.10
Acenaphthene	U	2700	mg/kg	0.10	< 0.10
Fluorene	U	2700	mg/kg	0.10	< 0.10
Phenanthrene	U	2700	mg/kg	0.10	< 0.10
Anthracene	U	2700	mg/kg	0.10	< 0.10
Fluoranthene	U	2700	mg/kg	0.10	< 0.10
Pyrene	U	2700	mg/kg	0.10	< 0.10
Benzo[a]anthracene	U	2700	mg/kg	0.10	< 0.10
Chrysene	U	2700	mg/kg	0.10	< 0.10
Benzo[b]fluoranthene	U	2700	mg/kg	0.10	< 0.10
Benzo[k]fluoranthene	U	2700	mg/kg	0.10	< 0.10
Benzo[a]pyrene	U	2700	mg/kg	0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	U	2700	mg/kg	0.10	< 0.10
Dibenz(a,h)Anthracene	U	2700	mg/kg	0.10	< 0.10
Benzo[g,h,i]perylene	U	2700	mg/kg	0.10	< 0.10
Coronene	N	2700	mg/kg	0.10	< 0.10
Total Of 17 PAH's	N	2700	mg/kg	2.0	< 2.0
Total Phenols	U	2920	mg/kg	0.30	< 0.30

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
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2300	Cyanides & Thiocyanate in Soils	Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Alkaline 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)
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.

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None of the results in this report have been recovery corrected

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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

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customerservices@chemtest.com



Final Report

Report No.: 20-31991-1
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
Gabiella 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 20-0399D Bus Connects Route 9

Quotation No.: Q20-21063

Date Received: 23-Nov-2020

Order No.:

Date Instructed: 24-Nov-2020

No. of Samples: 5

Turnaround (Wkdays): 5

Results Due: 30-Nov-2020

Date Approved: 30-Nov-2020

Approved By:

Details: Glynn Harvey, Technical Manager

Results - Water

Project: 20-0399D Bus Connects Route 9

Client: Causeway Geotech Ltd		Chemtest Job No.:		20-31991	20-31991	20-31991	20-31991	20-31991	
Quotation No.: Q20-21063		Chemtest Sample ID.:		1101918	1101919	1101920	1101921	1101922	
		Sample Location:		R9-CP02	R9-CP08	R9-CP11	R9-CPGS01	R9-CPGS04	
		Sample Type:		WATER	WATER	WATER	WATER	WATER	
		Date Sampled:		19-Nov-2020	19-Nov-2020	19-Nov-2020	19-Nov-2020	19-Nov-2020	
Determinand	Accred.	SOP	Units	LOD					
pH	U	1010		N/A	8.2	7.6	7.7	7.6	7.7
Electrical Conductivity	U	1020	µS/cm	1.0	640	1200	720	960	880
Ammonia (Free) as N	U	1220	mg/l	0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Nitrite as N	U	1220	mg/l	0.010	< 0.010	0.028	0.025	0.30	0.016
Nitrate as N	U	1220	mg/l	0.50	< 0.50	8.3	< 0.50	3.3	3.6
Phosphorus (Total)	N	1220	mg/l	0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
Phosphate as P	U	1220	mg/l	0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Nitrogen (Total)	N	1340	mg/l	5.0	< 5.0	16	< 5.0	9.0	6.8
Calcium	U	1415	mg/l	5.0	73	160	83	120	110
Magnesium	U	1415	mg/l	0.50	17	29	7.7	19	9.4
Sodium	U	1415	mg/l	0.50	33	34	25	56	37
Total Hardness as CaCO3	U	1270	mg/l	15	250	520	240	370	310
Arsenic (Dissolved)	U	1450	µg/l	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Boron (Dissolved)	U	1450	µg/l	20	23	170	29	69	27
Barium (Dissolved)	U	1450	µg/l	5.0	73	64	66	68	61
Cadmium (Dissolved)	U	1450	µg/l	0.080	< 0.080	< 0.080	0.32	< 0.080	0.13
Copper (Dissolved)	U	1450	µg/l	1.0	1.4	1.9	2.3	< 1.0	1.0
Iron (Dissolved)	N	1450	µg/l	20	310	500	340	290	330
Mercury (Dissolved)	U	1450	µg/l	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Manganese (Dissolved)	U	1450	µg/l	1.0	24	18	170	300	9.4
Molybdenum (Dissolved)	U	1450	µg/l	1.0	1.2	1.1	2.6	3.6	1.8
Nickel (Dissolved)	U	1450	µg/l	1.0	< 1.0	6.3	14	6.1	2.1
Lead (Dissolved)	U	1450	µg/l	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Antimony (Dissolved)	U	1450	µg/l	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Selenium (Dissolved)	U	1450	µg/l	1.0	11	6.1	< 1.0	3.7	4.3
Zinc (Dissolved)	U	1450	µg/l	1.0	2.3	5.8	7.4	8.1	4.7
Chromium (Trivalent)	N	1490	µg/l	20	[B] < 20	[B] < 20	[B] < 20	[B] < 20	[B] < 20
Chromium (Hexavalent)	U	1490	µg/l	20	[B] < 20	[B] < 20	[B] < 20	[B] < 20	[B] < 20
Total Organic Carbon	U	1610	mg/l	2.0	85	120	89	94	88
Mineral Oil	N	1670	µg/l	10	< 10	< 10	< 10	< 10	< 10
Total TPH >C6-C40	U	1670	µg/l	10	< 10	< 10	< 10	< 10	< 10
Naphthalene	U	1800	µg/l	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Acenaphthylene	U	1800	µg/l	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Acenaphthene	U	1800	µg/l	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Fluorene	U	1800	µg/l	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Phenanthrene	U	1800	µg/l	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Anthracene	U	1800	µg/l	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Fluoranthene	U	1800	µg/l	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Pyrene	U	1800	µg/l	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[a]anthracene	U	1800	µg/l	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Chrysene	U	1800	µg/l	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10

Results - Water

Project: 20-0399D Bus Connects Route 9

Client: Causeway Geotech Ltd		Chemtest Job No.:		20-31991	20-31991	20-31991	20-31991	20-31991
Quotation No.: Q20-21063		Chemtest Sample ID.:		1101918	1101919	1101920	1101921	1101922
		Sample Location:		R9-CP02	R9-CP08	R9-CP11	R9-CPGS01	R9-CPGS04
		Sample Type:		WATER	WATER	WATER	WATER	WATER
		Date Sampled:		19-Nov-2020	19-Nov-2020	19-Nov-2020	19-Nov-2020	19-Nov-2020
Determinand	Accred.	SOP	Units	LOD				
Benzo[b]fluoranthene	U	1800	µg/l	0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[k]fluoranthene	U	1800	µg/l	0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[a]pyrene	U	1800	µg/l	0.10	< 0.10	< 0.10	< 0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	U	1800	µg/l	0.10	< 0.10	< 0.10	< 0.10	< 0.10
Dibenz(a,h)Anthracene	U	1800	µg/l	0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[g,h,i]perylene	U	1800	µg/l	0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Of 16 PAH's	U	1800	µg/l	2.0	< 2.0	< 2.0	< 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:
1101918			R9-CP02	19-Nov-2020	B	Coloured Winchester 1000ml
1101918			R9-CP02	19-Nov-2020	B	EPA Vial 40ml
1101918			R9-CP02	19-Nov-2020	B	Plastic Bottle 1000ml
1101919			R9-CP08	19-Nov-2020	B	Coloured Winchester 1000ml
1101919			R9-CP08	19-Nov-2020	B	EPA Vial 40ml
1101919			R9-CP08	19-Nov-2020	B	Plastic Bottle 1000ml
1101920			R9-CP11	19-Nov-2020	B	Coloured Winchester 1000ml
1101920			R9-CP11	19-Nov-2020	B	EPA Vial 40ml
1101920			R9-CP11	19-Nov-2020	B	Plastic Bottle 1000ml
1101921			R9-CPGS01	19-Nov-2020	B	Coloured Winchester 1000ml
1101921			R9-CPGS01	19-Nov-2020	B	EPA Vial 40ml
1101921			R9-CPGS01	19-Nov-2020	B	Plastic Bottle 1000ml
1101922			R9-CPGS04	19-Nov-2020	B	Coloured Winchester 1000ml
1101922			R9-CPGS04	19-Nov-2020	B	EPA Vial 40ml
1101922			R9-CPGS04	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 CaCO ₃ 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; Dibenzo[ah]Anthracene; Fluoranthene; Fluorene; Indeno[123cd]Pyrene; Naphthalene; Phenanthrene; Pyrene	Pentane extraction / GCMS detection

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:

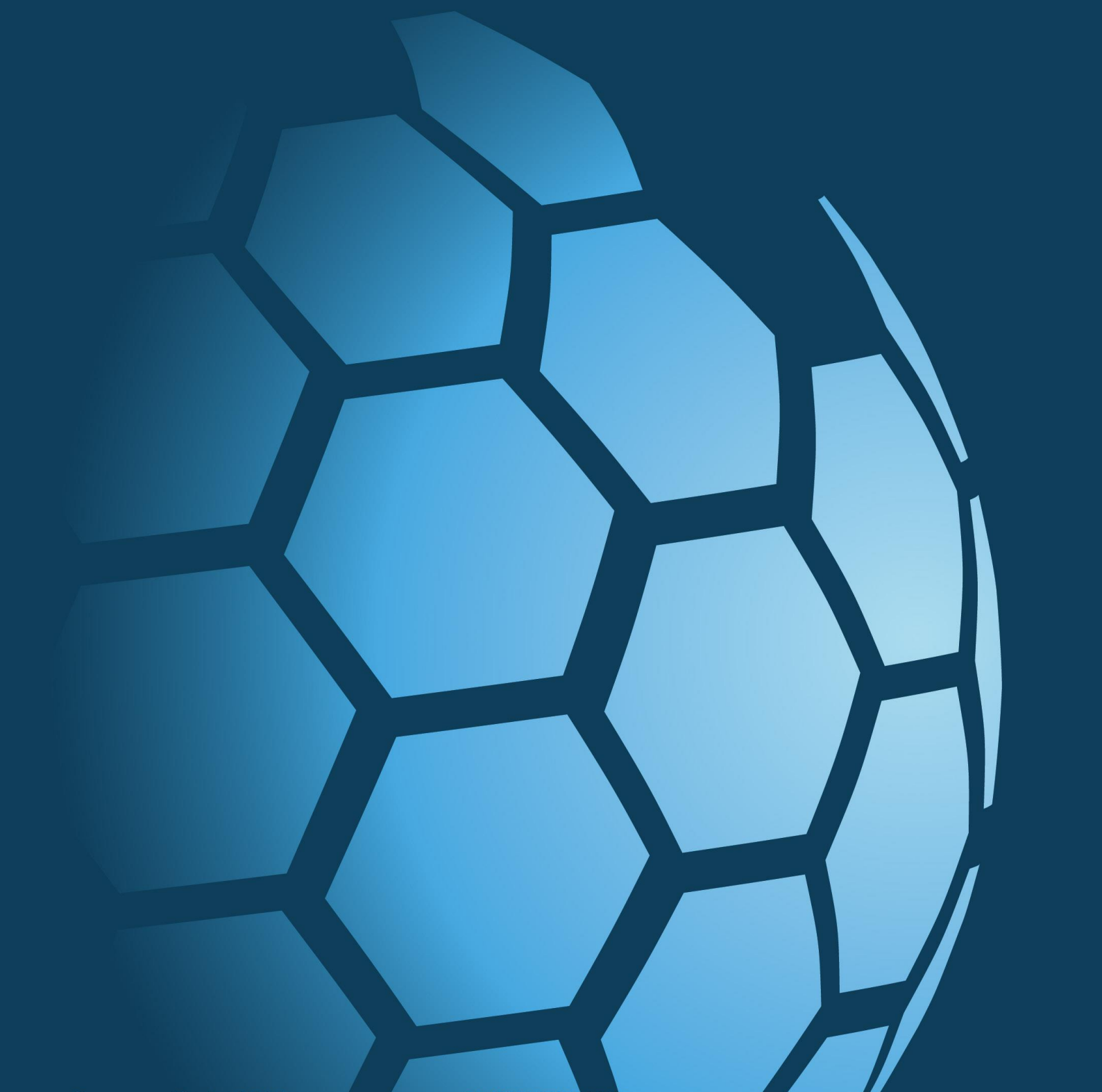
customerservices@chemtest.com



CAUSEWAY
— GEOTECH

APPENDIX I

SPT HAMMER ENERGY MEASUREMENT REPORT



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

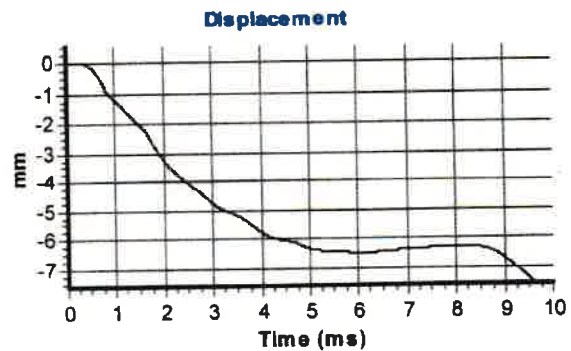
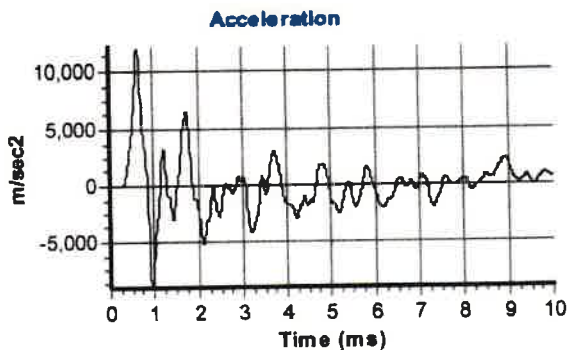
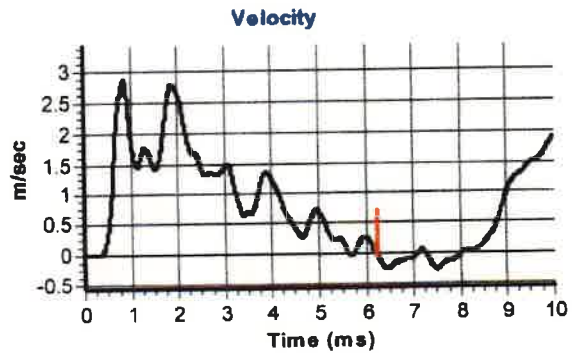
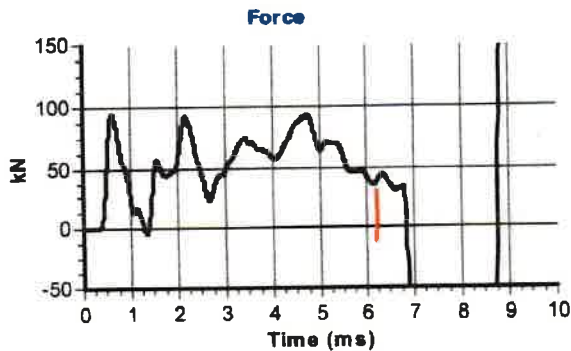
Diameter d_r (mm): 54
Wall Thickness t_r (mm): 6.0
Assumed Modulus E_a (GPa): 200
Accelerometer No.1: 6458
Accelerometer No.2: 9607

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 (mm^2): 905
Theoretical Energy E_{theor} (J): 473
Measured Energy E_{meas} (J): 400

Energy Ratio E_r (%): **85**

NPB Burrows
Signed: Neil Burrows
Title: Field Operations Manager

The recommended calibration interval is 12 months

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

SPT Hammer Ref: .T7
Test Date: 22/02/2020
Report Date: 03/03/2020
File Name: .T7.spt
Test Operator: NPB

Instrumented Rod Data

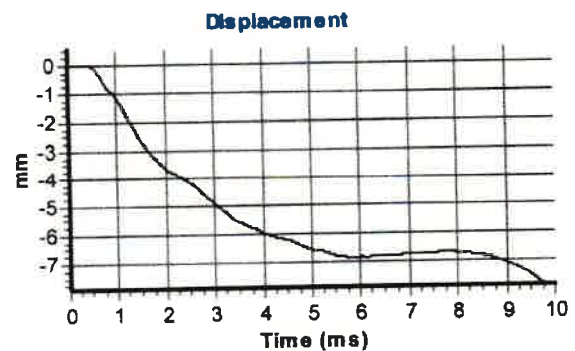
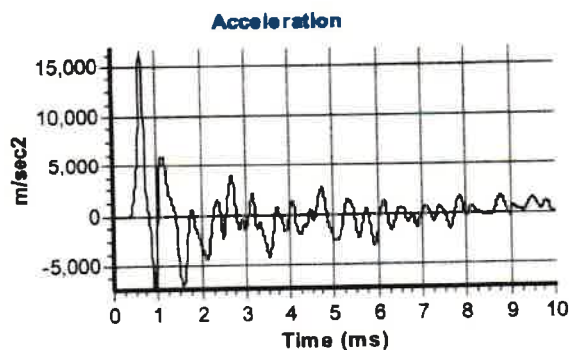
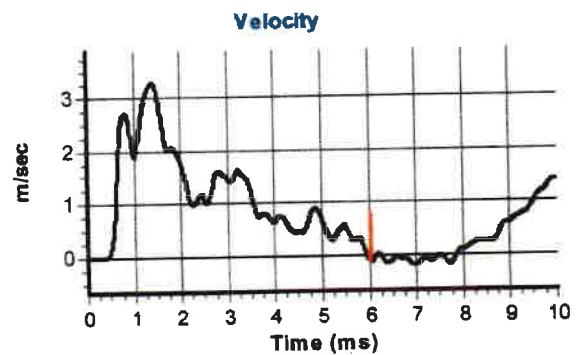
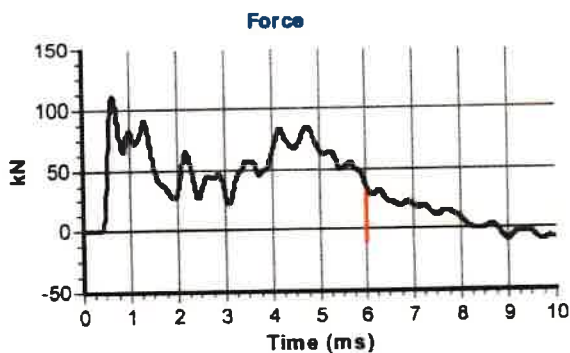
Diameter d_r (mm): 54
Wall Thickness t_r (mm): 6.0
Assumed Modulus E_a (GPa): 200
Accelerometer No.1: 6458
Accelerometer No.2: 9607

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): 399

Energy Ratio E_r (%): **84**

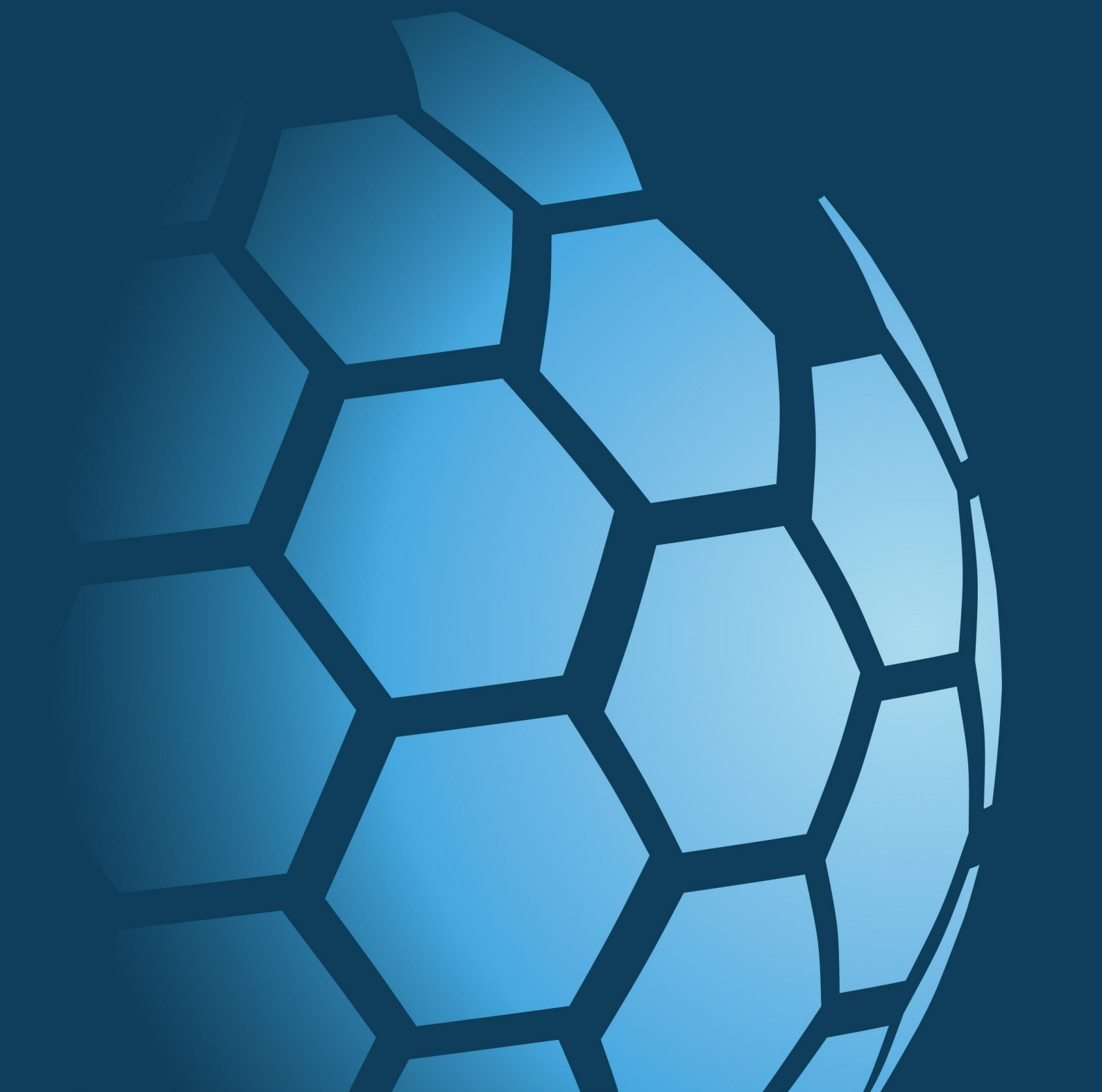

Signed: Neil Burrows
Title: Field Operations Manager

The recommended calibration interval is 12 months



CAUSEWAY
— GEOTECH

APPENDIX J
ARCHAEOLOGY REPORT



Report on Archaeological Monitoring BusConnects Infrastructure Dublin Detailed Ground Investigation Stage 1

Licence No. 20E0622

Client: Causeway Geotech Limited
Issue date: December 2020
Licensee: Grace Fegan
Prepared by: Thaddeus Breen, Marion Sutton and Grace Fegan, Shanarc
Archaeology Ltd.



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Executive Summary

Archaeological monitoring of Stage 1 detailed ground investigations relating to the National Transport Authority's BusConnects Infrastructure Dublin project was carried out by Shanarc Archaeology Ltd. under licence 20E0622.

The works, carried out in September and October 2020, were split over three routes, namely Route 02: Swords to City Centre, Route 09: Greenhills to City Centre and Route 13: Bray to City Centre.

A total of 22 ground investigation locations were subject to archaeological monitoring, due to their proximity to either a Recorded Monument and Place, other area of archaeological or cultural heritage potential, or as requested by Causeway Geotech Limited.

The works generally comprised the excavation of trial pits that ranged from 1.60m to 2.40m long x 0.60m wide and 1.0m to 4.2m deep, and cable percussion cores that ranged from 0.23m to 8m deep.

No archaeological features or deposits were identified during monitoring. An Irish halfpenny of George II, dated 1742, was recovered during monitoring on Route 13: Bray to City Centre, in Bray, Co. Wicklow.

1. Introduction

This report describes the results of archaeological monitoring of Stage 1 detailed ground investigations relating to the National Transport Authority's BusConnects Infrastructure Dublin project. The planning stage/Stage 1 detailed ground/geotechnical investigations were carried out on five routes, namely Route 02: Swords to City Centre Route, 06: Lucan to City Centre, Route 08: Clondalkin to Drimnagh, Route 09: Greenhills to City Centre and Route 13: Bray to City Centre (Figure 1).

Detailed ground investigation is being carried out in accordance with the *BusConnects Detailed Ground Investigation Contract: Stage 1* tendered by the National Transport Authority.

Only specified investigations on identified sections of the Stage 1 routes were subject to archaeological monitoring; the specified investigations were identified following a review by Shanarc Archaeology Ltd. of the proposed investigation locations.

Proposed investigation locations were reviewed by Shanarc Archaeology Ltd. to identify (1) whether proposed works fall with the historic core of Dublin (DU019-020), (2) whether proposed works fall within the Zone of Archaeological Potential associated with an individual recorded monument and (3) whether proposed works fall within an area of identified archaeological or cultural heritage potential.

21 no. ground investigation locations were identified for archaeological monitoring, on three routes, Route 02: Swords to City Centre, Route 09: Greenhills to City Centre and Route 13: Bray to City Centre, with Route 09: Greenhills to City Centre investigations forming the focus of archaeological monitoring. The identified locations are listed in Appendix 1.

Following modifications to Stage 1 detailed ground/geotechnical investigations at the construction stage, a total of 22 ground investigations locations were subject to archaeological monitoring. The monitored locations are listed in Appendix 2.

1.1 Location Description

The BusConnect routes are on existing main commuter routes into Dublin City Centre. Although some of the routes are partly within the Zone of Archaeological Potential of Dublin city (DU018-020), the areas covered by the *BusConnects Detailed Ground Investigation Contract: Stage 1* are not.

The Route 02: Swords to City Centre bus corridor commences on the Swords Road at the Pinnock Hill junction and is routed along Swords Road, Drumcondra Road Upper & Lower and Dorset Street to the junction with North Frederick Street. The ground investigation location monitored on Route 02 was located to the south side of the Tolka River at Drumcondra Bridge, on the R132 (Drumcondra Road Upper and Lower).

The Route 09: Greenhills core bus corridor commences on Belgard Square West, at the junction with Cookstown Way, Tallaght, routed along Belgard Square North and Belgard Square East towards the Blessington Road, continuing to Greenhills Road (R819), and along Ballymount Avenue, Calmount Road and Walkinstown Road (R819) to the junction with the Long Mile Road (R110). 20 ground investigation locations were monitored on this section of Route 09, beginning on Belgard Square North and located on, or in proximity of Greenhills Road (R819) to both sides of the M50 as far as Walkinstown.



Figure 1 BusConnects Corridor Map.

The Route 13: Bray to City Centre bus corridor commences at the Dargle River crossing, in Bray town, and is routed northwards along the Dublin Road (R119) to Loughlinstown roundabout, along Bray Road and Stillorgan Road (N11, R138), and via Donnybrook Road and Morehampton Road toward Dublin city centre, to the junction of Leeson Street Lower and St. Stephen's Green. One ground investigation location was monitored on Route 13, to the north of Bray town.

1.1 Project Description

BusConnects is the National Transport Authority's programme to greatly improve bus services in Dublin city. The ground/geotechnical investigation works will be variously in public areas, on land under control of a Local Authority and on private land, and are required to determine the condition and properties of the ground to inform the planning stage design of BusConnects core bus corridors. The investigation works provides for trial pits, slit trenches, cable percussion drilling (minimum diameter 200mm) and window samples, which may be associated with pitting and trenching up to 1.2m below the surface to locate and avoid underground services.

2. Receiving Environment

2.1 Route 2: Swords to City Centre

The ground investigation location, R2-SLT02, monitored on Route 02 was located to the south side of the Tolka River at Drumcondra Bridge, west of the R123, in Clonliffe West townland, within 380m of DU018-012001, the site of a 16th-17th century house incorporated into St. Patrick's Teacher Training College, 480m of DU018-011, a holy well, and 480m of DU018-013001 and DU018-013002, the church of St. John the Baptist (1734) and associated graveyard on the grounds of All Hallows College, which was built on a medieval foundation associated with the Prior of All Saints (Figure 2). In 1756, John Rocque records a terrace of buildings facing south onto Botanic Avenue, now the site of our Lady's Park. A terrace of buildings were still present on the first edition 6-inch Ordnance Survey map (1837-1843; Figure 3), known as Tolka Cottages, which appear to have been removed at some point in the 20th century. While no stray finds are provenance to Clonliffe West townland, the Topographical files at the National Museum of Ireland record a number of stray finds to Drisoge (1 x copper alloy coin) and Drumcondra (3 x flint scrapers; 1 x bone ring) townlands to the north of the Tolka River, highlighting the settlement potential in the catchment of the Tolka River.

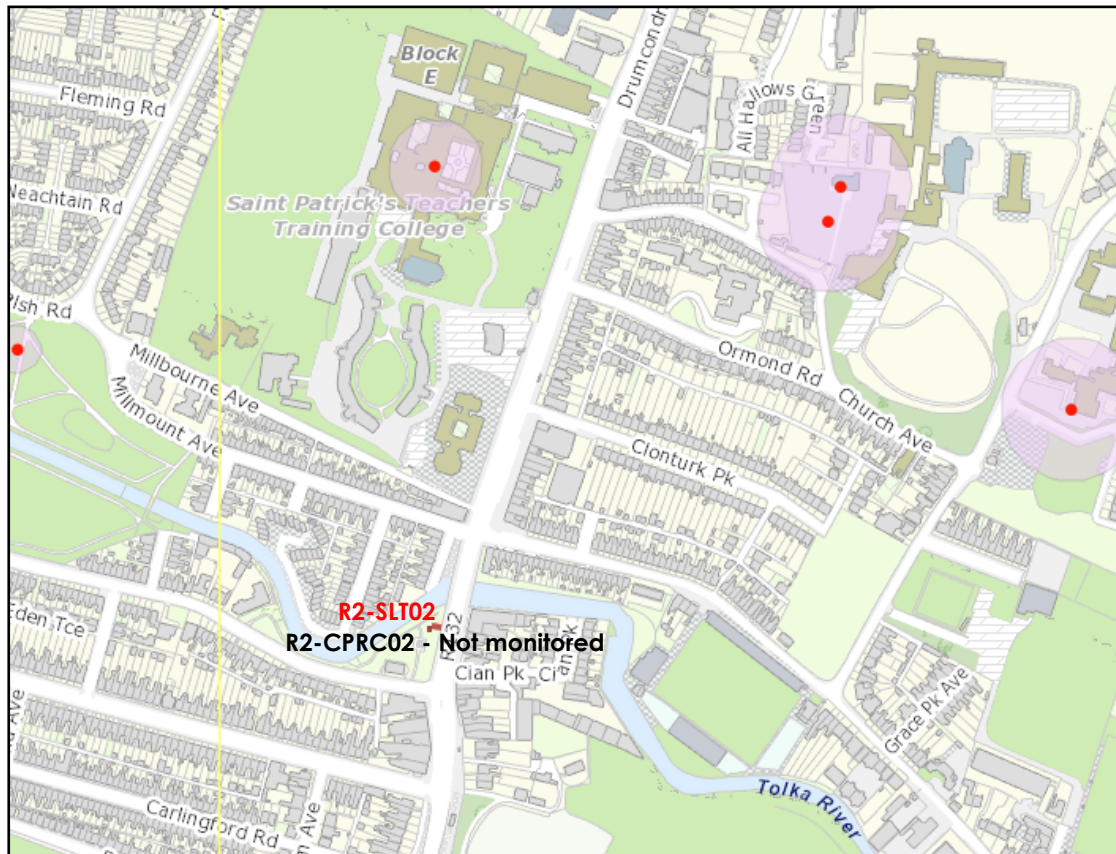


Figure 2 Location of R2-SLT02 (in red) next to R2-CPRC02, in relation to RMP sites (red dots) and Zones of Archaeological Potential (shaded pink) (OSi Licence No. EN 0077920).



Figure 3 Location of R2-SLT02 (in red) next to R2-CPRC02 on the first edition 6-inch OS map, 1837-1843 (OSi Licence No. EN 0077920).

2.2 Route 9: Greenhills to City Centre

The majority of ground investigation locations were monitored on Route 09, 20 sites in total, in Tallaght, Tymon North, Kilnamanagh and Greenhills townlands. The Greenhills route is situated in a landscape in which archaeological remains are well represented, which include Bronze Age (c. 2400-500 BC) burials in Greenhills townland, stray finds indicating early occupation from the Bancroft and Dodder River areas at Tallaght Village (Bolger 2010; NMI Topographical Files), which include a number of bronze axeheads from a sandpit in Tallaght, and well represented early and later medieval remains, the monastery at Tallaght being founded in the mid-8th century. With the arrival of the Anglo-Normans in 1169, the monastery passed to the control of the archbishop of Dublin, becoming a manor with borough status.

R9-TP01 and R9-TP02 are sited to the north side of Belgrade Square North, a short distance east of the entry to Tallaght General Hospital, 500m from the historic town and ecclesiastical manor at Tallaght (DU021-037) (Figure 4), on land that was formerly within the grounds of the Glebe House, later St. Maelruen's. The Glebe grounds were located within the wider Tallaght townland (Figure 5). R9-TP03, on the Greenhills Road (R819), is sited approximately 540m to the north-north-east of the historic town, which in addition to DU021-037003 and DU021-037004, Tallaght church and graveyard, comprises DU021-037012, a holy well, and two castles, DU021-037020 and DU022-018001 (Figure 6).

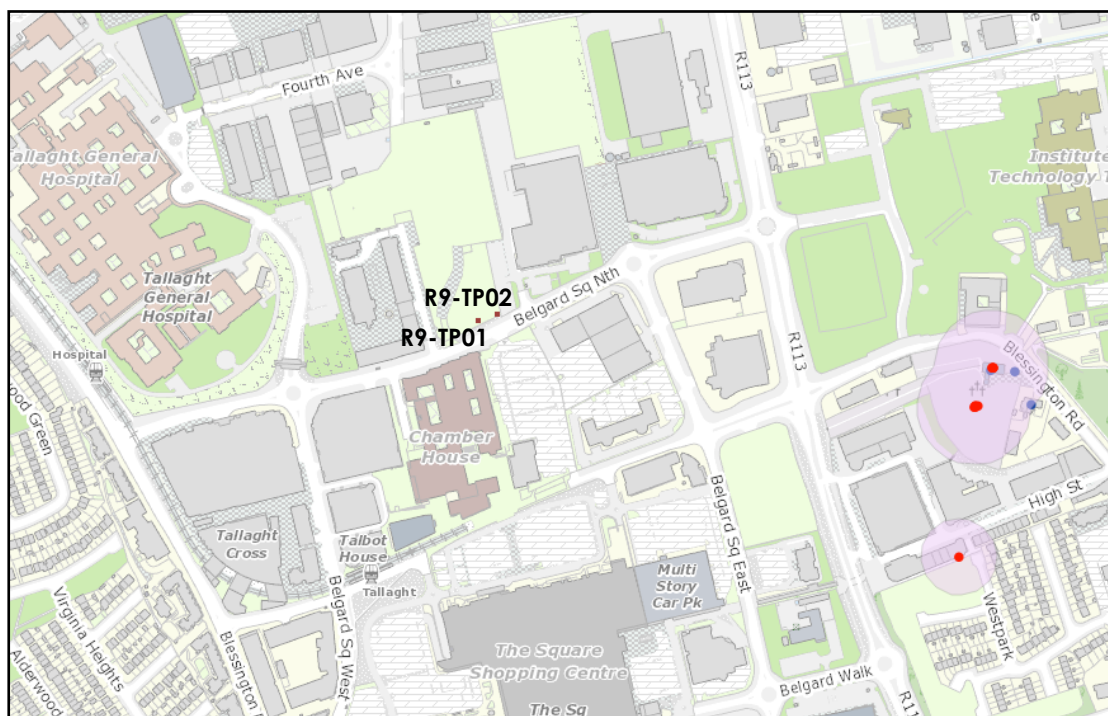


Figure 4 Locations of R9-TP01 and R9-TP02 in relation to RMP sites (red dots) and Zones of Archaeological Potential (shaded pink) (OSi Licence No. EN 0077920).

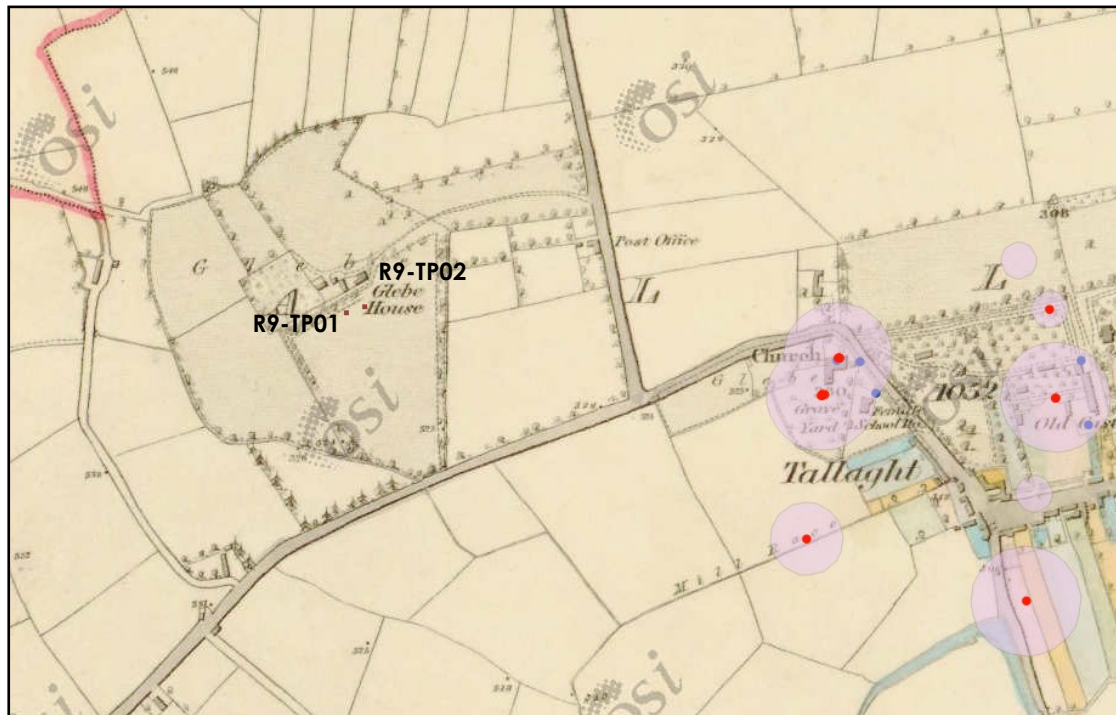


Figure 5 Locations of R9-TP01 and R9-TP02 on the first edition 6-inch OS map, 1837-1843 (OSi Licence No. EN 0077920).

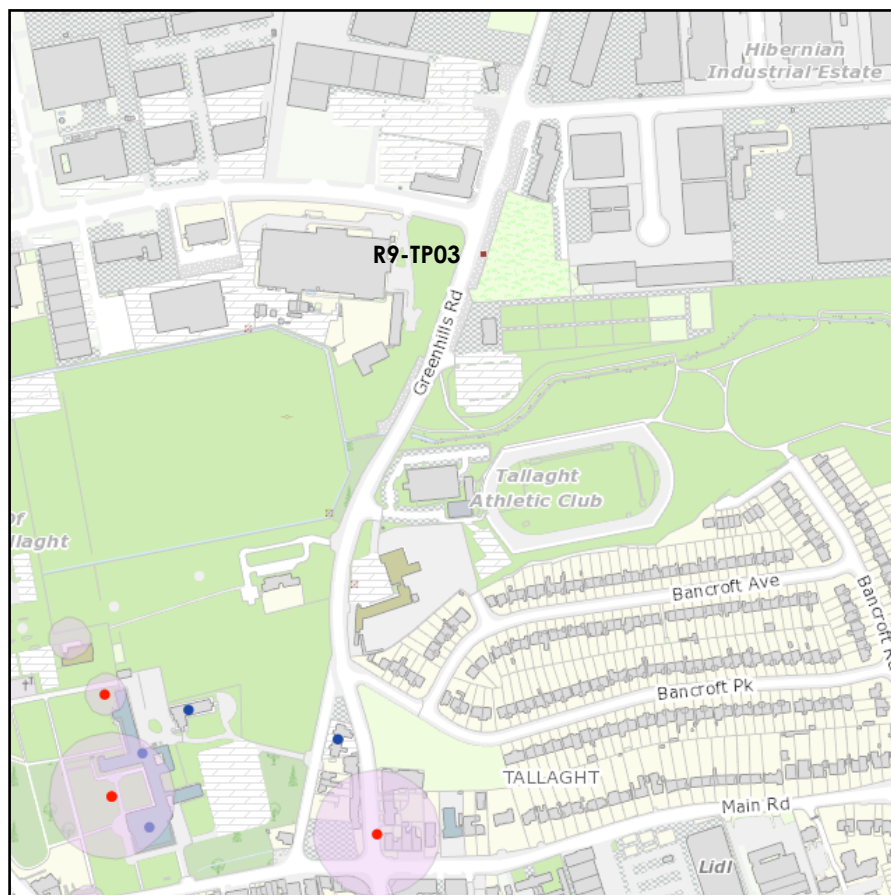


Figure 6 Location of R9-TP03 in relation to RMP sites (red dots) and Zones of Archaeological Potential (shaded pink) (OSi Licence No. EN 0077920).

A programme of archaeological monitoring of utility trenches along the route of Metro West in the vicinity of Tallaght was carried out in October 2010 in accordance with licence numbers 10E0309, 10E0415, 10E0416 and 10E0417. No archaeological features or deposits were found (Bolger 2010). John Rocque's 1760 map presents a rural landscape in the hinterland of the historic Tallaght village, with enclosed fields and sporadic dwellings largely fronting the mid-18th century road network, which included the precursors of the Old Blessington Road and the Greenhills Road. R9-TP03 is depicted positioned on the Greenhills Road on the first edition 6-inch Ordnance Survey map (Figure 7).

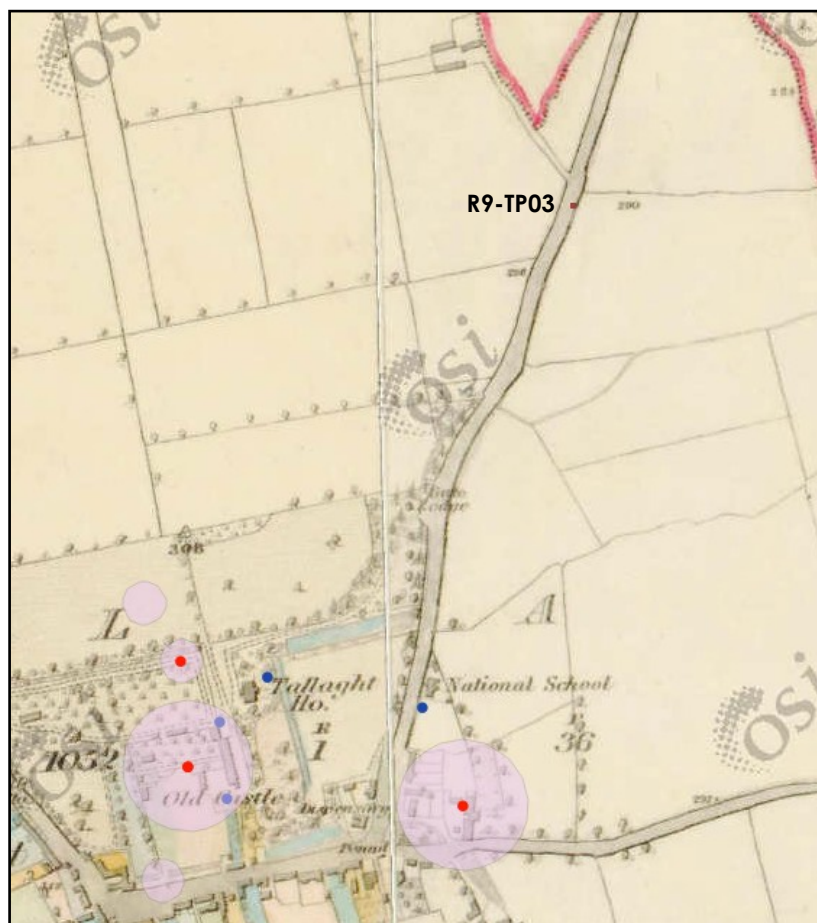


Figure 7 Location of R9-TP03 on the first edition 6-inch OS map, 1837-1843 (OSi Licence No. EN 0077920).

R9-CP03, R9-TP04, R9-TP05, R9-CP04 and R9-TP06 are all situated within 380m of a complex of medieval monuments at Kilnamanagh, a developed area with no visible surface remains (Figure 8). The complex incorporates DU022-005005, an ecclesiastical enclosure, bi-sected by Treepark Road - R9-TP05 is sited within the Zone of Archaeological Potential of the enclosure. The complex also includes DU022-005002, a church, DU022-005003, a graveyard, DU022-005004, a holy well, and DU022-005009 and DU022-005008, an earthwork and bawn enclosing Kilnamanagh Castle, DU022-005001.

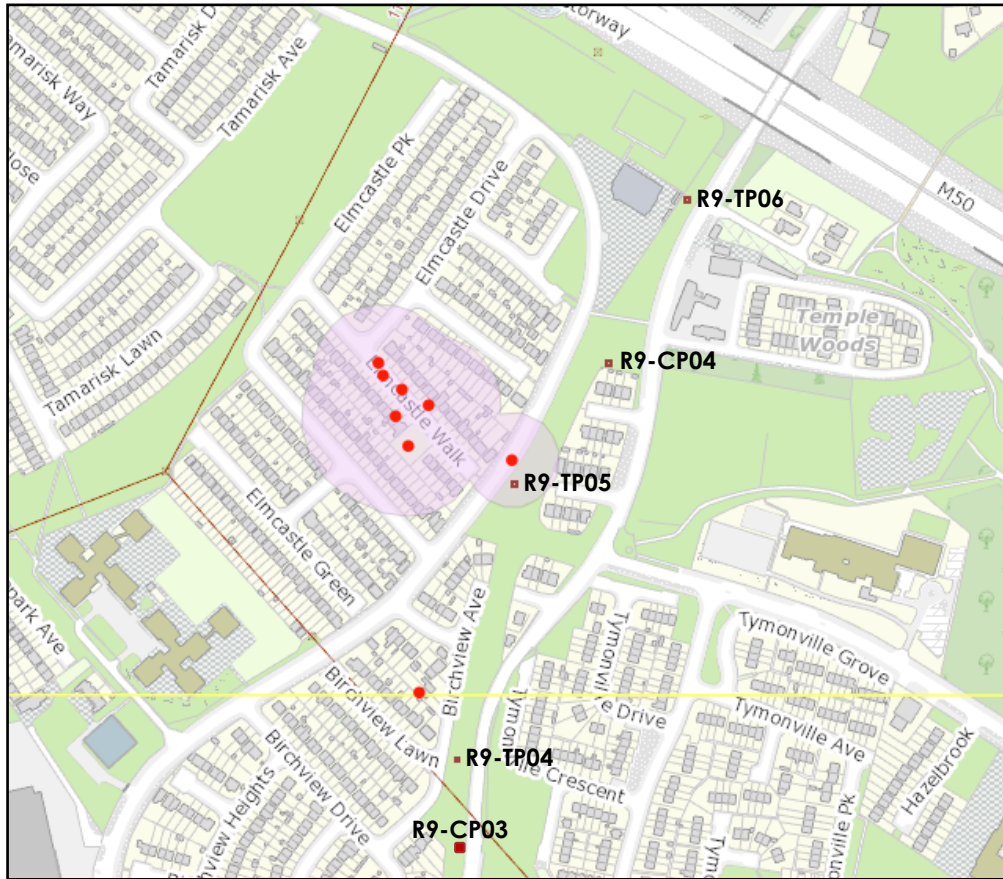


Figure 8 Locations of R9-CP03, R9-TP04, R9-TP05, R9-CP04 and R9-TP06 in relation to RMP sites (red dots) and Zones of Archaeological Potential (shaded pink) (OSi Licence No. EN 0077920).

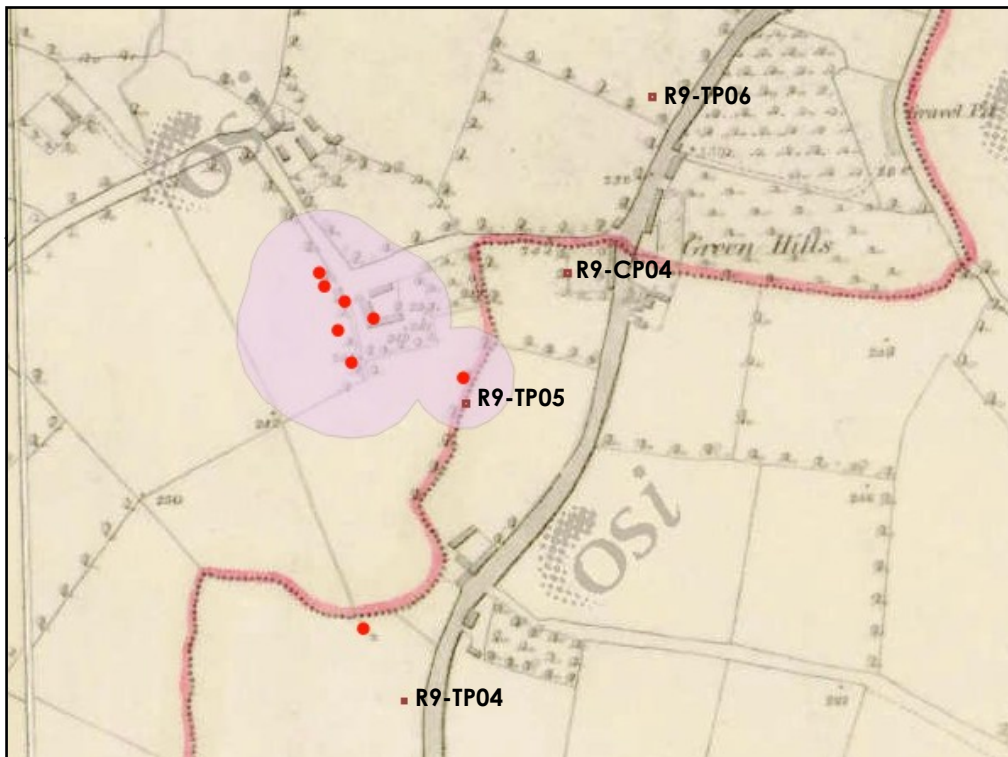


Figure 9 Locations of R9-TP04, R9-TP05, R9-CP04 and R9-TP06 on the first edition 6-inch OS map, 1837-1843 (OSi Licence No. EN 0077920).

Both Rocque, in 1760, and the Ordnance Survey (1837-1843) show the rural nature of the Kilnamanagh area, with a number of structures concentrated on the Greenhills Road in this area (Figure 9); with Rocque showing a spring to the east side of the precursor of the Greenhills Road. The National Museum of Ireland provenance a large number of stray finds to Kilnamanagh and Greenhills townlands, reflecting settlement in this area in prehistory and during the medieval and post medieval periods.

R9-CP05, R9-TP08, R9-WS01 and R9-TP09 are ground investigation locations situated peripheral to the medieval Kilnamanagh complex (Figure 10 and Figure 11).



Figure 10 Locations of R9-CP05, R9-TP08, R9-WS01 and R9-TP02 (OSi Licence No. EN 0077920).



Figure 11 Locations of R9-CP05, R9-TP08, R9-WS01 and R9-TP02 on the first edition 6-inch OS map, 1837-1843 (OSi Licence No. EN 0077920).

R9-CP08, R9-TP10, R9-TP11, R9-CP10, R9-CP07, R9-CP09, R9-CP12 and R9-CP13 are sited on, or in proximity of Greenhills Road (R819) near Walkinstown, between Greenhills Industrial Estate and Ballymount Court Business Centre (Figure 12). The investigation locations are within 95m-400m of DU022-002, a Bronze Age flat cemetery, and 330m-480m of DU022-001, a holy well. R9-CP12 is sited closest to the DU022-002, flat cemetery, just west of the designated Zone of Archaeological Potential. This area, to either side of the Greenhills Road was the focus of gravel extraction, at least from the 19th century, and the flat cemetery was first uncovered during the quarrying of a sand and gravel ridge in 1892. A spot height shown on the first edition 6-inch Ordnance Survey map (1837-1943) to the south-west of the cemetery site overlooked the locations of R9-CP09, R9-CP12 and R9-CP13.

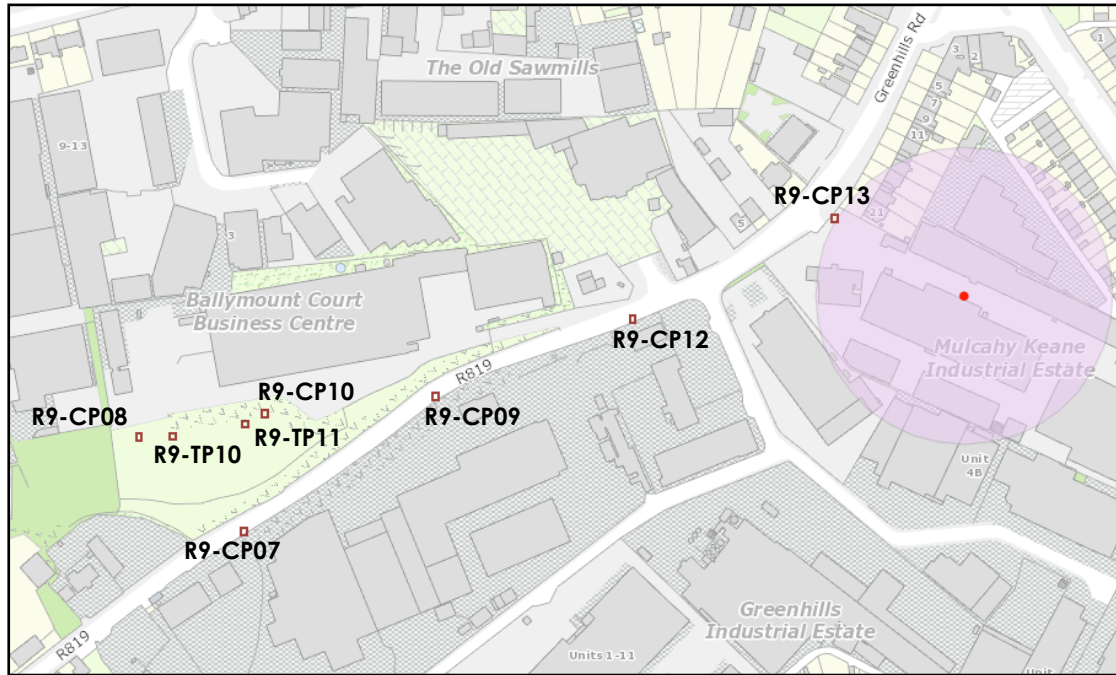


Figure 12 Locations of R9-CP08, R9-TP10, R9-TP11, R9-CP10, R9-CP07, R9-CP09, R9-CP12 and R9-CP13 in relation to RMP sites (red dots) and Zones of Archaeological Potential (shaded pink) (OSi Licence No. EN 0077920).

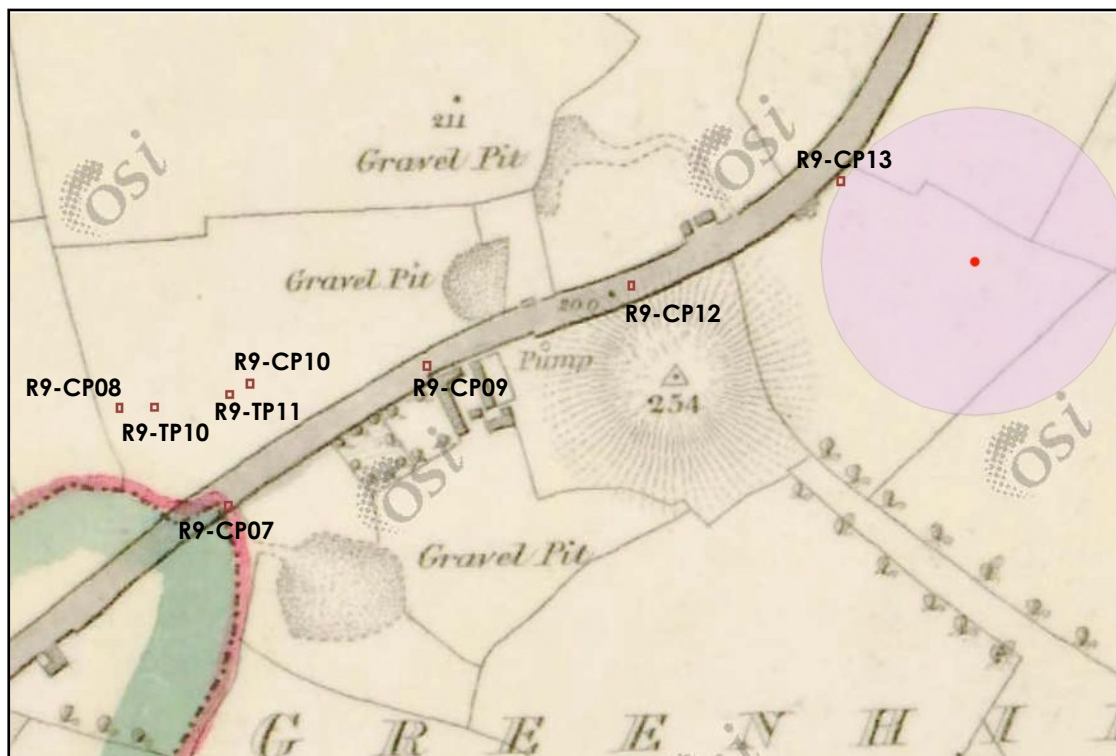


Figure 13 Locations of R9-CP08, R9-TP10, R9-TP11, R9-CP10, R9-CP07, R9-CP09, R9-CP12 and R9-CP13 on the first edition 6-inch OS map, 1837-1843 (OSi Licence No. EN 0077920).

2.3 Route 13: Bray to City Centre

The ground investigation location, R13-WS01, monitored on Route 13 was located in Ravenswell townland, to the east of the Dublin Road (R716) in the grounds of Saint Philomena's Primary School, situated outside, and to the north of the Zone of Archaeological Potential for the historic town at Bray (WI004-001). The window sample, approximately 120m north-west of the historic town, was sited 95m from WI004-001006, the findspot of a cross-slab, and 185m of WI004-001006, a castle site forming a sub-element of the historic town (Figure 14). A timber pier excavated on the Dargle River (WI004-006; Excavation Licence No. 95E0004), in Killarney townland, upriver of the town, has been radiocarbon dated to 4661-4360 BC, indicating Neolithic activity in the Dargle River and Bray area.

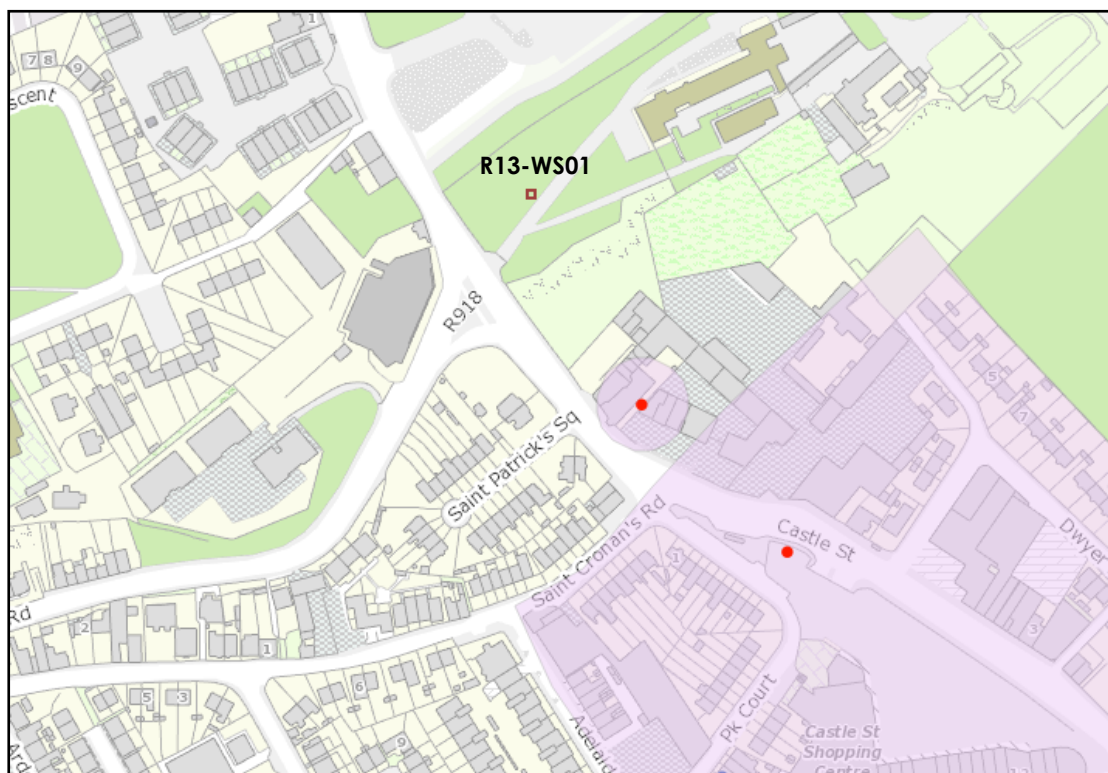


Figure 14 Location of R13-WS01 outside Bray (OSi Licence No. EN 0077920).

The first edition 6-inch Ordnance Survey map (1837-1843; Figure 15) shows the location of the window sample sited to the townland boundary between Ravenswell and Cork Great, to the north of Little Bray and the Dargle River. A grant of lands in the town of Little Bray in 1636 mentioned the castle, sited on Castle Street, along with six houses and gardens, orchards, the commons and fishing in the Dargle. The grounds of Ravenswell House, the residence of de Butt Esq., are now substantially developed as part of the Bray Golf Club, which has operated a course at Ravenswell since 1897.



Figure 15 Location of R13-WS01, outside Bray, on the first edition 6-inch OS map, 1837-1843 (OSi Licence No. EN 0077920).

3. Methodology

The objective of the programme of archaeological monitoring was to provide a watching brief of excavation and drilling associated with the of ground/geotechnical investigations for the purpose of identifying any archaeological features, deposits or finds that might be present and subject to potential development impacts.

Ground/geotechnical investigations comprised a combination of trial pits (TP), cable percussion cores (CP), slit trenches (SLT), and window samples (WS).

It was originally proposed that archaeological monitoring would occur at 21 locations (listed in Appendix 1). However, as a result of changes at the construction phase, investigation locations were subject to name changes, with some cancellations (i.e. R2-CPRC01) and with some additions (e.g. R2-SLT02). Changes to the construction programme also resulted in a number of investigation locations being excavated in the absence of an archaeologist i.e. R2-CPRC02, R13-CP01, R13-CP02 and R13-CP03. Although in the case of R2-CPRC02, an added slit trench R2-SLT02 in very close proximity was monitored, while R13-WS01 was monitored in the general proximity of R13-CP03. Ultimately, 22 locations were monitored (listed in Appendix 2), including a number of locations more peripheral to identified areas of archaeological potential that were monitored at the request of Causeway Geotech Limited.

4. Results of monitoring

The following tables provide details of the location and stratigraphy of each of the Stage I archaeologically monitored ground/geotechnical investigation locations. Relevant plates are provided in Section 7.

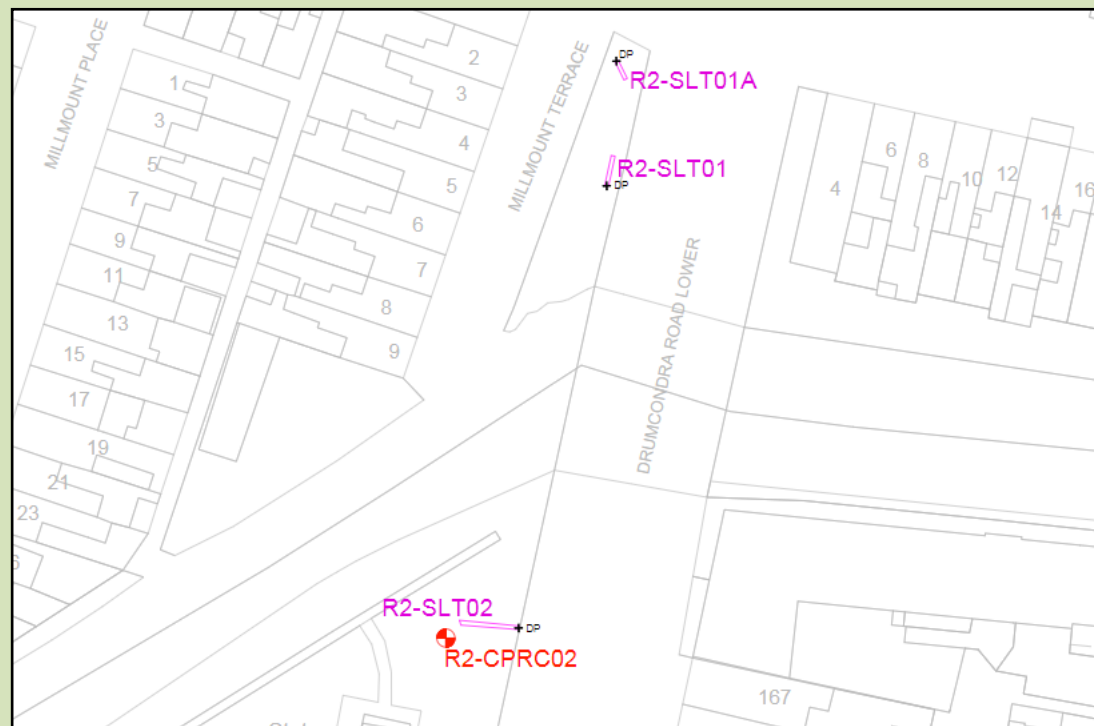
4.1 Results of Monitoring

Route 2: Swords to City Centre

Slit Trench	R2-SLT02
Location	Drumcondra, in a small park, Our Lady's Park, immediately south of the River Tolka
Date	29 September 2020
Type	Slit trench, 7m long, 0.40m wide
Depth	Description
0m-0.20m	Mid-brown loose topsoil with roots
0.20m-0.50m	Mid-brown stony soil with modern potsherds, F#'s 1-8 listed in Appendix 3
0.50m-1.30m	Very hard, compact, stony soil with brick and roof-tile fragments
1.30m-1.60m+	Some pea gravel present at 1.13m, then mid-brown gravelly clay continuing, still with fragments of brick, ceramic, glass and even plastic

Comments: Modern disturbance throughout the trench. Natural not reached. No archaeological significance. **Plate 1**

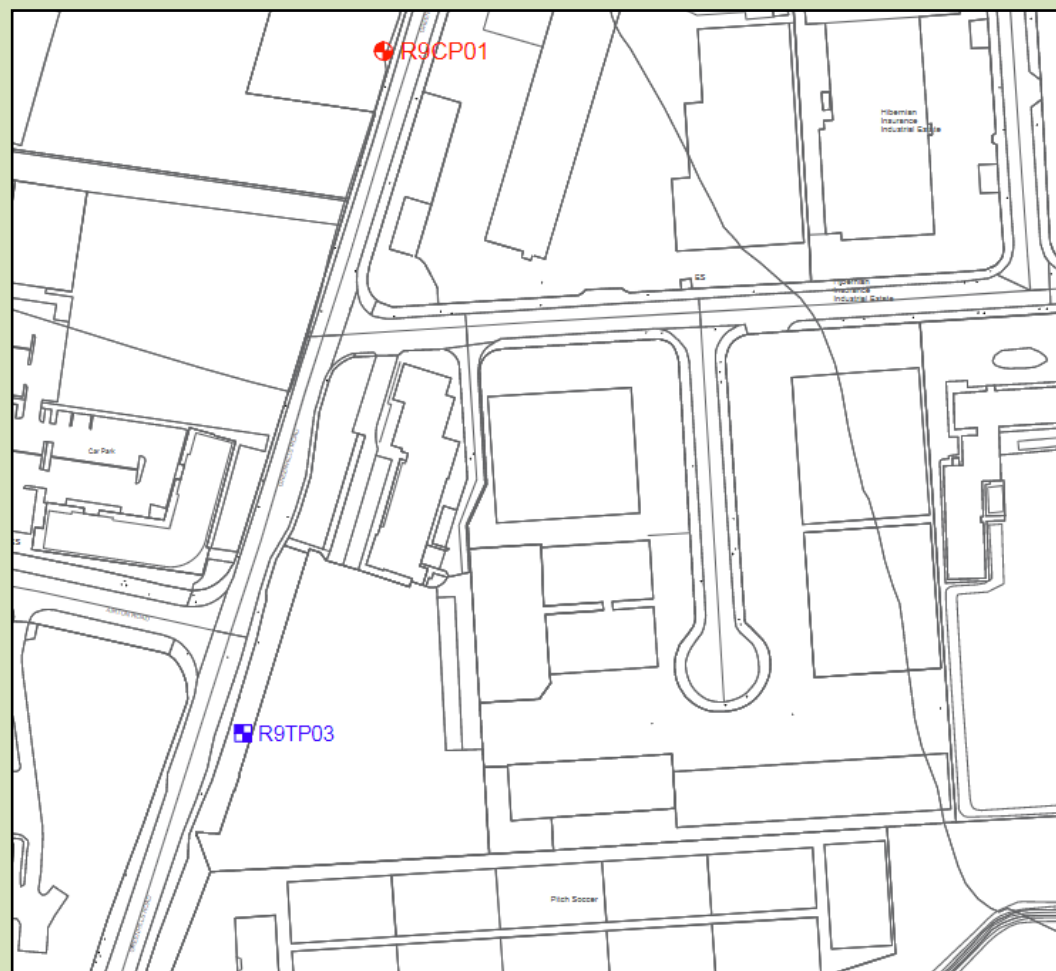
Location Plan showing R2-SLT02:



Depth	Description
0m-0.20m	Compacted gravel laid on geotextile
0.20m-0.85m	Hardcore
0.85m+	Leanmix, probably protecting services

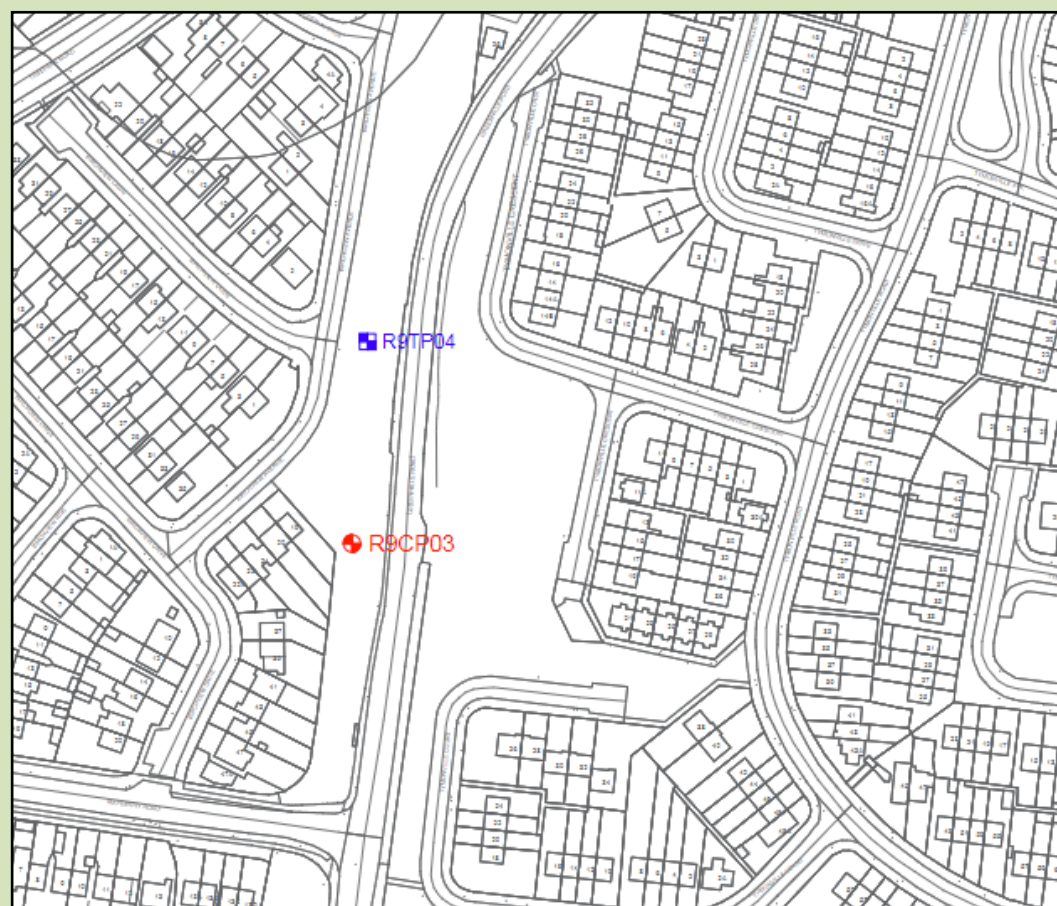
Comments: Pit abandoned because of probable services. No archaeological significance. **Plate 4**

Location Plan showing R9-TP03:



Cable Percussion	R9-CP03
Location	Kilnamanagh, on ornamental grassland in a housing estate
Date	6 October 2020
Type	Cable percussion, no hand-digging
Depth	Description
0m-1.00m	Mid-brown topsoil; sherd of sewer pipe
1.00m-1.50m	Similar material, but somewhat lighter in colour
1.50m-8.00m	Light yellow-brown natural
8.00m	Hard boulder clay; refusal
Comments: Made ground to a depth of 1.50m. No archaeological significance. Plate 5	

Location Plan showing R9-CP03 and R9-TP04 :

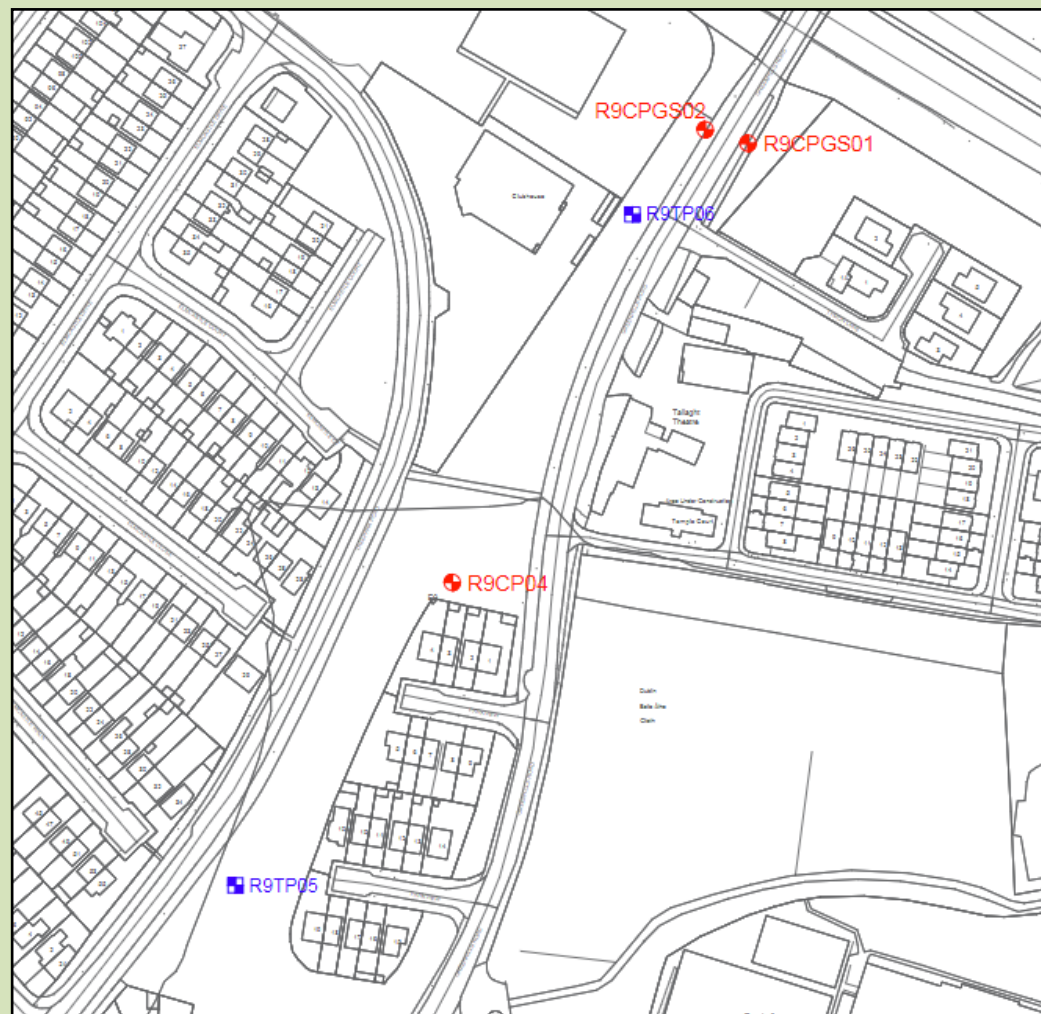


Trial Pit	R9-TP04
Location	Kilnamanagh, on ornamental grassland in a housing estate
Date	8 Oct 2020
Type	Machine-dug trial pit, 2.40m x 0.60m
Depth	Description
0m-0.20m	Loose dark brown topsoil with plastic and other modern refuse; modern potsherds and a clay pipe stem mixed in, F#'s 9-11 listed in Appendix 3
0.20m-0.80m	Mid-brown clayey soil
0.80m-2.00m+	Darker brown stony soil
Comments: Ornamental grassland in a housing estate. No archaeological significance. Plate 6	
Location Plan showing R9-TP04:	
See R9-CP03 above.	

Trial Pit	R9-TP05
Location	Kilnamanagh, on ornamental grassland in a housing estate
Date	8 Oct 2020
Type	Machine-dug trial pit, 2.40m x 0.60m
Depth	Description
0m-0.15m	Loose mid-brown sod layer
0.15m-2.00m+	Loose mid-brown soil with concrete blocks, fabric, plastic; larger stones at about 1.80m, and water coming in.

Comments: Higher than the level of the surrounding roads. Evidently used as a dump before being grassed over. No archaeological significance. **Plate 7**

Location Plan showing R9-TP05, R9-CP04 and R9-TP06:



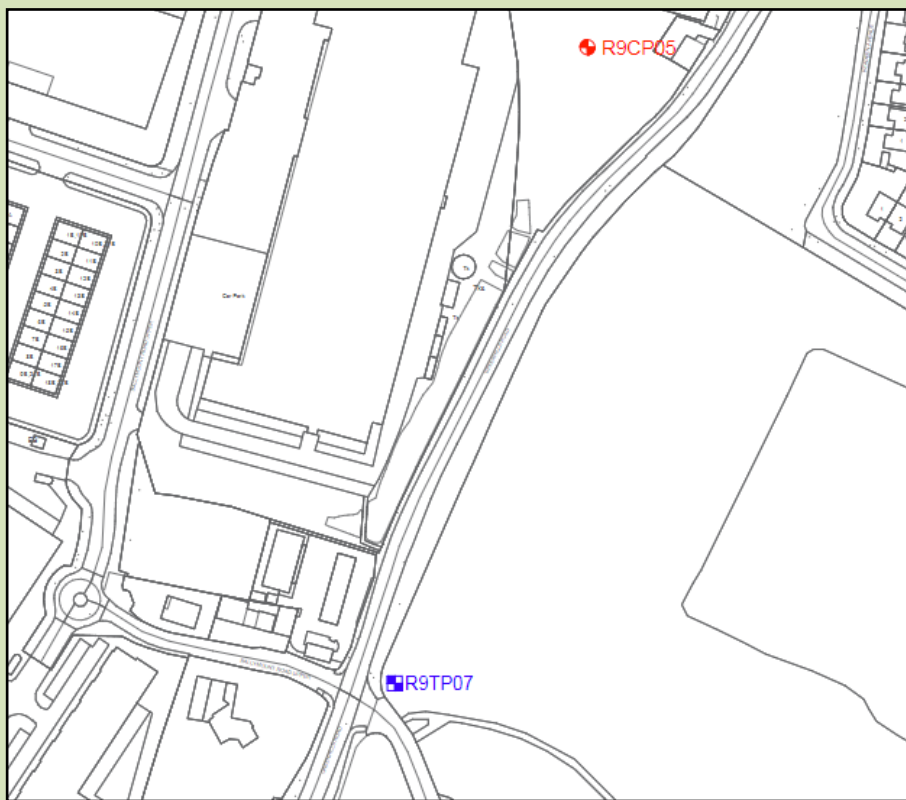
Pit/Cable Percussion	R9-CP04
Location	Kilnamanagh, on ornamental grassland in a housing estate
Date	5 October 2020
Type	Hand-dug inspection pit followed by cable percussion
Depth	Description
0m-2.00m	Mid-brown soil with stones and coarse modern refuse including a carpet
2.00m-3.00m	Gravelly brown natural; refusal at about 3.00m: probably boulder clay

Comments: Higher than the level of the surrounding roads. Evidently used as a dump before being grassed over. No archaeological significance. **Plate 8**

Location Plan showing R9-CP04:

See R9-TP05 above.

Trial pit	R9-TP06
Location	Greenhills Road, on ornamental grassland beside main road
Date	8 Oct 2020
Type	Machine-dug trial pit, 2.00m x 0.60m
Depth	Description
0m-0.30m	Mid-brown sod layer
0.30m-0.40m	Gravelly soil with beer cans
0.40m-0.95m	Hard stony clay with some brick fragments, wire, metal debris
0.95m-1.00m+	Similar material, but with boulders
Comments: Used as a dump before landscaping. No archaeological significance. Plate 9	
Location Plan showing R9-TP06: See R9-TP05 above.	

Cable Percussion	R9-CP05
Location	Narrow strip of waste land in an industrial estate/business park
Date	12 Oct 2020
Type	Cable percussion, no hand-digging
Depth	Description
0m-0.20m	Loose mid grey-brown soil with some fabric and plastic
0.20m-1.50m	Mid-grey-brown soil mixed with rubbish
1.50m-4.80m	Very clayey, but still with rubbish and stones; roofing felt at 4.00m
4.80m-5.00+	Natural gravel
Comments: Worked-out gravel pit used as a dump. No archaeological significance. Plate 10	
Location Plan showing R9-CP05:	
	

Trial Pit	R9-TP08
Location	Narrow strip of waste land in an industrial estate/business park
Date	8 October 2020
Type	Machine-dug trial pit, 1.70m x 0.50m
Depth	Description
0-0.55m	Loose mid-brown topsoil
0.55-1.00m	Gravel
1.00m+	Clayey gravel, boulders by 1.30m

Comments: Formerly in the middle of a field. Cartographic sources suggest that, unlike much of the land adjoining Greenhills Road, it was never quarried for gravel. Nothing of archaeological significance. **Plate 11**

Location Plan showing R9-TP08, R9-WS01 and R9-TP09:



Window Sample	R9-WS01
Location	Grass verge beside road in an industrial estate/business park
Date	19 Oct 2020
Type	Hand-dug inspection pit to 1.20m, then window sample drill
Depth	Description
0m-1.00m	Mid-brown gravelly soil, a lot of roots from adjoining tree
c. 1.10m	Electricity cable

Comments: Pit abandoned after electric cable cut. **Plate 12**

Location Plan showing R9-WS01:

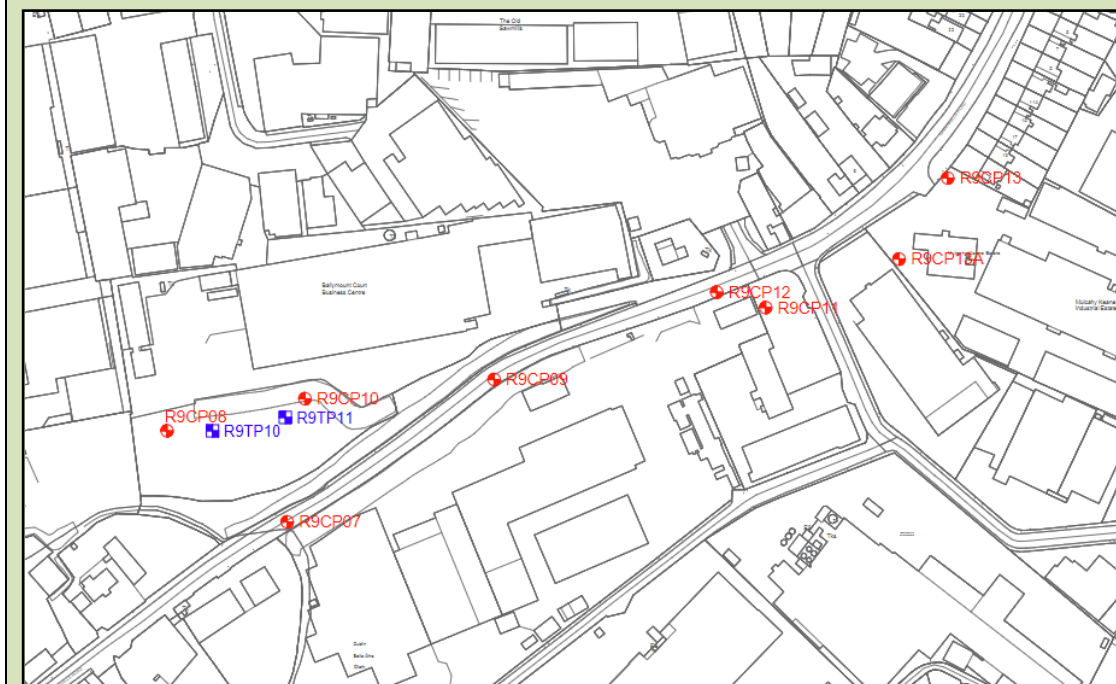
See R9-TP08 above.

Trial Pit	R9-TP09
Location	Waste ground on the edge of an industrial estate
Date	9 Oct 2020
Type	Machine-dug trial pit 1.60m x 0.60m
Depth	Description
0m-0.30m	Hardcore
0.30m-0.48m	Clay with lumps of concrete
0.48m-0.53m	Loose dark-brown soil
0.53m-1.00m	Black burnt layer
1.00m-2.5mm	Stony loose soil with rubble and domestic refuse (bottles, etc.)
2.50m-2.75m+	Gravel mixed with refuse and rubble
Comments: Worked-out gravel pit used as a dump. Nothing of archaeological significance. Plate 13	
Location Plan showing R9-TP09:	
See R9-TP08 above.	

Cable Percussion	R9-CP08
Location	Grounds of DPD premises, Greenhills. Raised area near car park.
Date	7 October 2020
Type	Cable percussion; no hand-digging
Depth	Description
0-0.20m	Gravel
0.20-0.50m	Light reddish-brown soil
0.50-2.00m	Stony/gravelly soil, lighter in colour but less red: tending to grey
2.00m+	Sticky clay with natural banding.

Comments: This is the edge of a worked-out gravel pit. Nothing of archaeological significance. **Plate 14**

Location Plan showing R9-CP08, R9-TP10, R9-TP11, R9-CP10, R9-CP07, R9-CP09, R9-CP12 and R9-CP13 :



Trial Pit	R9-TP10
Location	Grounds of DPD premises, Greenhills; cut into bank next to raised area.
Date	8 Oct 2020
Type	Machine-dug trial trench, 2.00m x 0.60m
Depth	Description
0m-0.30m	Loose mid-brown sod layer
0.30m-0.55m	Silty yellow-brown clayey layer
0.55m-0.80m	Soft yellow-brown sandy gravelly clay
0.80m-2.20m	Yellow-brown clayey gravelly sand
2.20m-4.20m+	Silt, banded
Comments: Cutting into glacial deposits at the edge of a worked-out gravel pit. Nothing of archaeological significance. Plate 15	
Location Plan showing R9-TP10:	
See R9-CP08 above.	

Trial Pit	R9-TP11
Location	Grounds of DPD premises, Greenhills; cut into bank next to raised area
Date	8 Oct 2020
Type	Machine-dug trial trench, 2.00m x 0.60m
Depth	Description
0m-0.90m	Loose dark-brown topsoil
0.90m-1.60m	Lighter yellow-brown silty soil
1.60m-3.00m	Very mixed silty material
3.00m-3.60m+	Silt
Comments: Cutting into glacial deposits at the edge of a worked-out gravel pit. Nothing of archaeological significance. Plate 16	
Location Plan showing R9-TP11:	
See R9-CP08 above.	

Cable Percussion	R9-CP10
Location	Grounds of DPD premises, Greenhills. Raised area near car park.
Date	7 October 2020
Type	Cable percussion, no hand-digging
Depth	Description
0m-0.20m	Gravel
0.20m-0.50m	Very stony soil
0.50m-2.00m	Silt, very fine; apparently water-deposited
2.00m+	Very sticky clay
Comments: This is the edge of a worked-out gravel pit. Nothing of archaeological significance. Plate 17	
Location Plan showing R9-CP10:	
See R9-CP08 above.	

Cable Percussion	R9-CP07
Location	Greenhills Road; road surface
Date	10 Oct 2020
Type	Cable percussion, no hand-digging

Depth	Description
0m-0.02m	Tarmacadam
0.02m-0.05m	Dense stone fill
0.05m-6.00m+	Dense brown gravel
Comments: Modern road surface overlying natural. No archaeological significance.	
Location Plan showing R9-CP07:	
See R9-CP08 above.	

Cable Percussion	R9-CP09
Location	Greenhills Road; road surface
Date	10 Oct 2020
Type	Cable percussion, no hand-digging
Depth	Description
0m-0.02m	Tarmacadam
0.02m-0.04m	Dense stone fill
0.04m-0.23m	Dense brown sand and gravel
Comments: Modern road surface. No archaeological significance.	
Location Plan showing R9-CP09:	
See R9-CP08 above.	

Cable Percussion	R9-CP12
Location	Greenhills Road; road surface
Date	10 Oct 2020
Type	Cable percussion, no hand-digging
Depth	Description
0m-0.02m	Tarmacadam
0.02m-0.05m	Dense stone fill
0.05m-0.4.70m	Dense brown gravel
4.70m-5.50m	Soft brown silty clay
5.50m-6.00m	Dark brown boulder clay
Comments: Modern road surface overlying natural. No archaeological significance.	
Location Plan showing R9-CP12:	
See R9-CP08 above.	

Cable Percussion	R9-CP13
Location	Mulcahy Keane industrial estate, Greenhills; corner of car park
Date	8 October 2020
Type	Cable percussion, no hand-digging.
Depth	Description
0m-0.08m	Tarmacadam
0.08m-0.50m	Very stony dark brown gritty soil
0.50m-0.80m	Grey-brown sandy soil with few stones, sherd of flowerpot
0.80m+	Yellow-brown silty soil
Comments: Former garden soil to about 0.80m. Nothing of archaeological significance. Plate 18	
Location Plan showing R9-CP13:	
See R9-CP08 above.	

4.2 Review of Finds

Artefacts were recovered from R2-SL02, R9-TP04 and R13-WS01.

The finds recovered from R2-SL02 consist of potsherds (F#'s 1-8 listed in Appendix 3), and include transfer-printed ware, polychrome ware, Willow Pattern, part of the handle of a white stoneware vessel and part of a whisky jar with the inscription:

...t Blak..

[Spir]it Merch[ant]

[Du]blin

There was also a piece of fairly coarse red ware with a pale green glaze, of possible 16th-17th century date.

This assemblage, from a slit trench beside the River Tolka, suggests that either the area behind the wall alongside the river was used as a dump, or that material dredged from the river could have been deposited there. The area is also sited in proximity of a terrace of cottages, Tolka Cottages, recorded in the mid-18th century but now demolished.

The finds from R9-TP04 comprised part of a pipe stem with spur and two potsherds, one of them with a gilt shamrock of fairly modern appearance (F#'s 9-11 listed in Appendix 3). These were mixed with undoubtedly modern refuse, but the clay pipe fragment shows that residual material from the agricultural soil was mixed in.

A copper coin from R13-WS01 was recovered from garden soil beside the driveway into Ravenswell House (F# 12 listed in Appendix 3). The coin comprises an Irish halfpenny depicted on the obverse side with the head of George II and on the reverse with Hibernia 1742 (Plate 20).

5. Conclusions

The stratigraphy revealed in the detailed ground/geotechnical investigations reflected mostly a landscape changed by modern industrial activities and development. A number of the sites in Greenhills were on the edges of worked-out sandpits, once a common feature of the area – the 'green hills' which gave the area its name were long ago removed in the course of sand-winning.

Other sites showed how ornamental grassland around housing developments were often used as a dump for building waste and general refuse before being landscaped.

No trace was found of any archaeological stratigraphy, even in Kilnamanagh, where there had been a group of medieval sites.

Finds retrieved during archaeological monitoring were mostly relatively recent, and reflected disposal of refuse. An 18th-century coin found during window sampling at Bray was a fortuitous find from garden soil.

6. References

Bolger, T., 2010. *Archaeological Monitoring of utility slit trenching along the proposed route of Metro West, Co. Dublin*. Unpublished report.

National Museum of Ireland Topographical Files

Cartographic Sources

John Rocque's map of Dublin city, 1757

John Rocque's map of County Dublin, 1760

1837-43, first edition 6-inch OS map

1908-13, 25" edition OS map

Cassini c. 1940s edition OS map

Electronic sources

www.excavations.ie Summary accounts of archaeological investigations

www.archaeology.ie Website listing RMP and NIAH sites

www.heritagemaps.ie Heritage Council website

<http://digital.ucd.ie> Historic OS maps

www.dublinhistoricmaps.ie 17th and 18th century historic maps of Dublin

www.stpetersparishbray.com Bray history

7. Monitoring Plates



Plate 1 Slit trench R2-SLT02



Plate 2 Trial pit R9-TP01



Plate 3 Trial pit R9-TP02



Plate 4 Trial pit R9-TP03



Plate 5 Cable percussion R9-CP03



Plate 6 Trial pit R9-TP04



Plate 7 Trial pit R9-TP05



Plate 8 Cable percussion R9-CP04



Plate 9 Trial pit R9-TP06



Plate 10 Cable percussion, R9-CP05



Plate 11 Trial pit R9-TP08



Plate 12 Window sample R9-WS01



Plate 13 Trial pit R9-TP09



Plate 14 Cable percussion R9-CP08



Plate 15 Trial pit R9-TP10



Plate 16 Trial pit R9-TP11



Plate 17 Cable percussion R9-CP10



Plate 18 Cable percussion R9-CP13



Plate 19 Window sample R13-WS01



Plate 20 R13-WS01, Irish halfpenny of George II, 1742

8. Appendix 1 Identified Investigation Locations

Route	Investigation Ref.	Townland, County	Monitoring proposed
CBC02 – Swords to City Centre	R2-CPRC01	Drishoge, Dublin	Yes
CBC02 – Swords to City Centre	R2-CPRC02	Clonliff West, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-M09-BH-01	Tymon North, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-M10-BH-01	Tymon North, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-M16-BH-04	Greenhills, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-M16-BH-05	Greenhills, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-M17-BH-01	Greenhills, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-M17-BH-02	Greenhills, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-M17-BH-04	Greenhills, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-M17-BH-06	Greenhills, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-M17-BH-07	Greenhills, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-M17-BH-08	Greenhills, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-M03-TP-01	Tallaght, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-M03-TP-02	Tallaght, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-M09-TP-03	Tymon North, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-M10-TP-01	Tymon North, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-M10-TP-04	Kilnamanagh, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-M11-TP-02	Kilmnamanagh, Dublin	Yes
CBC13 – Bray to City Centre	R13-CP01 unmonitored	Woodland, Dublin	Yes
CBC13 – Bray to City Centre	R13-CP02 unmonitored	Foxrock, Dublin	Yes
CBC13 – Bray to City Centre	R13-CP03	Ravenswell, Wicklow	Yes

9. Appendix 2 Monitored Investigation Locations

Route	Borehole Ref.	Townland, County	Archaeological Monitoring Completed
CBC02 – Swords to City Centre	R2-SLT02	Clonliff West, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-TP01	Tallaght, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-TP02	Tallaght, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-TP03	Tallaght, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-CP03	Tymon North, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-TP04	Tymon North, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-TP05	Tymon North, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-CP04	Tymon North, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-TP06	Kilnamanagh, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-CP05	Kilnamanagh, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-TP08	Kilnamanagh, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-WS01	Kilnamanagh, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-TP09	Kilnamanagh, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-CP08	Greenhills, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-TP10	Greenhills, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-TP11	Greenhills, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-CP10	Greenhills, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-CP07	Greenhills, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-CP09	Greenhills, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-CP12	Greenhills, Dublin	Yes
CBC09 – Greenhills to City Centre	R9-CP13	Greenhills, Dublin	Yes
CBC13 – Bray to City Centre	R13-WS01	Ravenswell, Bray, Wicklow	Yes

10. Appendix 3 Register of Finds

Licence #	Find#	Type	Description	Date	Investigation Location	Townland
20E0622	1	Potsherd	Rim of large transfer-printed plate	29-Sep-20	R02-SLT02	Clonliff West
20E0622	2	Potsherd	Handle of white stoneware vessel	29-Sep-20	R02-SLT02	Clonliff West
20E0622	3	Potsherd	Fragment of transfer-printed plate	29-Sep-20	R02-SLT02	Clonliff West
20E0622	4	Potsherd	Rim of transfer-printed cup	29-Sep-20	R02-SLT02	Clonliff West
20E0622	5	Potsherd	Base of hand-painted cup	29-Sep-20	R02-SLT02	Clonliff West
20E0622	6	Potsherd	Base of Willow Pattern plate '[S]TONE W[...]'	29-Sep-20	R02-SLT02	Clonliff West
20E0622	7	Potsherd	Part of plate with red fabric and light green glaze	29-Sep-20	R02-SLT02	Clonliff West
20E0622	8	Potsherd	Part of stoneware vessel with brown glaze. '...t Blak[e, Spir]it Merch[ant..... Du]blin'	29-Sep-20	R02-SLT02	Clonliff West
20E0622	9	Potsherd	Part of cup with shamrock decoration	08-Oct-20	R09-TP04	Kilnamanagh
20E0622	10	Potsherd	Piece of transfer-printed ware	08-Oct-20	R09-TP04	Kilnamanagh
20E0622	11	Clay-pipe	Part of stem with spur	08-Oct-20	R09-TP04	Kilnamanagh
20E0622	12	Coin	Irish halfpenny of George II, 1742	19-Oct-20	R13-WS01	Ravenswell



CAUSEWAY
— GEOTECH

Bus Connects Route 8 Tallaght/Clondalkin to City Centre – Ground Investigation

Client: National Transport Authority (NTA)

Client's Representative: AECOM/Mott MacDonald

Report No.: 20-0399C

Date: December 2020

Status: Final for Issue

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Document Control Sheet




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APPENDICES

Appendix A	Site and exploratory hole location plans
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Document Control Sheet

Report No.:		20-0399C			
Project Title:		Bus Connects Route 8 Tallaght/Clondalkin to City Centre			
Client:		National Transport Authority (NTA)			
Client's Representative:		AECOM/Mott MacDonald			
Revision:	A01	Status:	Final for Issue	Issue Date:	14 th December 2020
Prepared by:		Reviewed by:		Approved by:	
 Sean Ross BSc MSc MIEI		 Colm Hurley BSc FGS PGeo		 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 $N \times 5 = C_u$ 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 8 Tallaght/Clondalkin to City Centre

1 AUTHORITY

On the instructions of AECOM/Mott MacDonald, (“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, soil and rock core sampling, environmental sampling, groundwater monitoring, in-situ and laboratory testing, and the preparation of a factual report on the findings.

3 DESCRIPTION OF SITE

As shown on the site location plan in Appendix A, the works were conducted from north west to north east across the junction of the Long Mile Road and the Naas Road in Drimnagh Dublin 12. The junctions also comprise the Luas Red Line from the Red Cow to Connolly station.

4 SITE OPERATIONS

4.1 Summary of site works

Site operations, which were conducted between 13th and 22nd October 2020, comprised:

- four light cable percussion boreholes
- four rotary follow-on boreholes
- a standpipe installation in two boreholes

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

Four boreholes (R8-CPGS01-R8-CPGS04) were put down by a combination of light cable percussion boring using a Dando 2000 rig and rotary follow-on drilling techniques with core recovery in bedrock using a truck mounted Berretta T44 rotary drilling rig.

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

Disturbed (bulk and small bag) samples were taken within the encountered strata. Undisturbed (U100) samples were taken where appropriate and as directed within fine soils. Environmental samples were taken at standard intervals, as directed by the Client's Representative.

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

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

Where the cable percussion borehole had not been advanced onto bedrock, rotary percussive methods were employed to advance the borehole to bedrock after which rotary coring was employed to recover core samples of the bedrock. Symmetrix cased full-hole drilling was used, with SPTs carried out at standard intervals as required.

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 E.

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 R8-CPGS02 and R8-CPGS04.

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

4.4 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 (Irl)) at each location are recorded on the individual exploratory hole logs. The exploratory hole plan presented in Appendix A shows these as-built positions.

4.5 Groundwater monitoring

Following completion of site works, groundwater monitoring was conducted on one round. 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.
- **soil chemistry:** pH and water soluble sulphate content

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

The test results are presented in Appendix D.

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 D.

6 GROUND CONDITIONS

6.1 General geology of the area

Published geological mapping indicate the superficial deposits underlying the site comprise Glacial Till. These deposits are underlain by limestones and shales 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:

- **Paved surface:** all boreholes encountered paving brick at ground level. Beneath this were both bitmac and concrete of varying thickness likely representing old road surfaces. Concrete was encountered to a maximum depth of 1.00m in R8-CPGS01 and R8-CPGS02.
- **Made Ground (sub-base):** approximately 200-300mm of aggregate fill beneath the paved surface beneath the deepest paved surface to a maximum depth of 1.20m in R8-CPGS01 and R8-CPGS02.
- **Glacial Till:** sandy gravelly clay, frequently with low cobble content, typically firm or stiff in upper horizons, becoming very stiff with increasing depth.
- **Bedrock (Limestone):** Rockhead was encountered at depths ranging from 4.50m in R8-CPGS01-R8-CPGS03 to 6.00m in R8-CPGS04.

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 and rotary drilling through soil and rock as groundwater strikes as shown in Table 1 below.

Table 1: Groundwater strikes encountered during the ground investigation

GI Ref	Water Level (mbgl)	Comments
R8-CPGS01	4.30	
R8-CPGS02	3.40	
	3.60	Rose to 3.50m after 20 mins
R8-CPGS03	4.20	
R8-CPGS04	3.50	

It should be noted that the casing used in supporting the borehole walls during drilling may have sealed out any 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.

Subsequent groundwater monitoring of the standpipe installations recorded water levels as shown in Table 2.

Table 2: Groundwater monitoring

Date	Water level (mbgl)	
	R8-CPGS02	R8-CPGS04
19/11/20	3.29	2.53

Seasonal variation in groundwater levels should also be factored into design considerations and continued monitoring of the two installed standpipes will give an indication of the seasonal variation.

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.

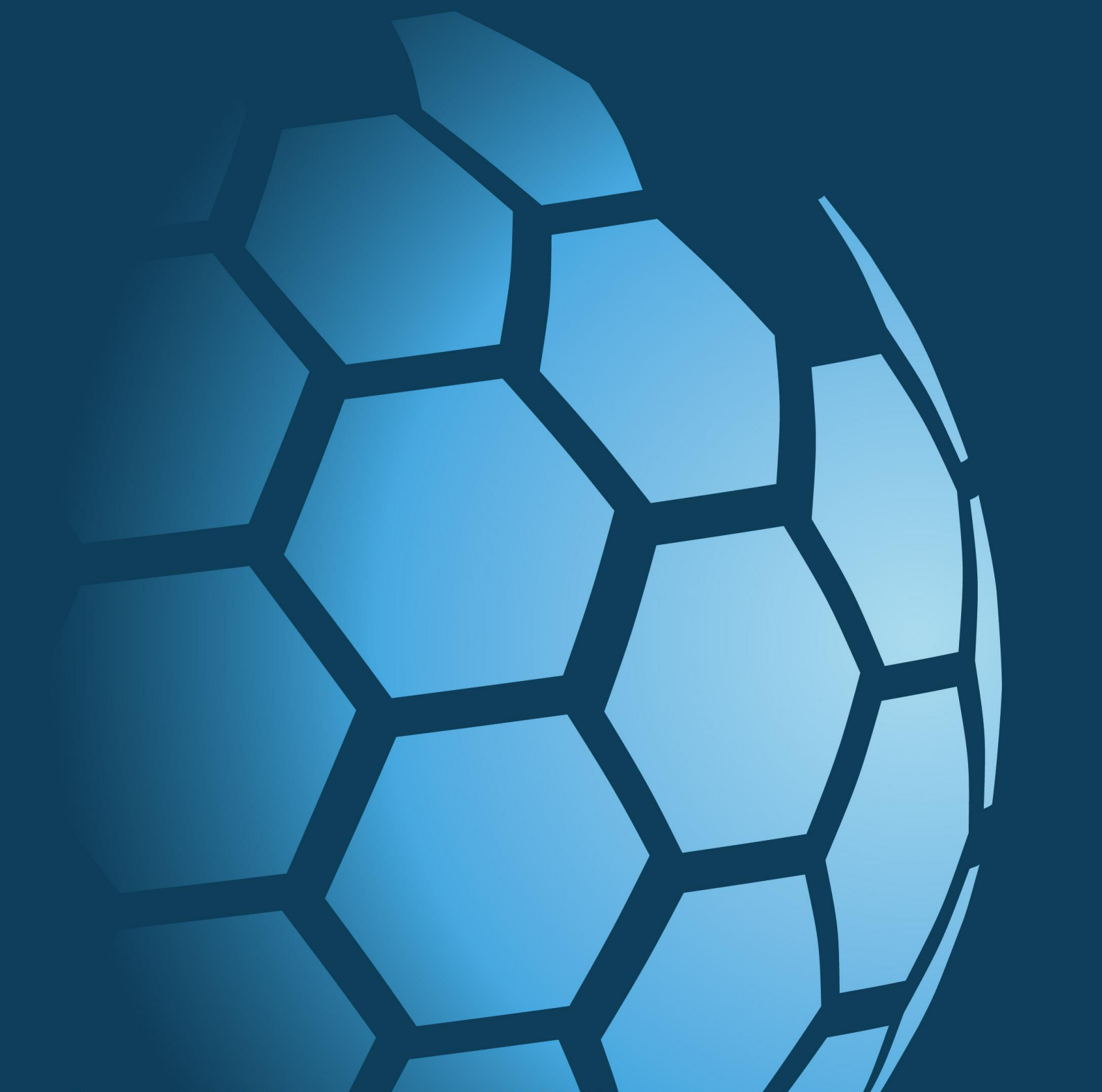
BS EN ISO 14689-1:2018: Geotechnical investigation and testing. Identification and classification of rock. Identification and description.

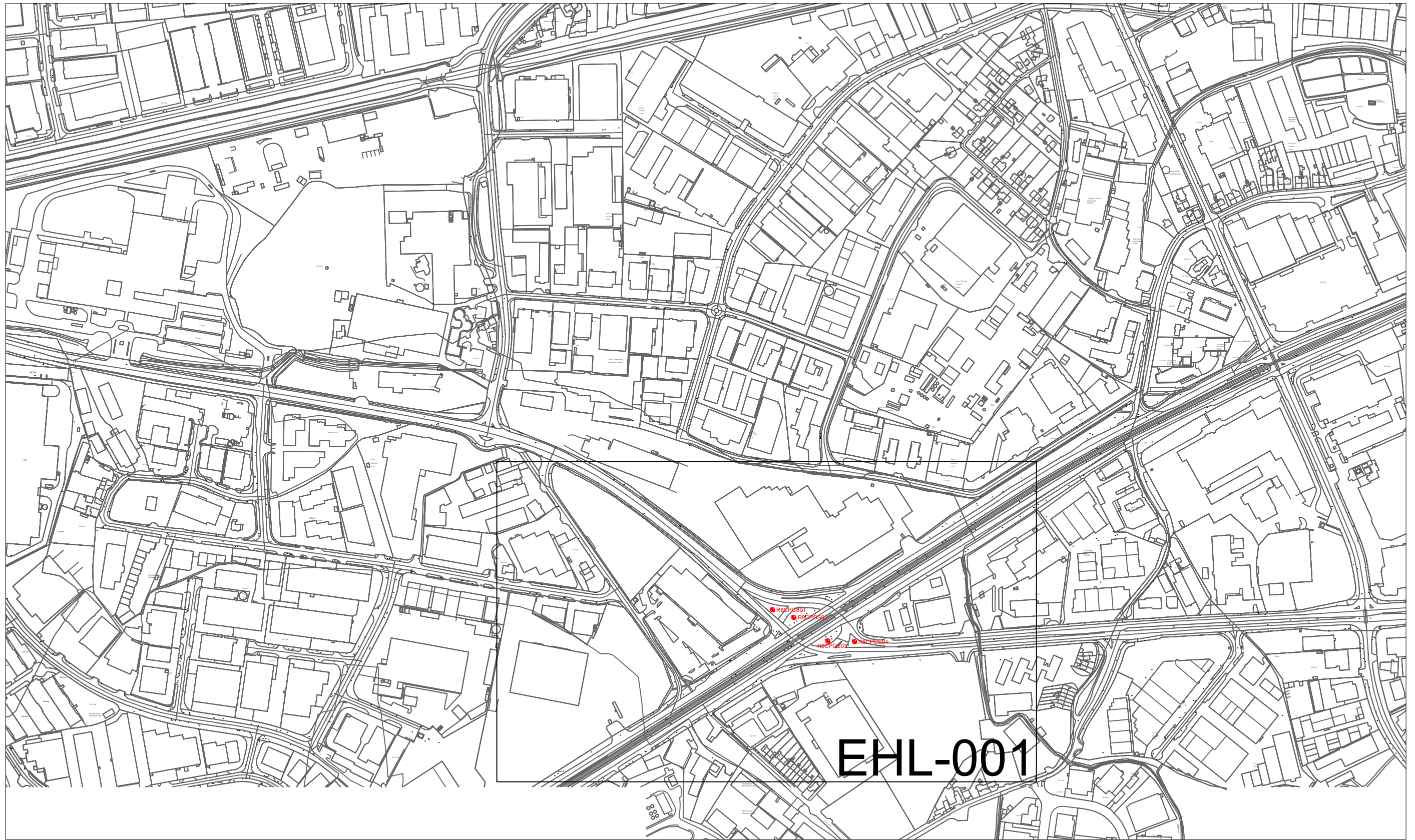
BS EN ISO 22476-3:2005+A1:2011: Geotechnical investigation and testing. Field testing. Standard penetration test.



CAUSEWAY
— GEOTECH

APPENDIX A
SITE AND EXPLORATORY HOLE LOCATION PLAN





EHL-001

PROJECT: Bus Connects Route 8 Tallaght/Clondalkin to City Centre

TITLE: Exploratory hole location plan (Overview)

CLIENT: National Transport Authority (NTA)

KEY:  Borehole



SCALE: NTS@A3

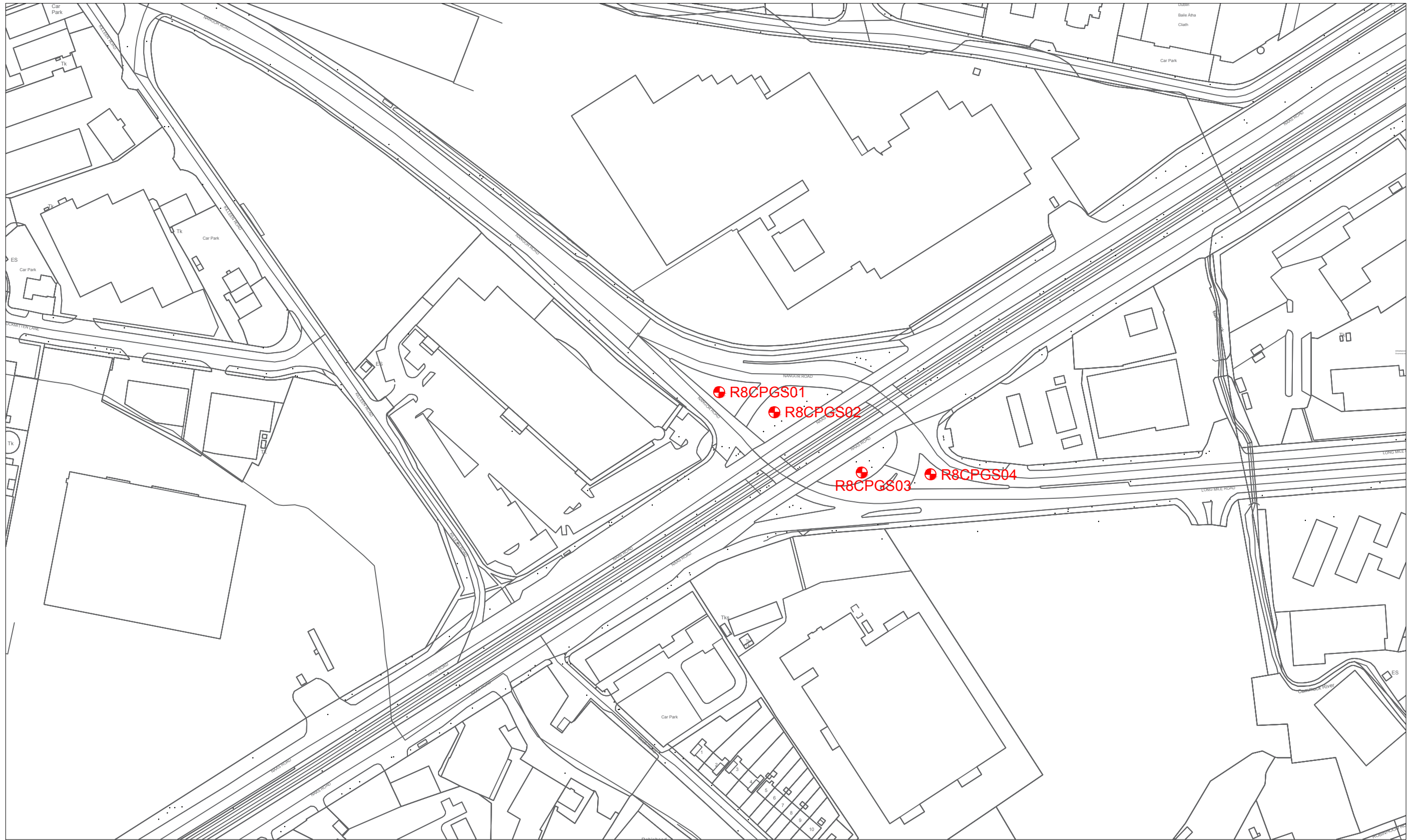
DATE: 23/11/2020

ENGINEER: AECOM/Mott MacDonald

DRWN: BS
CHCK: CH

SERIES: 1 of 1

DWG No: 20-0399C-EHL-OW-001



PROJECT: Bus Connects Route 8 Tallaght/Clondalkin to City Centre

TITLE: Exploratory hole location plan

CLIENT: National Transport Authority (NTA)

KEY:  Borehole



SCALE: NTS@A3

DATE: 23/11/2020

ENGINEER: AECOM/Mott MacDonald

DRWN: BS
CHCK: CH

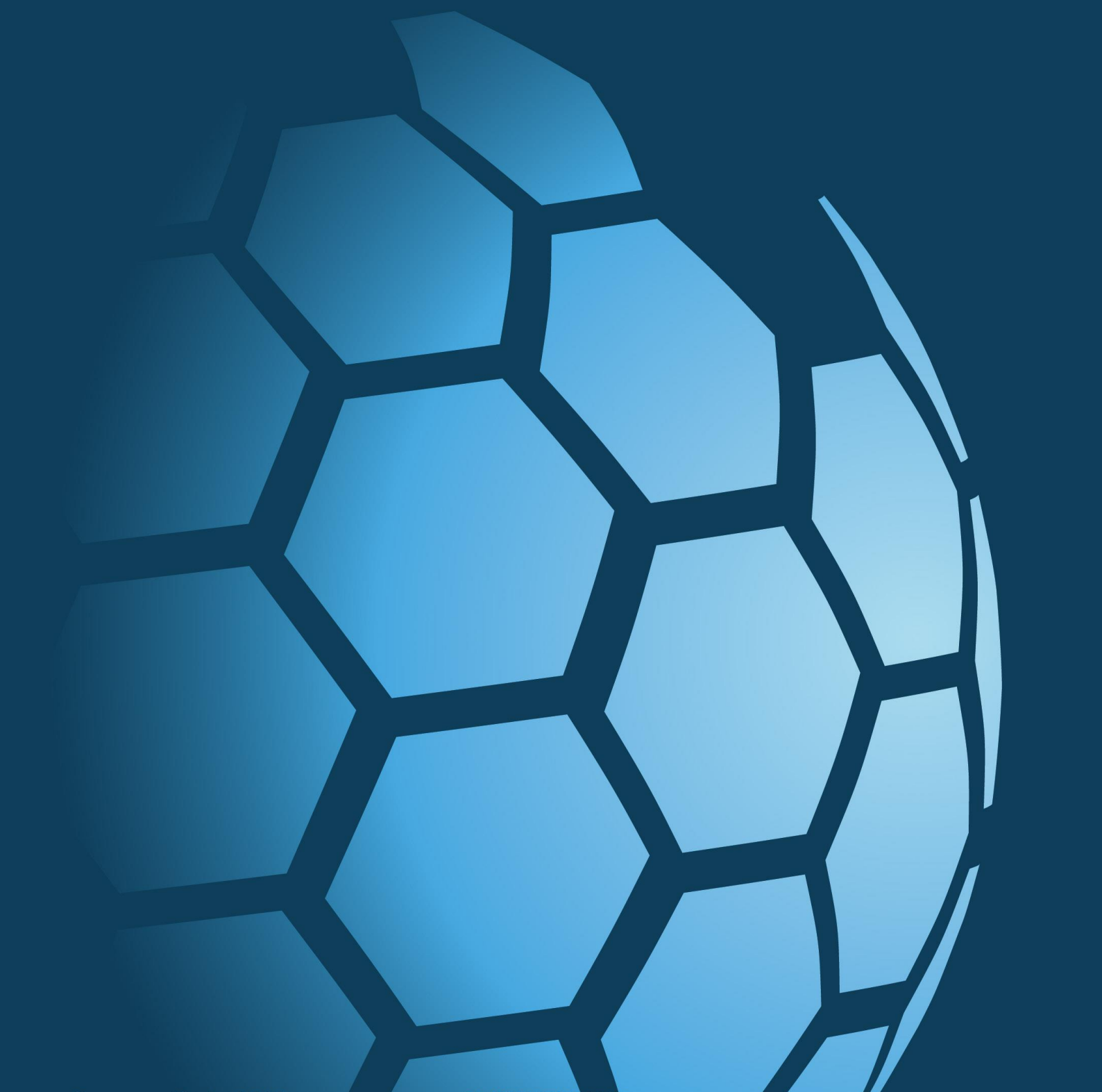
SERIES: 1 of 1

DWG No: 20-0399C-EHL-001



CAUSEWAY
— GEOTECH

APPENDIX B
BOREHOLE LOGS





Method	Plant Used	Top (m)	Base (m)	Coordinates	Final Depth:	Start Date:	Driller:	Sheet 1 of 2
Cable Percussion	Dando 2000	0.00	4.00	709700.59 E	10.00 m	13/10/2020	BM+GT	Scale: 1:50
Rotary Drilling	Beretta T44	4.00	4.50	731671.04 N				
Rotary Coring	Beretta T44	4.50	10.00		Elevation: 48.19 mOD	End Date: 19/10/2020	Logger: CH+NP	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill			
0.50	B6	N=50 (25 for 75mm/50 for 75mm) Hammer SN = 0643	0.00	Dry	48.09	0.10	MADE GROUND: Paving brick						
0.50	ES1				47.89	0.30	CONCRETE						
1.00	B7				47.69	0.50	BITMAC						
1.00	ES2				47.49	0.70	MADE GROUND: Grey angular fine to coarse GRAVEL of mixed lithologies.						
1.20	D12				47.19	1.00	CONCRETE						
1.20 - 1.35	SPT (S)				46.99	1.20	MADE GROUND: Grey sandy silty subangular fine to coarse GRAVEL of mixed lithologies. Sand is fine to coarse.						
1.50	ES3				46.19	2.00	Very stiff black slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies. Cobbles are subrounded of mixed lithologies.						
2.00	B8				N=50 (11,15/50 for 135mm) Hammer SN = 0643	0.00	Dry	46.19	2.00	Very stiff brownish grey slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies. Cobbles are subrounded of mixed lithologies.			
2.00	D13												
2.00	ES4												
2.00 - 2.28	SPT (S)												
3.00	B9												
3.00	D14	N=42 (18,16/12,10,10,10) Hammer SN = 0643	0.00	Dry									
3.00	ES5												
3.00 - 3.45	SPT (S)												
4.00	B10	N=50 (25 for 25mm/50 for 25mm) Hammer SN = 0643	0.00	Dry	44.19	4.00	Very stiff brownish grey sandy gravelly CLAY with low cobble content. (Driller's description)						
4.00 - 4.05	SPT (S)				43.89	4.30	Grey LIMESTONE. (Driller's description)						
4.30	B11	Strike at 4.30m.			43.69	4.50	Medium strong (locally weak) thinly bedded dark grey LIMESTONE. Partially weathered: reduced strength, closer fracture spacing with brown clay deposits and brown staining on fracture surfaces. Discontinuities;						
4.50	ES							(0.65)	1. 0 to 15 degree bedding fractures, closely spaced (25/80/200), slightly undulating, smooth with brown clay deposits and brown staining on fracture surfaces.				
4.60	C								2. At 4.50m to 4.70m and 4.70m to 5.05m: 75 to 90 degree joints, undulating, smooth with brown clay deposits and brown staining				
5.00	C				100	97	53		Medium strong (locally strong) thinly bedded dark grey LIMESTONE. Partially weathered: slightly reduced strength, slightly closer fracture spacing with brown clay deposits. Discontinuities;				
5.75	C								1. 0 to 15 degree bedding fractures, medium spaced (45/220/720), plana and slightly undulating, smooth with brown clay deposits on fracture surfaces.				
5.90	C								2. 35 to 40 degree joints, widely spaced (240/615/>3400), slightly undulating, smooth with brown clay infill up to 5mm between fracture surfaces.				
6.00	C								3. At 5.25m to 5.55m and 8.60m to 8.85m: 75 degree joints, undulating, smooth with brown clay infill up to 32mm between joint surfaces.				
6.35	C												
6.60	C				93	73	67						
6.90	C												
7.50	C												
7.50	C	100	100	92	3								
9.00													

Water Strikes				Chiselling Details			Remarks
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)	
4.30	4.30			4.00	4.30	01:00	
Casing Details		Water Added		Core Barrel	Flush Type	Termination Reason	Last Updated
To (m)	Diam (mm)	From (m)	To (m)				
				SK6L	Polymer	Terminated at scheduled depth.	14/12/2020





Method	Plant Used	Top (m)	Base (m)	Coordinates	Final Depth:	Start Date:	Driller:	Sheet 2 of 2
Cable Percussion	Dando 2000	0.00	4.00	709700.59 E 731671.04 N	10.00 m	13/10/2020	BM+GT	Scale: 1:50
Rotary Drilling	Beretta T44	4.00	4.50		Elevation: 48.19 mOD	End Date: 19/10/2020	Logger: CH+NP	FINAL
Rotary Coring	Beretta T44	4.50	10.00					

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
9.35	C	96	96	76	8			38.19	10.00		Medium strong (locally strong) thinly bedded dark grey LIMESTONE. Partially weathered: slightly reduced strength, slightly closer fracture spacing with brown clay deposits. Discontinuities: 1. 0 to 15 degree bedding fractures, medium spaced (45/220/720), plana and slightly undulating, smooth with brown clay deposits on fracture surfaces. 2. 35 to 40 degree joints, widely spaced (240/615/>3400), slightly undulating, smooth with brown clay infill up to 5mm between fracture surfaces. 3. At 5.25m to 5.55m and 8.60m to 8.85m: 75 degree joints, undulating, smooth with brown clay infill up to 32mm between joint surfaces. End of Borehole at 10.00m		
10.00													

Water Strikes				Chiselling Details			Remarks		
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)			
4.30	4.30			4.00	4.30	01:00			
Casing Details		Water Added		Core Barrel			Flush Type	Termination Reason	Last Updated
To (m)	Diam (mm)	From (m)	To (m)	SK6L			Polymer	Terminated at scheduled depth.	14/12/2020



Project No.
20-0399C

Project Name: Bus Connects Route 8 Tallaght/Clondalkin to City Centre
Client: National Transport Authority (NTA)
Client's Rep: AECOM/Mott MacDonald

Borehole ID
R8-CPGS02

Method	Plant Used	Top (m)	Base (m)	Coordinates	Final Depth:	Start Date:	Driller:	Sheet 1 of 2
Cable Percussion Rotary Drilling Rotary Coring	Dando 2000 Beretta T44 Beretta T44	0.00 4.00 4.50	4.00 4.50 10.00	709730.16 E 731660.28 N	10.00 m	14/10/2020	BM+GT	Scale: 1:50
								FINAL
					Elevation:	End Date:	Logger:	
					47.59 mOD	20/10/2020	CH+NP	

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill				
0.50	B5	N=50 (25 for 75mm/50 for 50mm) Hammer SN = 0643	0.00	Dry	47.49	0.10	MADE GROUND: Paving brick	Very stiff greyish black slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies. Cobbles are subrounded of mixed lithologies.	Water	Backfill				
0.50	ES1					0.40	CONCRETE							
1.00	B6					0.60	BITMAC							
1.00	ES2					1.00	CONCRETE							
1.20	D10					1.20	MADE GROUND: Grey angular fine to coarse GRAVEL of mixed lithologies.							
1.20 - 1.32	SPT (S)					1.50	Very stiff brown slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies. Cobbles are subrounded of mixed lithologies.							
2.00	B7					N=50 (14,26/50 for 125mm) Hammer SN = 0643	0.00				Dry	46.09	2.00	Very stiff greyish black slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies. Cobbles are subrounded of mixed lithologies.
2.00	D11												3.60	Very stiff greyish black slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies. Cobbles are subrounded of mixed lithologies.
2.00	ES3												4.00	subrounded fine to coarse of mixed lithologies. Cobbles are subrounded of mixed lithologies.
2.00 - 2.28	SPT (S)												4.30	Very stiff greyish black sandy gravelly CLAY. (Driller's description)
3.00	B8	4.50	Grey LIMESTONE. (Driller's description)											
3.00	ES4	(1.05)	Medium strong (locally weak) thinly bedded dark grey LIMESTONE. Partially weathered: slightly reduced strength, closer fractures spacing with localised brown clay deposits and brown staining on fracture surfaces.											
3.00 - 3.40	U13	5.55	Discontinuities: 1. 10 to 15 degree bedding fractures, medium spaced (100/210/270), slightly undulating, smooth with brown clay infill up to 4mm between fracture surfaces and brown staining on fracture surfaces. 2. 60 to 70 degree joints, medium spaced (90/260/350), slightly undulating, smooth with brown clay deposits on joint surfaces and brown staining on joint surfaces.											
4.00	B9	Ublow=30 80% Strike at 3.40m. Slow seepage at 3.60m	Dry	43.99	43.59			4.00	Medium strong (locally weak) thinly bedded dark grey LIMESTONE. Partially weathered: slightly reduced strength, closer fracture spacing with localised brown clay deposits and brown staining on fracture surfaces.					
4.00	D12							4.30	Discontinuities: 1. 10 to 20 degree bedding fractures, closely, spaced (20/150/310), slightly undulating, smooth with patchy brown clay deposits and brown staining on fracture surfaces. 2. 60 to 85 degree joints, probably widely spaced, slightly undulating to undulating, smooth with brown staining on joint surfaces and localised brown clay infill up to 12mm between joint surfaces.					
4.00 - 4.08	SPT(S) N=50 (25 for 25mm/50 for 50mm) Hammer SN = 0643							4.50	8.56m to 8.69m: Very weak thickly laminated carbonaceous MUDSTONE					
4.50	C					5.00								
4.70	ES					5.55								
5.45	C					6.00								
5.55	C					6.80								
6.00	C					7.10								
6.80	C					7.50								
7.10	C					8.10								
7.50	C	8.50												
8.10	C	9.00												
8.50		>20												
9.00														
		TCR	SCR	RQD	FI									

Water Strikes				Chiselling Details			Remarks
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)	
3.40				3.70	4.00	01:00	
3.60	3.60	20	3.50				
Casing Details		Water Added		Core Barrel	Flush Type	Termination Reason	Last Updated
To (m)	Diam (mm)	From (m)	To (m)				
4.50	200						
				SK6L	Polymer	Terminated at scheduled depth.	14/12/2020





Method	Plant Used	Top (m)	Base (m)	Coordinates	Final Depth:	Start Date:	Driller:	Sheet 2 of 2
Cable Percussion	Dando 2000	0.00	4.00	709730.16 E 731660.28 N	10.00 m	14/10/2020	BM+GT	Scale: 1:50
Rotary Drilling	Beretta T44	4.00	4.50		Elevation: 47.59 mOD	End Date: 20/10/2020	Logger: CH+NP	FINAL
Rotary Coring	Beretta T44	4.50	10.00					

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
9.35	C	96	96	81	8			37.59	10.00		Medium strong (locally weak) thinly bedded dark grey LIMESTONE. Partially weathered: slightly reduced strength, closer fracture spacing with localised brown clay deposits and brown staining on fracture surfaces. Discontinuities: 1. 10 to 20 degree bedding fractures, closely, spaced (20/150/310), slightly undulating, smooth with patchy brown clay deposits and brown staining on fracture surfaces. 2. 60 to 85 degree joints, probably widely spaced, slightly undulating to undulating, smooth with brown staining on joint surfaces and localised brown clay infill up to 12mm between joint surfaces. End of Borehole at 10.00m		
10.00													

Water Strikes				Chiselling Details			Remarks
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)	
3.40				3.70	4.00	01:00	
3.60	3.60	20	3.50				
Casing Details		Water Added		Core Barrel			Termination Reason
To (m)	Diam (mm)	From (m)	To (m)	Flush Type			
4.50	200			SK6L	Polymer		
							Last Updated
							14/12/2020





Method	Plant Used	Top (m)	Base (m)	Coordinates	Final Depth:	Start Date:	Driller:	Sheet 1 of 2
Cable Percussion Rotary Drilling Rotary Coring	Dando 2000 Beretta T44 Beretta T44	0.00 3.00 4.50	3.00 4.50 10.00	709776.99 E 731627.95 N	10.00 m	16/10/2020	BM+GT	Scale: 1:50
								FINAL
					Elevation:	End Date:	Logger:	
					47.08 mOD	21/10/2020	CH+NP	

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill			
0.50	B7	Ublow=20 80%	0.00	Dry		46.98	0.10	MADE GROUND: Paving brick					
0.50	ES1					46.78	0.30	CONCRETE					
1.00	B8					46.48	0.60	MADE GROUND: Grey slightly sandy angular fine to coarse GRAVEL of mixed lithologies. Sand is fine to coarse.					
1.00	ES2							Firm brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded of mixed lithologies.					
1.20 - 1.65	U20												
2.00	B9												
2.00	D16												
2.00	ES3												
2.00 - 2.40	SPT (S)					N=50 (2,5/50 for 245mm) Hammer SN = 0643	0.00	Dry			44.58	2.50	Very stiff dark grey slightly sandy very gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded of mixed lithologies.
3.00	B10										44.08	3.00	Very stiff dark grey sandy gravelly CLAY. (Driller's description)
3.00	D11												
3.00	ES4												
3.00 - 3.06	SPT (S)	N=50 (25 for 25mm/50 for 30mm) Hammer SN = 0643	0.00	Dry									
		Strike at 4.20m.											
4.55	C				42.78	4.30	Grey LIMESTONE. Driller's description)						
4.70	ES				42.58	4.50	Medium strong thickly bedded dark grey LIMESTONE. Partially weathered: slightly reduced strength, slightly closer fracture spacing with localised brown clay deposits.						
5.05	C						Discontinuities:						
5.30	C	100 97 72					1. 0 to 15 degree bedding fractures, medium spaced (65/225/480), planar, and slightly undulating, smooth with brown clay infill up to 58mm between some fracture surfaces and orange staining on fracture surfaces.						
6.00	C						2. 20 to 40 degree joints, widely spaced (210/1235/1370), undulating, smooth with brown clay infill up to 6mm between some joint surfaces and no staining on joint surfaces.						
6.00	C						3. At 5.85m to 6.00m and 7.95m to 8.15m: 85 to 90 degree joints, undulating, smooth with brown clay deposits on joint surfaces.						
6.30	C												
6.80	C	100 100 96		6		(5.15)							
7.50	C												
7.50	C	100 100 82											
9.00	C												
9.05	C												

Water Strikes				Chiselling Details			Remarks	
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)		
4.20				2.50	3.00	01:00		Hand dug inspection pit excavated to 1.20m.
Casing Details		Water Added						
To (m)	Diam (mm)	From (m)	To (m)					
4.50	200							
				Core Barrel	Flush Type	Termination Reason	Last Updated	
				SK6L	Polymer	Terminated at scheduled depth.	14/12/2020	



Method	Plant Used	Top (m)	Base (m)	Coordinates	Final Depth: 10.00 m	Start Date: 16/10/2020	Driller: BM+GT	Sheet 2 of 2 Scale: 1:50
Cable Percussion Rotary Drilling Rotary Coring	Dando 2000 Beretta T44 Beretta T44	0.00 3.00 4.50	3.00 4.50 10.00	709776.99 E 731627.95 N	Elevation: 47.08 mOD	End Date: 21/10/2020	Logger: CH+NP	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
10.00		100	57	55	NI			37.43	9.65 (0.35)		Medium strong thickly bedded dark grey LIMESTONE. Partially weathered: slightly reduced strength, slightly closer fracture spacing with localised brown clay deposits. Discontinuities: 1. 0 to 15 degree bedding fractures, medium spaced (65/225/480), planar, and slightly undulating, smooth with brown clay infill up to 58mm between some fracture surfaces and orange staining on fracture surfaces. 2. 20 to 40 degree joints, widely spaced (210/1235/1370), undulating, smooth with brown clay infill up to 6mm between some joint surfaces and no staining on joint surfaces. 3. At 5.85m to 6.00m and 7.95m to 8.15m: 85 to 90 degree joints, undulating, smooth with brown clay deposits on joint surfaces. <u>9.43m to 9.51m: Brown sandy gravelly clay infill.</u> Soft becoming firm brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to coarse of limestone. End of Borehole at 10.00m		9.5 10.0 10.5 11.0 11.5 12.0 12.5 13.0 13.5 14.0 14.5 15.0 15.5 16.0 16.5 17.0 17.5 18.0 18.5
								37.08	10.00				

Water Strikes				Chiselling Details			Remarks Hand dug inspection pit excavated to 1.20m.
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)	
4.20				2.50	3.00	01:00	
Casing Details		Water Added					
To (m)	Diam (mm)	From (m)	To (m)				
4.50	200						
				Core Barrel	Flush Type	Termination Reason	Last Updated
				SK6L	Polymer	Terminated at scheduled depth.	14/12/2020



Method	Plant Used	Top (m)	Base (m)	Coordinates	Final Depth:	Start Date:	Driller:	Sheet 1 of 2
Cable Percussion Rotary Drilling Rotary Coring	Dando 2000 Beretta T44 Beretta T44	0.00 4.00 6.00	4.00 6.00 12.00	709813.86 E 731627.02 N	12.00 m	15/10/2020	BM+GT	Scale: 1:50
					Elevation:	End Date:	Logger:	FINAL
					46.53 mOD	22/10/2020	CH+NP	

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill								
0.50	B5	N=13 (2,2/3,3,3,4) Hammer SN = 0643	0.00	Dry	46.43	0.10	MADE GROUND: Paving brick	Firm brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.	Water	Backfill								
0.50	ES1					0.30	CONCRETE											
1.00	B6					0.70	MADE GROUND: Grey angular fine to coarse GRAVEL of mixed lithologies.											
1.00	ES2																	
1.20	D12																	
1.20 - 1.65	SPT (S)																	
2.00	B7					Ublow=20 100%	0.00				Dry	44.53	2.00	Stiff greyish black slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies. Cobbles are subrounded of mixed lithologies.				
2.00	ES3																	
2.00 - 2.45	U13																	
3.00	B8																	
3.00	D11																	
3.00	ES4																	
3.00 - 3.45	SPT (S)	N=20 (2,3/4,5,5,6) Hammer SN = 0643 Strike at 3.50m.	0.00	Dry	42.93			3.60	Very stiff greyish black slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mixed lithologies.									
4.00	B12	N=50 (25 for 15mm/50 for 50mm) Hammer SN = 0643	0.00	3.60	42.53			4.00	Very stiff greyish black sandy gravelly CLAY. (Driller's description)									
4.00	D13																	
4.00 - 4.07	SPT (S)																	
5.00 - 5.25	SPT (S)					N=50 (8,15/50 for 100mm) Hammer SN = 0209	5.00	3.50	41.03	5.50	Grey LIMESTONE. (Driller's description)							
6.00	C					<table border="1"> <tr> <td>TCR</td> <td>SCR</td> <td>RQD</td> <td>FI</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> </tr> </table>	TCR	SCR	RQD	FI					4	40.53	6.00	Medium strong thinly bedded dark grey LIMESTONE. Partially weathered: slightly reduced strength, slightly closer fracture spacing with brown slightly sandy slightly gravelly clay deposits. Discontinuities: 1. 0 to 10 degree bedding fractures, closely spaced (50/170/470), slightly undulating, smooth with brown slightly sandy slightly gravelly clay infill up to 40mm between some fracture surfaces and non staining on fracture surfaces. 2. At 7.20m to 7.60m: 85 to 90 degree joint, undulating, rough with brown slightly sandy slightly gravelly clay infill up to 7mm between joint surfaces. <i>6.75m to 7.20m: Firm grey becoming brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to medium of limestone.</i>
TCR	SCR						RQD	FI										
6.10	C						100	70	51	NI								
6.20	C																	
7.40	ES									>20								
7.50	C																	
7.60	C																	
7.70	C	100	97	69	8													
8.90	C				11													
9.00	C																	
9.20	C																	
					38.28	8.25	Medium strong becoming strong thickly bedded dark grey LIMESTONE. Partially weathered: closer fracture spacing with localised brown clay deposits. Discontinuities: 1. 0 to 10 degree bedding fractures, closely spaced (30/150/400), planar and slightly undulating, smooth with localised brown clay infill											

Water Strikes				Chiselling Details			Remarks
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)	
3.50				3.60	4.00	01:00	Hand dug inspection pit excavated to 1.20m.
Casing Details		Water Added		Core Barrel	Flush Type	Termination Reason	Last Updated
To (m)	Diam (mm)	From (m)	To (m)				
6.00	200			SK6L	Polymer	Terminated at scheduled depth.	14/12/2020





Method	Plant Used	Top (m)	Base (m)	Coordinates	Final Depth:	Start Date:	Driller:	Sheet 2 of 2
Cable Percussion Rotary Drilling Rotary Coring	Dando 2000 Beretta T44 Beretta T44	0.00 4.00 6.00	4.00 6.00 12.00	709813.86 E 731627.02 N	12.00 m	15/10/2020	BM+GT	Scale: 1:50
								FINAL
					Elevation:	End Date:	Logger:	
					46.53 mOD	22/10/2020	CH+NP	

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
10.15	C	100	100	62	>20					<p>Medium strong becoming strong thickly bedded dark grey LIMESTONE. Partially weathered: closer fracture spacing with localised brown clay deposits. Discontinuities: 1. 0 to 10 degree bedding fractures, closely spaced (30/150/400), planar and slightly undulating, smooth with localised brown clay infill up to 7mm between some fracture surfaces. 2. At 8.30m to 8.74m, 9.60m to 9.80m and 10.50m to 10.85m: 75 to 90 degree incipient joints, undulating, rough with localised brown clay infill up to 8mm and no staining on joint surfaces. 3. At 9.80m to 9.90m; 70 degree incipient joint, undulating, smooth with brown staining on joint surface.</p>			
10.50					9				(3.75)				
11.05	C	100	100	75	3								
12.00								34.53	12.00			End of Borehole at 12.00m	

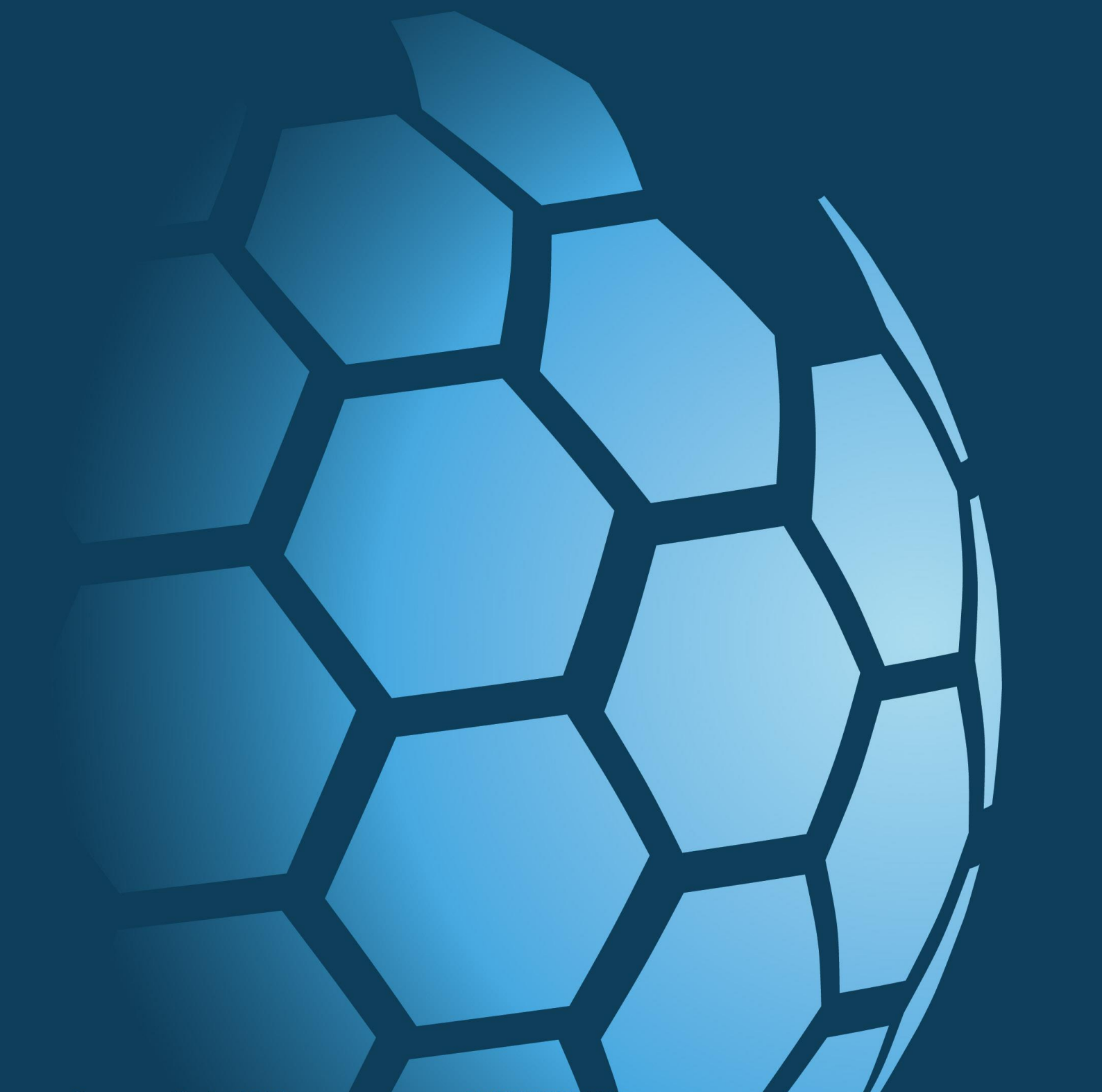
Water Strikes				Chiselling Details			Remarks
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)	
3.50				3.60	4.00	01:00	
Casing Details		Water Added					
To (m)	Diam (mm)	From (m)	To (m)				
6.00	200						
				Core Barrel	Flush Type	Termination Reason	Last Updated
				SK6L	Polymer	Terminated at scheduled depth.	14/12/2020





CAUSEWAY
— GEOTECH

APPENDIX C
CORE PHOTOGRAPHS





R8-CPGS01 Box 1 4.50-6.00m



R8-CPGS01 Box 2 6.00-7.50m



R8-CPGS01 Box 3 7.50-9.00m



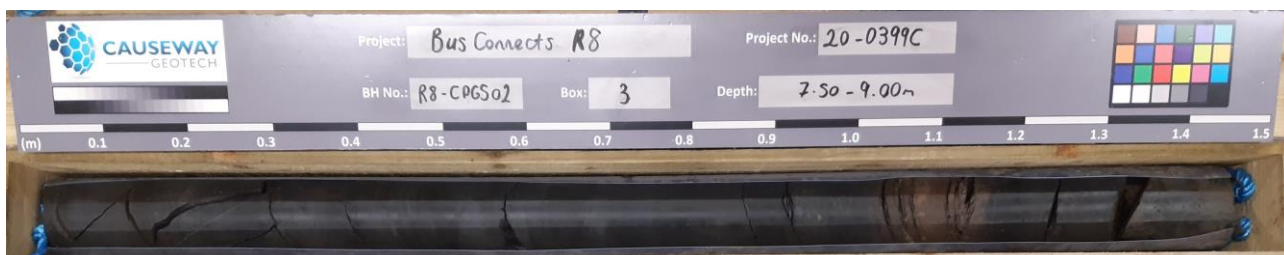
R8-CPGS01 Box 4 9.00-10.00m



R8-CPGS02 Box 1 4.50-6.00m



R8-CPGS02 Box 2 6.00-7.50m



R8-CPGS02 Box 3 7.50-9.00m



R8-CPGS02 Box 4 9.00-10.00m



R8-CPGS03 Box 1 4.50-6.00m



R8-CPGS03 Box 2 6.00-7.50m



R8-CPGS03 Box 3 7.50-9.00m



R8-CPGS03 Box 4 9.00-10.00m



R8-CPGS04 Box 1 6.00-7.50m



R8-CPGS04 Box 2 7.50-9.00m



R8-CPGS04 Box 3 9.00-10.50m



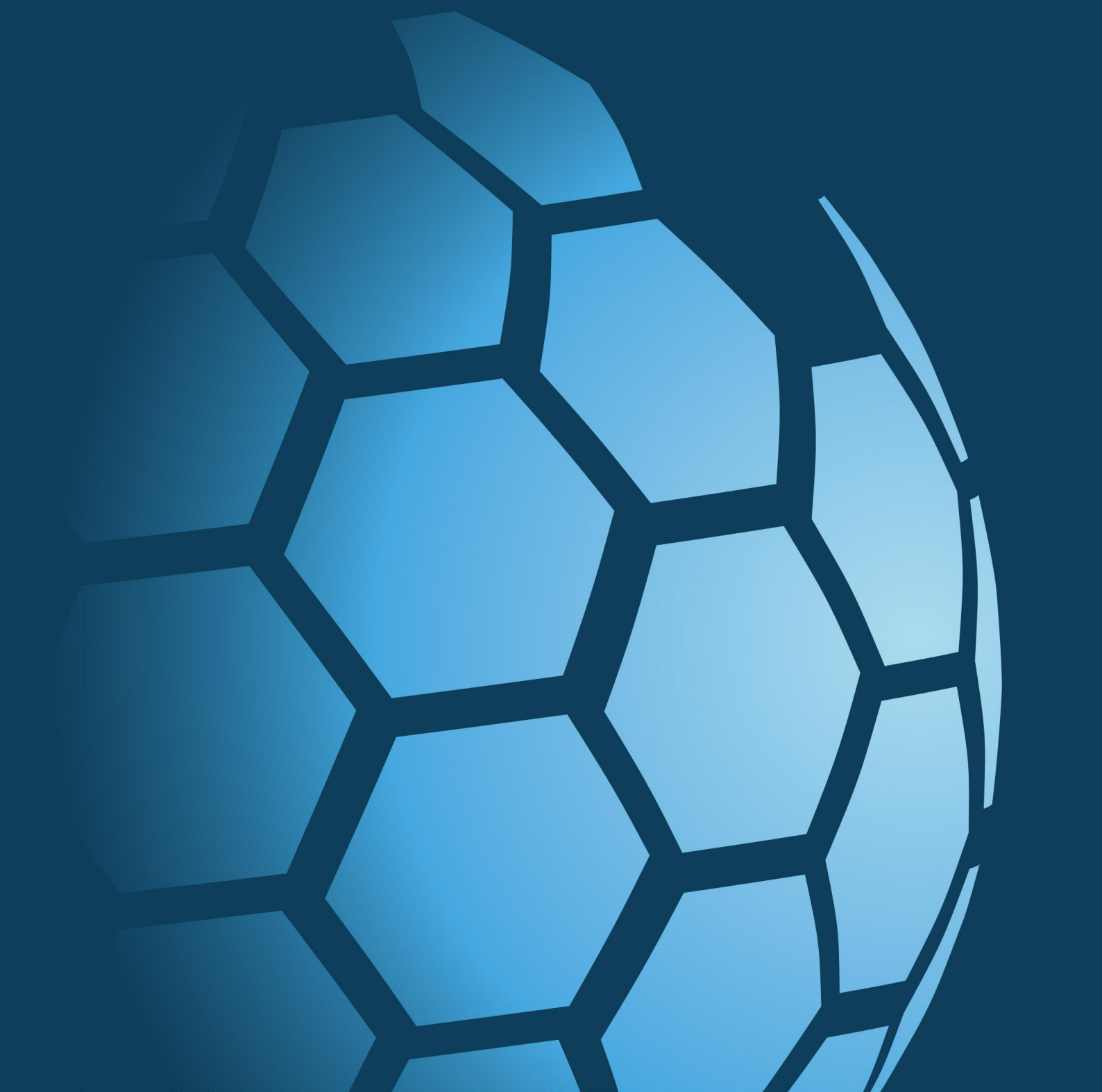
R8-CPGS04 Box 4 10.50-12.00m



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APPENDIX D

GEOTECHNICAL LABORATORY TEST RESULTS





**SOIL AND ROCK SAMPLE ANALYSIS
LABORATORY TEST REPORT**

19 November
2020

Project Name:	Bus Connects Route 8 Tallaght/Clondalkin to City Centre
Project No.:	20-0399C
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 8 - Tallaght/Clondalkin 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	14
SOIL	Liquid and Plastic Limits of soil-1 point cone penetrometer method	BS 1377-2: 1990: Cl 4.4, 5.3 & 5.4	3
SOIL	Particle size distribution - wet sieving	BS 1377-2: 1990: Cl 9.2	1
SOIL	Particle size distribution - sedimentation hydrometer method	BS 1377-2: 1990: Cl 9.5	1
SOIL	Undrained shear strength – triaxial compression without measurement of pore pressure (loads from 0.12 to 24 kN)	BS 1377-7: 1990: Cl 8	1
ROCK	Point load index	ISRM Commission on Testing Methods. Suggested Method for Determining Point Load Strength 1985	20
ROCK	Uniaxial Compressive Strength (UCS)*	ISRM Suggested Methods -Rock Characterization Testing and Monitoring, Ed. E T Brown - 1981	14

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 (<i>UKAS 2183</i>)	pH Value of Soil		4
SOIL – Subcontracted to Eurofins Chemtest Ltd (<i>UKAS 2183</i>)	Sulphate Content water extract		4


Summary of Classification Test Results

Project No. 20-0399C	Project Name Bus Connects Route 8 - Tallaght/Clondalkin to City Centre
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Hole No.	Sample				Soil Description	Density		w %	Passing 425µm %	LL %	PL %	PI %	Particle density Mg/m3	Casagrande Classification
	Ref	Top	Base	Type		bulk Mg/m3	dry							
R8-CPGS01	12	1.20		D	Grey sandy silty subangular fine to coarse GRAVEL.			7.9						
R8-CPGS01	13	2.00		D	Brown sandy gravelly silty CLAY.			10.0						
R8-CPGS01	14	3.00		D	Grey sandy silty subangular fine to coarse GRAVEL.			0.8						
R8-CPGS02	10	1.20		D	Greyish brown gravelly silty fine to coarse SAND.			6.9						
R8-CPGS02	11	2.00		D	Grey sandy slightly gravelly silty CLAY.			10.0						
R8-CPGS02	13	3.00		U	Grey sandy gravelly silty CLAY.			21.0	78	39 -1pt	19	20		CI
R8-CPGS02	12	4.00		D	Brown gravelly clayey fine to coarse SAND.			4.8						
R8-CPGS03	8	1.00		B	Grey sandy very gravelly silty CLAY.			15.0						
R8-CPGS03	20	1.20		U	Grey sandy slightly gravelly silty CLAY.			21.0	76	36 -1pt	19	17		CI
R8-CPGS03	16	2.00		D	Grey sandy gravelly silty CLAY.			7.7						
R8-CPGS03	11	3.00		D	Greyish brown sandy silty subangular fine to coarse GRAVEL.			1.6						
R8-CPGS04	13	2.00		U	Brown sandy slightly gravelly silty CLAY.			19.0	74	37 -1pt	19	18		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 <p style="text-align: center;">19/11/2020</p>	Approved By <p style="text-align: center;">Stephen.Watson</p>	 10122
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Summary of Classification Test Results

Project No. 20-0399C	Project Name Bus Connects Route 8 - Tallaght/Clondalkin to City Centre
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Hole No.	Sample				Soil Description	Density		w %	Passing 425µm %	LL %	PL %	PI %	Particle density Mg/m3	Casagrande Classification
	Ref	Top	Base	Type		bulk Mg/m3	dry							
R8-CPGS04	11	3.00		D	Grey sandy gravelly silty CLAY.			9.8						
R8-CPGS04	13	4.00		D	Grey slightly sandy slightly silty subangular fine to coarse GRAVEL.			0.9						

All tests performed in accordance with BS1377:1990 unless specified otherwise LAB 01R Version 4

Key Density test Linear measurement unless : wd - water displacement wi - immersion in water Liquid Limit 4pt cone unless : cas - Casagrande method 1pt - single point test Particle density sp - small pyknometer gj - gas jar	Date Printed <p style="text-align: center;">19/11/2020</p>	Approved By <p style="text-align: center;">Stephen.Watson</p>	
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PARTICLE SIZE DISTRIBUTION

Job Ref **20-0399C**

Borehole/Pit No. **R8-CPGS03**

Site Name **Bus Connects Route 8 - Tallaght/Clondalkin to City Centre**

Sample No. **8**

Soil Description **Grey sandy very gravelly silty CLAY.**

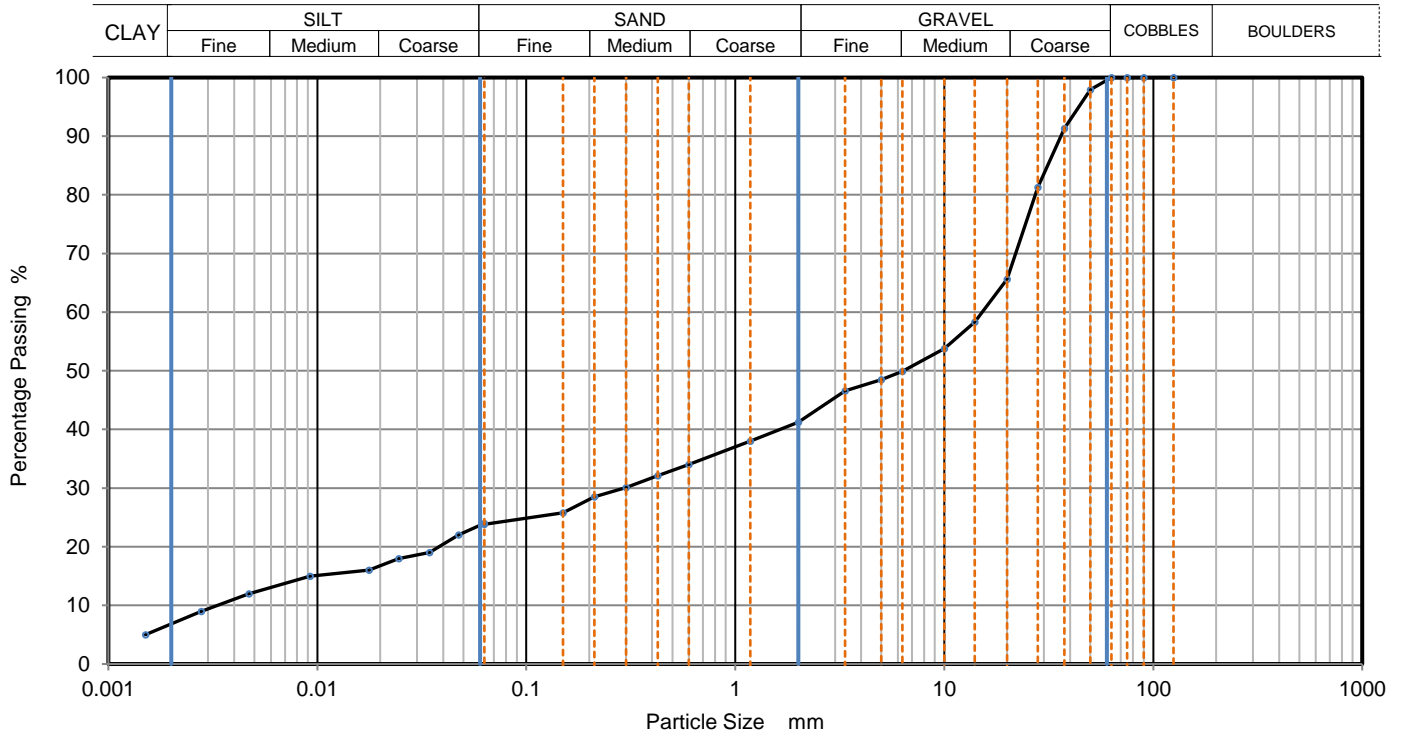
Depth, m **1.00**

Specimen Reference **4** Specimen Depth **1** m

Sample Type **B**

Test Method **BS1377:Part 2:1990, clauses 9.2 and 9.5**

KeyLAB ID **Caus2020103052**



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06290	24
90	100	0.04744	22
75	100	0.03447	19
63	100	0.02454	18
50	98	0.01769	16
37.5	91	0.00925	15
28	81	0.00471	12
20	66	0.00278	9
14	58	0.00150	5
10	54		
6.3	50		
5	49		
3.35	47		
2	41		
1.18	38		
0.6	34		
0.425	32	Particle density (assumed) 2.65 Mg/m3	
0.3	30		
0.212	29		
0.15	26		
0.063	24		

Dry Mass of sample, g

6123

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	58.8
Sand	17.4
Silt	16.6
Clay	7.2

Grading Analysis	
D100	mm
D60	mm 15.2
D30	mm 0.294
D10	mm 0.00318
Uniformity Coefficient	4800
Curvature Coefficient	1.8

Remarks

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

Approved

Stephen.Watson

LAB 05R Version 4



10122



**Unconsolidated Undrained Triaxial
Compression Test without measurement
of pore pressure - single specimen**

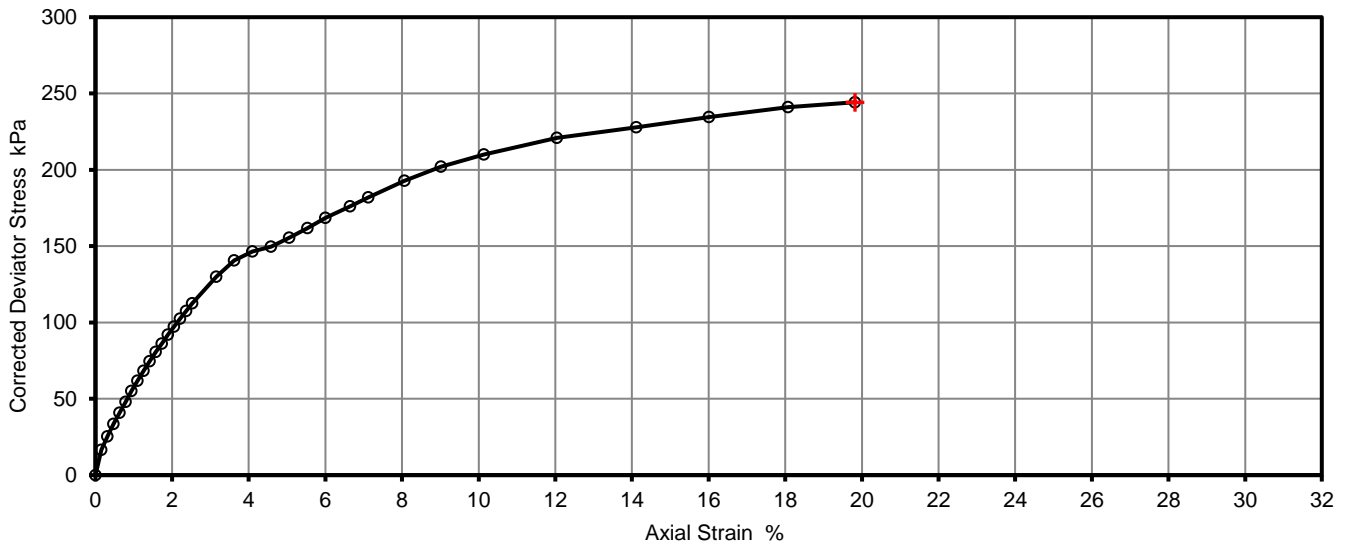
Job Ref	20-0399C
Borehole/Pit No.	R8-CPGS04
Sample No.	13
Depth	2.00
Sample Type	U
KeyLAB ID	Caus2020103056
Date of test	09/11/2020

Site Name	Bus Connects Route 8 - Tallaght/Clondalkin to City Centre		
Soil Description	Brown sandy slightly gravelly silty CLAY.		
Specimen Reference	6	Specimen Depth	2.05 m
Specimen Description	Stiff brown sandy slightly gravelly silty CLAY.		
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen		

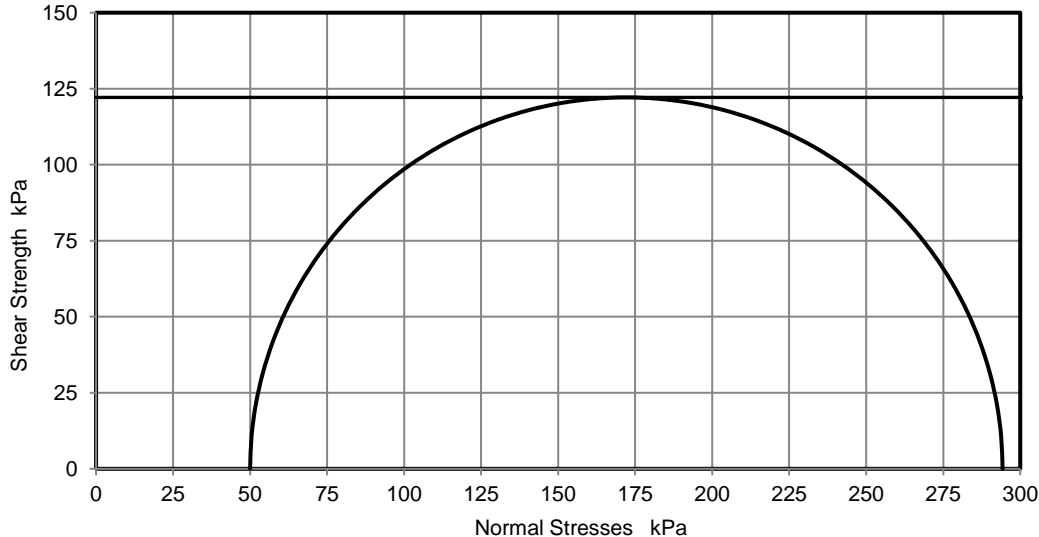
Test Number	1	
Length	209.4	mm
Diameter	104.5	mm
Bulk Density	2.39	Mg/m ³
Moisture Content	10.6	%
Dry Density	2.16	Mg/m ³

Rate of Strain	2.0	%/min
Cell Pressure	50	kPa
At failure	19.8	%
Axial Strain	244	kPa
Deviator Stress, ($\sigma_1 - \sigma_3$) _f	122	kPa $\frac{1}{2}(\sigma_1 - \sigma_3)$
Undrained Shear Strength, <i>c_u</i>		
Mode of Failure		

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects based on Fig 11 BS1377-7:1990

Mohr circles and their interpretation is not covered by BS1377-7. This is provided for information only.

Remarks

No failure defined. Testing terminated at 20% axial strain

Approved

Stephen.Watson

Printed

16/11/2020 14:12

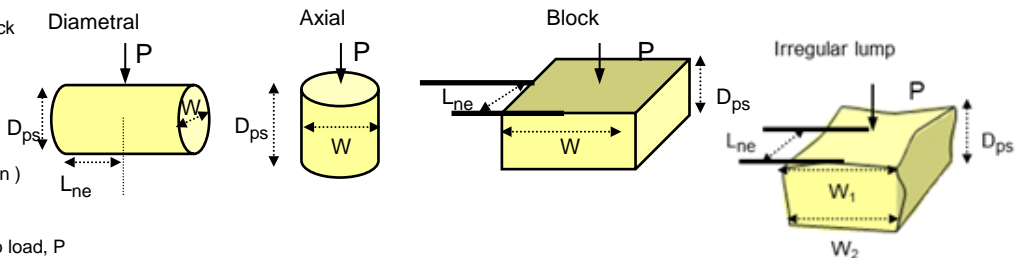


Point Load Strength Index Tests Summary of Results

Project No. 20-0399C	Project Name Bus Connects Route 8 - Tallaght/Clondalkin to City Centre
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Borehole No.	Sample			Specimen		Rock Type	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P kN	Equivalent diameter, D _e mm	Point Load Strength Index		Remarks (including water content if measured)	
	Depth m	Ref.	Type	Ref.	Depth m		Type (D, A, I, B)	Direction (L, P or U)		L _{ne} mm	W mm	D _{ps} mm	D _{ps'} mm			I _s MPa	I _s (50) MPa		
R8-CPGS01	4.60		C	1	4.60	LIMESTONE	A	U	NO		101.5	57.0	55.0	21.0	84.3	3.0	3.7		
R8-CPGS01	5.00		C	2	5.00	LIMESTONE	A	U	YES		101.6	61.0	57.0	18.4	85.9	2.5	3.2		
R8-CPGS01	5.75		C	3	5.75	LIMESTONE	D	U	NO		88.9	101.8	101.8	100.0	24.3	100.9	2.4	3.3	
R8-CPGS01	5.90		C	4	5.90	LIMESTONE	D	U	YES		81.2	101.6	101.6	99.0	19.6	100.3	1.9	2.7	
R8-CPGS01	6.35		C	5	6.35	LIMESTONE	A	U	YES		101.7	54.0	50.0	17.1	80.5	2.6	3.3		
R8-CPGS01	6.90		C	6	6.90	LIMESTONE	D	U	NO		78.3	101.4	101.4	97.0	14.9	99.2	1.5	2.1	
R8-CPGS02	4.50		C	7	4.50	LIMESTONE	D	U	NO		74.6	101.4	101.4	99.0	22.3	100.2	2.2	3.0	
R8-CPGS02	5.45		C	8	5.45	LIMESTONE	A	U	YES		101.3	59.0	56.0	17.6	85.0	2.4	3.1		
R8-CPGS02	6.00		C	9	6.00	LIMESTONE	D	U	YES		69.7	101.4	101.4	99.0	18.2	100.2	1.8	2.5	
R8-CPGS02	7.10		C	10	7.10	LIMESTONE	D	U	YES		73.9	101.5	101.5	97.0	19.8	99.2	2.0	2.7	
R8-CPGS03	4.55		C	11	4.55	LIMESTONE	D	U	YES		70.2	101.1	101.1	98.0	19.1	99.5	1.9	2.6	
R8-CPGS03	5.30		C	12	5.30	LIMESTONE	A	U	YES		101.3	48.0	44.0	18.0	75.3	3.2	3.8		
R8-CPGS03	6.30		C	13	6.30	LIMESTONE	D	U	NO		77.5	101.2	101.2	100.0	20.8	100.6	2.1	2.8	
R8-CPGS03	6.80		C	14	6.80	LIMESTONE	A	U	YES		101.3	55.0	51.0	17.6	81.1	2.7	3.3		
R8-CPGS04	6.00		C	15	6.00	LIMESTONE	D	U	NO		72.1	101.2	101.2	100.0	21.6	100.6	2.1	2.9	
R8-CPGS04	6.10		C	16	6.10	LIMESTONE	A	U	YES		101.3	59.0	54.0	24.5	83.5	3.5	4.4		
R8-CPGS04	7.60		C	17	7.60	LIMESTONE	D	U	NO		80.6	101.3	101.3	100.0	22.6	100.6	2.2	3.1	
R8-CPGS04	8.90		C	18	8.90	LIMESTONE	A	U	YES		101.2	51.0	47.0	16.5	77.8	2.7	3.3		

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
D_{ps} - Distance between platens (platen separation)
D_{ps'} - at failure (see ISRM note 6)
L_{ne} - 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
19/11/2020

Approved By

Stephen.Watson



UNIAXIAL COMPRESSION TEST ON ROCK - SUMMARY OF RESULTS

Project No. 20-0399C	Project Name Bus Connects Route 8 - Tallaght/Clondalkin to City Centre
-------------------------	---

Hole No.	Sample				Rock Type	Specimen Dimensions ²			Bulk Density ² Mg/m ³	Water Content ¹ %	Uniaxial Compression ³			Remarks
	Ref	Top	Base	Type		Dia. mm	Length mm	H/D			Condition	Mode of failure	UCS MPa	
R8-CPGS01		6.60		C	LIMESTONE	101.4	261.7	2.6	2.69	0.2	as received	F	99.9	
R8-CPGS01		7.50		C	LIMESTONE	101.4	251.9	2.5	2.69	0.1	as received	F	73.4	
R8-CPGS01		9.35		C	LIMESTONE	101.5	252.8	2.5	2.69	0.2	as received	F	93.6	
R8-CPGS02		5.55		C	LIMESTONE	101.4	253.7	2.5	0.27	0.1	as received	F	80.2	
R8-CPGS02		6.80		C	LIMESTONE	101.4	254.1	2.5	2.68	0.3	as received	F	88.2	
R8-CPGS02		8.10		C	LIMESTONE	101.5	252.7	2.5	2.68	0.1	as received	F	80.7	
R8-CPGS02		9.35		C	LIMESTONE	101.4	252.6	2.5	2.68	0.2	as received	F	104.0	
R8-CPGS03		5.05		C	LIMESTONE	101.5	254.1	2.5	2.69	0.2	as received	F	88.7	
R8-CPGS03		6.00		C	LIMESTONE	101.5	251.9	2.5	2.69	0.2	as received	F	92.4	
R8-CPGS03		7.50		C	LIMESTONE	101.4	253.6	2.5	2.72	0.2	as received	F	72.8	
R8-CPGS03		9.05		C	LIMESTONE	101.3	251.5	2.5	2.68	0.1	as received	F	76.7	
R8-CPGS04		6.20		C	LIMESTONE	101.4	255.6	2.5	2.68	0.2	as received	F	104.0	
R8-CPGS04		7.70		C	LIMESTONE	101.4	254.4	2.5	2.71	0.1	as received	F	99.3	
R8-CPGS04		11.05		C	LIMESTONE	101.5	251.0	2.5	2.67	0.1	as received	F	108.0	

Notes

- | | |
|--|---|
| 1 ISRM p87 test 1, water content at 105 ± 3 °C, specimen as tested for UCS | Mode of failure : |
| 2 ISRM p86 clause (vii), Caliper method used for determination of bulk volume and derivation of bulk density | S - Single shear MS - multiple shear |
| 3 ISRM p153 part 1, determination of Uniaxial Compressive Strength (UCS) of Rock Materials | AC - Axial cleavage F - Fragmented |
| above notes apply unless annotated otherwise in the remarks | |

Test Specification International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007	Date Printed 19/11/2020	Approved By Stephen.Watson	Table 1 sheet 1
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Final Report

Report No.: 20-30005-1
Initial Date of Issue: 10-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
Gabiella 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 20-0399C Bus Connects 8

Quotation No.: **Date Received:** 05-Nov-2020

Order No.: **Date Instructed:** 05-Nov-2020

No. of Samples: 4

Turnaround (Wkdays): 5 **Results Due:** 11-Nov-2020

Date Approved: 10-Nov-2020

Approved By:

Details: Glynn Harvey, Technical Manager

Results - Soil

Project: 20-0399C Bus Connects 8

Client: Causeway Geotech Ltd		Chemtest Job No.:		20-30005	20-30005	20-30005	20-30005	
Quotation No.:		Chemtest Sample ID.:		1092179	1092180	1092181	1092182	
Order No.:		Client Sample Ref.:		8	10	8	12	
		Sample Location:		R8-CPGS01	R8-CPGS01	R8-CPGS03	R8-CPGS04	
		Sample Type:		SOIL	SOIL	SOIL	SOIL	
		Top Depth (m):		2.00	4.00	1.00	4.00	
		Date Sampled:		04-Nov-2020	04-Nov-2020	04-Nov-2020	04-Nov-2020	
Determinand	Accred.	SOP	Units	LOD				
Moisture	N	2030	%	0.020	13	8.5	14	0.47
pH	U	2010		4.0	8.4	8.7	8.6	9.6
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	0.36	0.13	0.17	0.014

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



Final Report

Report No.: 20-31072-1
Initial Date of Issue: 19-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
Gabiella 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 20-0399C Route 8 Tallaght/
Clondalkin to City Centre

Quotation No.:		Date Received:	16-Nov-2020
Order No.:		Date Instructed:	16-Nov-2020
No. of Samples:	4		
Turnaround (Wkdays):	5	Results Due:	20-Nov-2020
Date Approved:	19-Nov-2020		

Approved By:

Details: Glynn Harvey, Technical Manager

Results - Soil

Project: 20-0399C Route 8 Tallaght/Clondalkin to City Centre

Client: Causeway Geotech Ltd	Chemtest Job No.:				20-31072	20-31072	20-31072	20-31072
Quotation No.:	Chemtest Sample ID.:				1097043	1097044	1097045	1097046
	Sample Location:				R8CPGS01	R8CPGS02	R8CPGS03	R8CPGS04
	Sample Type:				SOIL	SOIL	SOIL	SOIL
	Top Depth (m):				4.50	4.70	4.70	7.40
	Date Sampled:				13-Nov-2020	13-Nov-2020	13-Nov-2020	13-Nov-2020
Determinand	Accred.	SOP	Units	LOD				
Moisture	N	2030	%	0.020	0.38	0.58	1.3	5.1
pH	U	2010		4.0	8.9	9.2	8.8	8.9
Sulphate (2:1 Water Soluble) as SO ₄	U	2120	g/l	0.010	0.018	0.023	0.059	< 0.010

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

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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

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customerservices@chemtest.com

LABORATORY RESTRICTION REPORT

Project Reference	20-0399C	To	Sean Ross
Project Name	Bus Connects Route 8 Tallaght/Clondalkin to City Centre	Position	Project Manager
TR reference	20-0399C / 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			
R8 CPG S02	13	3.00	U	UU Triaxial	Unable to obtain specimen for test - coarse gravel content too high	CANCEL
R8 CPG S03	20	1.20	U	UU Triaxial	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

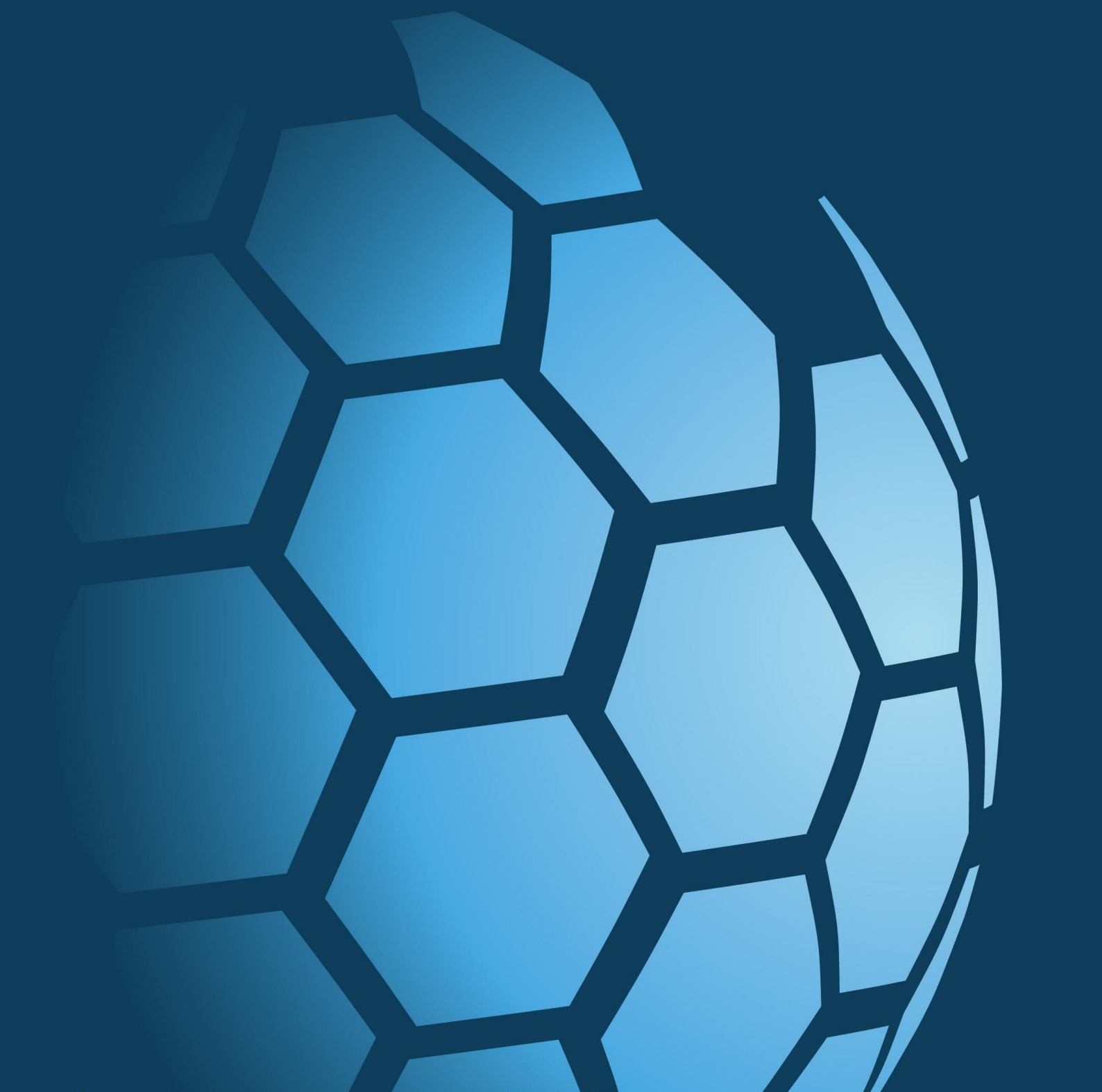
Laboratory Signature Joseph Nicholl	Project Manager Signature Sean Ross
Date 13 November 2020	Date



CAUSEWAY
— GEOTECH

APPENDIX E

SPT HAMMER ENERGY MEASUREMENT REPORT



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

SPT Hammer Ref: .0209
Test Date: 22/02/2020
Report Date: 03/03/2020
File Name: .0209.spt
Test Operator: NPB

Instrumented Rod Data

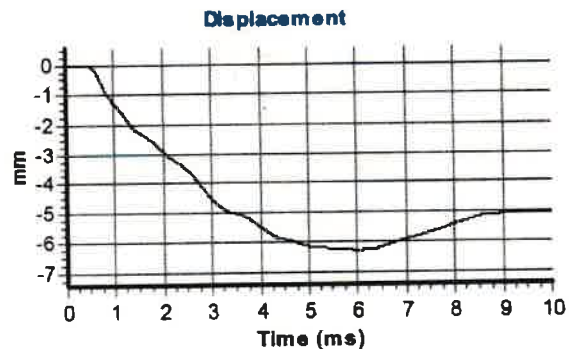
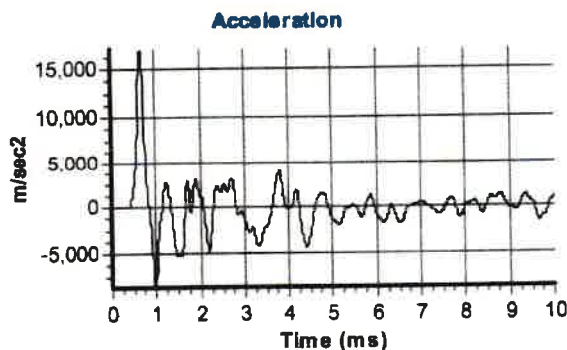
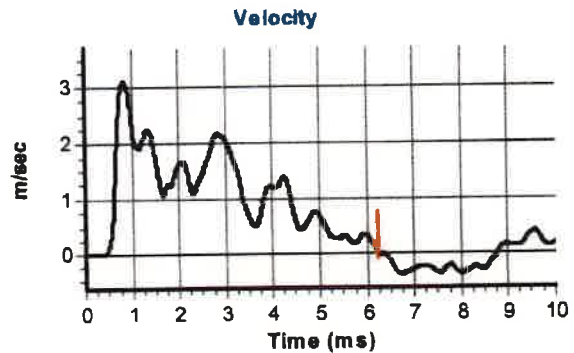
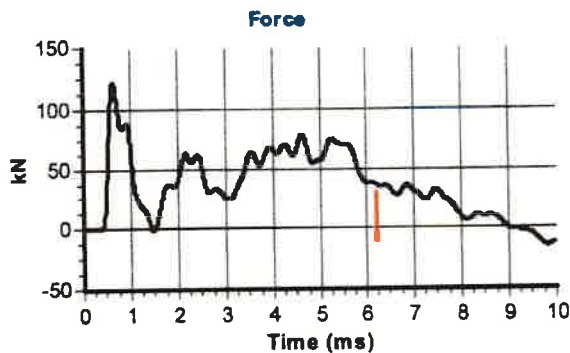
Diameter d_r (mm): 54
Wall Thickness t_r (mm): 6.0
Assumed Modulus E_a (GPa): 200
Accelerometer No.1: 6458
Accelerometer No.2: 9607

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 (mm^2): 905
Theoretical Energy E_{theor} (J): 473
Measured Energy E_{meas} (J): 317

Energy Ratio E_r (%): **67**

Signed: Neil Burrows
Title: Field Operations Manager

The recommended calibration interval is 12 months

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

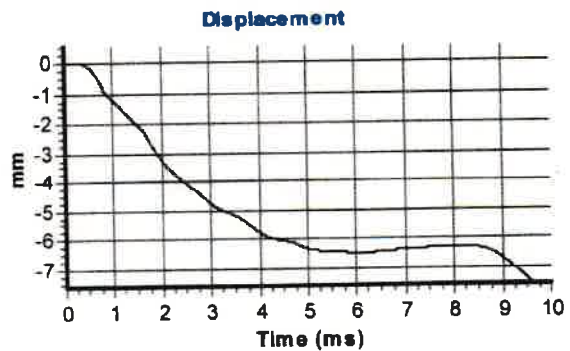
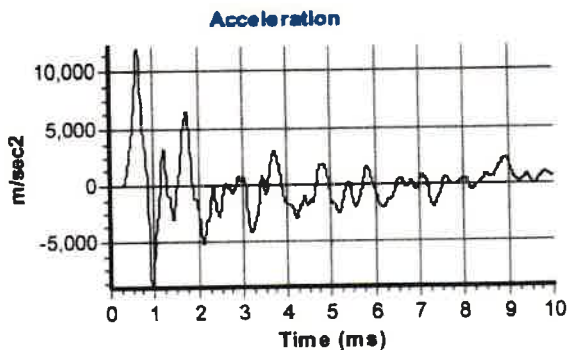
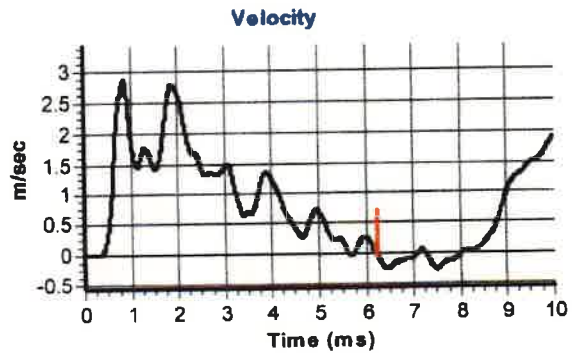
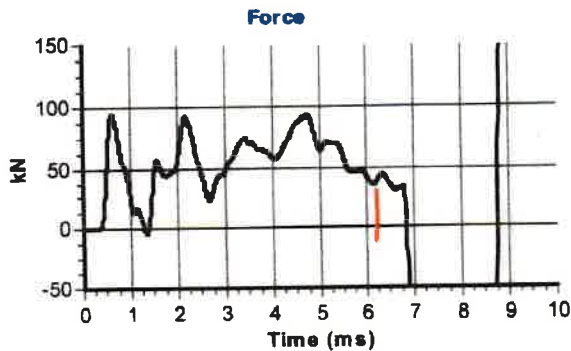
Diameter d_r (mm): 54
Wall Thickness t_r (mm): 6.0
Assumed Modulus E_a (GPa): 200
Accelerometer No.1: 6458
Accelerometer No.2: 9607

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 (mm^2): 905
Theoretical Energy E_{theor} (J): 473
Measured Energy E_{meas} (J): 400

Energy Ratio E_r (%): **85**

NPB Burrows
Signed: Neil Burrows
Title: Field Operations Manager

The recommended calibration interval is 12 months