Elm Grove – Ground Investigation

Client:	Cavan County Council
Client's Representative:	Alan Traynor Consulting Engineers Ltd
Report No.:	20-0749A
Date:	October 2020
Status:	Final for Issue

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Document Control Sheet

Report No.:		20-0749A			
Project Title:		Elm Grove – Ground Investigation			
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The works were conducted in accordance with:

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

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

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

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

Laboratory testing was conducted in accordance with:

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

METHODS OF DESCRIBING SOILS AND ROCKS

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

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

Elm Grove

1 AUTHORITY

On the instructions of Alan Traynor Consulting Engineers Ltd, ("the Client's Representative"), acting on the behalf of Cavan County Council ("the Client"), a ground investigation was undertaken at the above location to provide geotechnical information for input to the design and construction of a proposed residential development.

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. A discussion on the recommendations for construction is also provided.

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 sampling, in-situ and laboratory testing, and the preparation of a report on the findings including recommendations for construction.

3 DESCRIPTION OF SITE

As shown on the site location plan in Appendix A, the works were conducted on a previously developed site with a large shed near Elm Grove and Church Street, Cavan. The site is bordered by residential buildings to the east, west, and south and a car park to the north.

4 SITE OPERATIONS

4.1 Summary of site works

Site operations, which were conducted between 24th and 26th August 2020, comprised:

- seven boreholes by dynamic (windowless) sampling methods
- three dynamic probes from ground level
- four indirect CBR tests.

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

Seven boreholes (BH01-BH07) were put down to completion by light percussion boring techniques using a Dando Terrier dynamic sampling rig. The boreholes were put down initially in 150mm diameter, reducing in diameter with depth as required, down to 50mm by use of the smallest sampler.

Hand dug inspection pits were carried out between ground level and 1.20m depth to ensure boreholes were put down clear of services or subsurface obstructions. The boreholes were taken to depths ranging between 4.00m and 5.00m where they were terminated on encountering virtual refusal on obstructions.

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 ($SPT_{(s)}$). 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.

Disturbed (bulk and small bag) samples were taken within the encountered strata. Undisturbed (U100) samples were taken as appropriate within fine grained strata. Environmental samples were taken 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. Details of the water strikes are presented on the individual borehole logs.

Appendix B presents the borehole logs.

4.3 Dynamic probes

Dynamic probes (DP01-DP03) were conducted from ground level at three locations using the DPSHB method as described in BS EN ISO 22476-3:2005+A1:2011. The method entails a 63.5kg hammer falling 0.75m onto a 50.5mm diameter cone with an apex angle of 90°.

Appendix B provides the dynamic probe logs in the form of plots, against depth, of the number of blows per 100mm penetration.

4.4 Indirect CBR tests

Four indirect CBR tests (CBR01-CBR04) were conducted using a Dynamic Cone Penetrometer (DCP). The equipment was developed in conjunction with the UK Transport Research Laboratory, is used widely throughout the world, and is referred to in the UK Highway Agency Interim Advice Note 73/06.

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

Log CBR = 2.48-1.057 Log (mm/blow)

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

5 LABORATORY WORK

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

5.1 Geotechnical laboratory testing of soils

Laboratory testing of soils comprised:

- **soil classification:** moisture content measurement, Atterberg Limit tests and particle size distribution analysis.
- **shear strength** (total stress): unconsolidated undrained triaxial tests
- **soil chemistry:** 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 Environmental laboratory testing of soils

Environmental testing, as specified by the Client's Representative was conducted on a selected environmental soil sample in borehole BH02 by Chemtest at its laboratory in Newmarket, Suffolk.

Testing was carried out for a range of determinants, including:

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

Results of environmental laboratory testing are presented in Appendix D following geotechnical testing results.

6 GROUND CONDITIONS

6.1 General geology of the area

Published geological mapping indicate the superficial deposits underlying the site comprise Glacial Till shown in close proximity to the site. These deposits are underlain by greywacke of the Red Island 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:** boreholes BH04, BH05, and BH06 encountered 170-190mm of concrete surfacing.
- **Topsoil:** encountered typically in 100mm thickness.
- **Made Ground (sub-base):** aggregate fill beneath the paved surface in boreholes BH04, BH05, and BH06.
- **Made Ground (fill):** reworked sandy gravelly silty clay or sandy clayey gravel fill with occasional

fragments bitmac, brick and plastic.

- **Glacial Till:** sandy gravelly clay, frequently with low cobble content, locally very soft to soft but typically firm in upper horizons, becoming stiff with increasing depth.

6.3 Groundwater

Groundwater was encountered during percussion boring through soil as water strikes at 2.60-4.40m in boreholes BH01-BH04. Boreholes BH05-BH07 were dry.

Details of the individual groundwater strikes are presented on the exploratory hole logs for each location. Seasonal variation in groundwater levels should be factored into design considerations.

7 DISCUSSION

7.1 Proposed construction

It is proposed to construct new residential buildings on the site.

No further details were available to Causeway Geotech at the time of preparing this report and any designs based on the recommendations or conclusions within this report should be completed in accordance with the current design codes, taking into account the variation and the specific details contained within the exploratory holes. Causeway Geotech were commissioned to provide a geotechnical report, and it is outwith our remit to advise on structure design.

7.2 Recommendations for construction

7.2.1 Summary

Based on the presence of firm to stiff glacial till at relatively shallow depths across much of the site, the implementation of traditional shallow (spread) foundations (strip/pad and trench fill) are considered suitable in these areas, however the shallow water table at this site may complicate construction and will likely require groundwater control. Structures in the area of BH03 will also require deep foundation solutions such as ground improvement or piled foundations. If groundwater control is not possible, structures in other areas of the site, particularly around BH02 will also require piled foundations or ground improvement solutions.

Should piling be adopted as the preferred foundation type, it is highly recommended that further ground investigation works involving rotary drilling be carried out to prove the depth to bedrock across the site.

7.2.2 Soil strength parameters

When estimating the shear strength of fine soils (silt/clay), reference is made to the results of Standard Penetration Tests (SPT's) carried out within the boreholes. The undrained shear strength of fine soils can be estimated using the correlation developed by Stroud & Butler:

$$C_u = f_1 \times N$$

where f_1 is typically in the range 4 to 6. A median f_1 value of 5 is adopted for this report.

For granular soils (sand/gravel), a graphical relationship between SPT "N" value and angle of shearing resistance, φ, has been developed by Peck, Hanson and Thorburn. This is published in *Foundation Design and Construction* (Tomlinson, 2001) and is referenced in this report when deriving angles of shearing resistance for the gravel soils.

7.2.3 Foundations and ground floor construction

Foundations should transfer loading to below any Made Ground or subsoil. The recommended foundation construction and allowable bearing pressure (ABP) at the borehole locations are presented in Table 1.

Table 1: Construction recommendations

Borehole	Depth below EGL* to suitable bearing stratum	Estimated ABP (kPa)	Strata description	Foundation type	Ground floor construction	Groundwater
BH01	2.00m	210	Stiff Glacial Till	Trench fill	Ground bearing	2.60 and 3.20mbgl
BH02	3.80m	100	Firm Glacial Till	Trench fill (with trench support and possible sump pumping)	Suspended	3.80mbgl
	>5.0m	-	Bedrock	Piling	Suspended	
BH03	Base of soft soils not identified due to refusal#					3.80 and 4.40mbgl
BH04	2.00m	140	Firm Glacial Till	Trench fill	Ground bearing	4.00mbgl
BH05	1.20m	150	Firm Glacial Till	Strip & pad	Ground bearing	Not encountered
BH06	2.00m	150	Firm Glacial Till	Trench fill	Ground bearing	Not encountered

Borehole	Depth below EGL* to suitable bearing stratum	Estimated ABP (kPa)	Strata description	Foundation type	Ground floor construction	Groundwater
BH07	3.00m	270	Stiff Glacial Till	Trench fill	Suspended	Not encountered

*Existing Ground Level
#Further ground investigation works are required to provide a recommended foundation design

Based on the findings of the site investigation, spread foundations (trench fill) may be suitable over portions of the site with estimated allowable bearing pressures between 100kPa and 270kPa at depths between 1.20m and 3.80m on firm glacial till. However, borehole BH02 may require an alternative foundations solution due to the presence of soft soils. In addition, the base of soft soils was not identified in borehole BH03 and will require further ground investigation.

The base of foundation excavations should be thoroughly inspected in accordance with the Earthworks Specification; any soft soils should be removed with the resultant void backfilled with ST1 concrete. A consistent bearing stratum should be provided for any building unit to limit differential settlements.

Given the generally fine grained/cohesive nature of the soils throughout the proposed formation levels, excavations for foundations are likely to be relatively stable. However, any instability can be minimised by battering the side slopes at 2 vertical to 1 horizontal and by limiting the duration that the excavation is open. Groundwater control, where required, will be possible by pumping from sumps formed in the base of excavations.

If spread foundations are considered too problematic the practicable alternative foundation solutions are:

1. The adoption of ground improvement using 'vibro' techniques, providing a foundation construction method flexible to the variable ground conditions across the site. The most appropriate technique is likely to be vibro-stone columns installed using the bottom feed process: these would penetrate through the Made Ground and soft/loose soils to terminate in stiff / medium dense soils.

Ground improvement would allow the use of spread foundations at shallow depths.

Detailed design proposals should be obtained from specialist contractors: these should include the means to verify that the adopted treatment has achieved the specified ground bearing capacity.

The adoption of ground improvement below building footprints would allowing the application of ground bearing floor slabs

2. Piling to transfer loadings to depth:

Piling to transfer loadings to depth is suggested to be the most practicable and applicable option given the variation in depth to a consistent bearing stratum across the site, coupled with the relatively shallow water table which would be problematic for any open trench shallow foundation systems.

Driven piles are the preferred pile type – of precast concrete or steel/ductile iron. The piles should be driven to a predetermined set – each pile will, therefore, be effectively proof tested by the installation method.

If the surrounding land use precludes the use of hard drive piles, due to environmental restrictions with respect to noise and vibration, low vibration driven piles, continuous flight auger (CFA) or continuous helical displacement (CHD) piles will be required.

Piles will acquire capacity from shaft friction through the glacial deposits, and end bearing on the weathered bedrock.

Where site levels are to be raised, piles should be designed to resist additional loading that will arise due to negative skin friction along the pile length passing through Made Ground and soft soils.

The detailed design of piles should be undertaken in conjunction with specialist piling contractors. Their proposals should include the means to verify that the required load capacity has been achieved: for example, dynamic pile tests and/or static load tests.

Where pile foundation solution is adopted, floor slabs should be supported by ground beams spanning between piles caps supported by piles.

7.2.4 Floor slabs

Floor slabs should not bear directly onto Made Ground or soft soils. Consequently, the use of ground bearing floor slabs is considered appropriate following the removal of any surface Made Ground and soft clay layers and their replacement using well-graded well-compacted granular fill. However, a suspended floor slab should be adopted where the difference in levels of the proposed floor and the base of Made Ground/soft soils is greater than 600mm. Where a suspended floor slab is adopted the use of intermediate lines of support stub walls would reduce the spans required for flooring units.

7.2.5 Excavations for services

For the installation of services ducts/trenches, it is suggested that open trenching will be the most practicable construction method. Generally speaking, the ground conditions should render the use of open trenching by backhoe excavator possible, with some trench support required for the uppermost stratum.

Where working in open trenches, it is thought that trench support systems, by way of a trench box (or possibly sheet piles), will be required to maintain trench stability and safe working conditions. Groundwater control at these locations should be possible by means of sump pumping.

To preclude the eventuality of differential settlements in pipes, they should be laid on a consistent stratum of appropriate allowable bearing capacity and protected with appropriate fill cover.

Where ducts and chambers must be installed in areas where localised soft spots are encountered, the use of geogrid reinforcement along the base of the excavation on is recommended. This will stiffen the base of the trench and help control longitudinal differential settlement.

Backfilling of trenches may be completed by using compacted Cl 804 granular fill and reinstated as appropriate.

7.2.6 Soil aggressivity

An assessment of the Aggressive Chemical Environment for Concrete (ACEC) was undertaken through reference to the Building Research Establishment (BRE) Special Digest 1 (2017).

As noted by BRE Special Digest 1, sulphates in the soil and groundwater are the chemical agents most likely to attack concrete. The extent to which sulphates affect concrete is linked to their concentrations, the type of ground, the presence of groundwater, the type of concrete and the form of construction in which concrete is used.

BRE Special Digest 1 identifies four different categories of site which require specific procedures for investigation for aggressive ground conditions:

- Sites not subjected to previous industrial development and not perceived as containing pyrite;
- Sites not subjected to previous industrial development and perceived as containing pyrite;
- Brownfield sites not perceived as containing pyrite;
- Brownfield sites perceived as containing pyrite.

For the purposes of this report the site was classified as not having been subject to previous industrial development and not perceived as containing pyrite.

The results of chemical tests (pH and water soluble sulphate contents) on soil samples indicate Design Sulphate Class DS-1 and ACEC Class AC-1 – reference Table C1 of BRE Special Digest 1 (Building Research Establishment, 2005). The Special Digest does not require any measures to protect underground concrete elements greater that 140mm thick.

7.2.7 Access roads, car parks and hard standing

Based on a summary of the CBR test undertaken at the site, it is envisaged that the upper deposits at the site would be suitable for the placement of road make up layers. A CBR value in excess of 5% at a depth of 0.5mbgl was recorded across the site.

Table 2.1 of volume 7 section2 of the Design Manual for Roads and Bridges (below), gives guidance on the average thickness of the pavement layers in relation to the CBR results. As can be seen, a CBR in excess of 5% requires a 400mm thick capping layer.

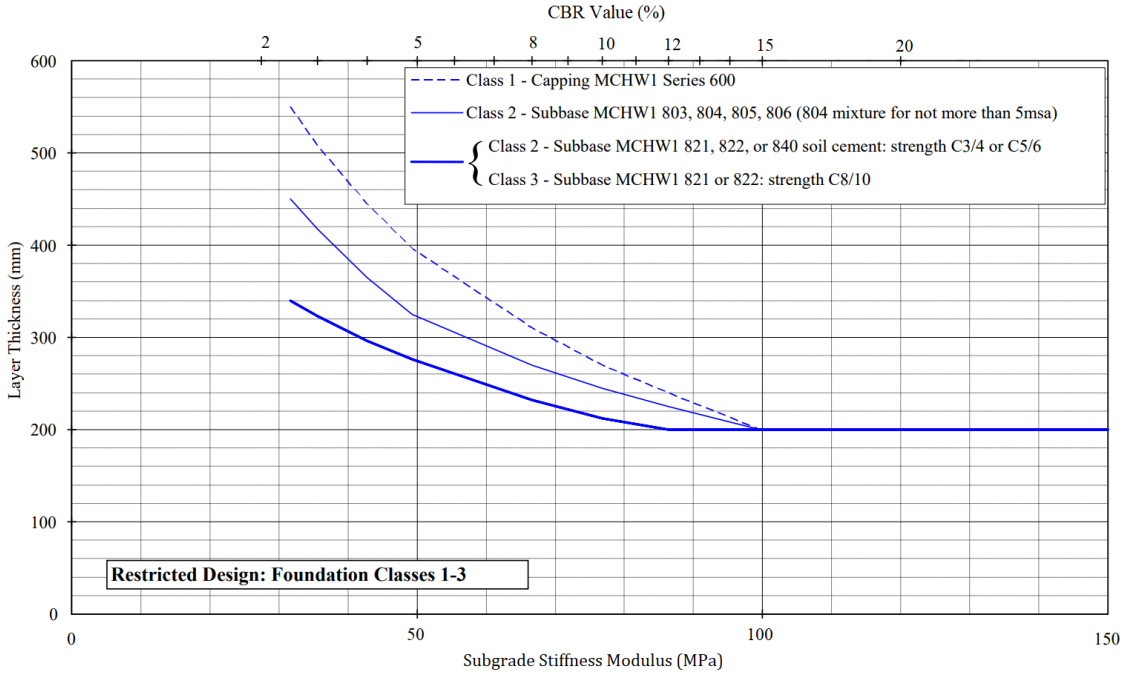


Table 2.1 (DMRB Vol.7 Sec2) 2009

It is recommended that further testing be undertaken during the course of construction works at intervals as set out in the Earthworks Specification, and should any areas indicate lower than expected value, the above plot should be used to determine the thicknesses of any capping or sub-base layers that may need to be placed in these areas.

The use of geosynthetics in the construction of paved areas, will be beneficial, particularly in areas of Made Ground. These could include a geosynthetic (e.g., a geogrid) at subgrade level with further benefit gained by incorporating further layer(s) within the capping/sub-base layer. Road design should be undertaken by a specialist earthworks contractor/designer.

7.3 Site contamination

Selected soil samples were analysed for a range of potential contaminants including:

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

- Sulphates and sulphide;
- Phenols; and
- Asbestos screening

In the initial examination of the potential risk of site contamination, the laboratory results have been compared to the LQM/CIEH S4UL's assessment criteria relevant to the proposed land use.

The results from the tested samples do not identify significantly elevated concentrations above the available S4UL's.

It should be noted that the above assessment is based on the results of the soil samples against available S4UL's and this assessment has not been undertaken following the CLR11 guidelines. Any potential contamination identified during site development by visual or olfactory means should be investigated, including further laboratory testing and assessment and appropriate health & safety waste disposal and remediation measures adopted.

8 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 22476-3:2005+A1:2011: Geotechnical investigation and testing. Field testing. Standard penetration test.

Building Research Establishment (2005) BRE Special Digest 1, Concrete in aggressive ground.

CAUSEWAY GEOTECH

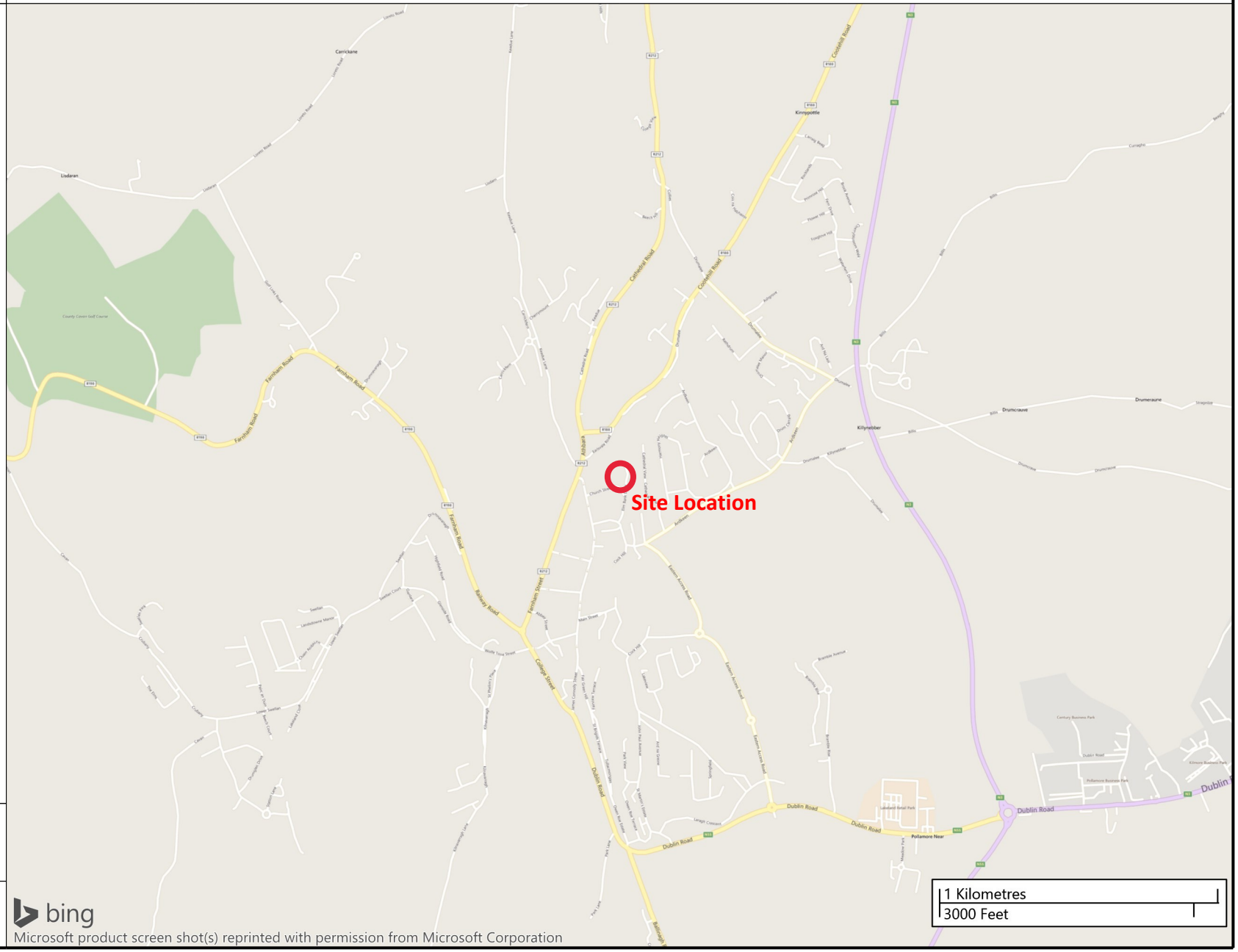
APPENDIX A

SITE AND EXPLORATORY HOLE LOCATION PLANS

CAUSEWAY GEOTECH

Project No.:	20-0749a	**Client:**	Cavan County Council
Project Name:	Elm Grove	**Client's Representative:**	Alan Traynor Consulting Engineers Ltd.

Legend Key



Microsoft product screen shot(s) reprinted with permission from Microsoft Corporation

Title:
Site Location Plan

Last Revised:	**Scale:**
01/10/2020	1:20000

CAUSEWAY GEOTECH

Project No.:	20-0749a	**Client:**	Cavan County Council
Project Name:	Elm Grove	**Client's Representative:**	Alan Traynor Consulting Engineers Ltd.

Legend Key

- Borehole location
- CBR location
- Dynamic probe location

Title:
Exploratory Hole Location Plan

Last Revised:	**Scale:**
01/10/2020	1:1000

CAUSEWAY GEOTECH

APPENDIX B

BOREHOLE & DYNAMIC PROBE LOGS

CAUSEWAY GEOTECH

Project No.	Project Name:	Borehole ID
20-0749A	Elm Grove	BH01
	Client: Cavan County Council	
	Client's Rep: Alan Traynor Consulting Engineers Ltd.	

Method	Plant Used	Top (m)	Base (m)	Coordinates
Light Percussion	Dando Terrier	0.00	4.00	242139.17 E 305235.66 N

Final Depth:	Start Date:	Driller:	Sheet 1 of 1
4.00 m	25/08/2020	PL	Scale: 1:40
Elevation: mOD	**End Date:** 25/08/2020	**Logger:** SF	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
0.10 - 0.50	B2					0.10		TOPSOIL		
								MADE GROUND: Soft brownish grey slightly sandy slightly gravelly silty CLAY. Sand is fine to coarse. Gravel is subangular fine to coarse.		
0.50	ES1					0.50				
0.50 - 1.20	B3							Soft to firm orangish brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to coarse.		
1.20	U10	Ublow=38 75%	1.20	Dry		1.20				
1.20 - 2.00	B4							Firm orangish brown sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to medium.		
2.00	D7					2.00				
2.00 - 3.00	B5							Stiff brown slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is angular fine to coarse.		
2.00 - 2.45	SPT (S)	N=21 (3,4/4,5,6,6) Hammer SN = 0267 Water strike at 2.60m							▼	
3.00	D8					3.00				
3.00 - 4.00	B6							Stiff brown slightly sandy very gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to medium.		
3.00 - 3.45	SPT (S)	N=25 (3,4/4,5,7,9) Hammer SN = 0267 Water strike at 3.20m							▼	
4.00	D9					4.00				
4.00 - 4.16	SPT (S)	N=50 (25 for 115mm/50 for 50mm) Hammer SN = 0267						End of Borehole at 4.00m		

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
2.60	2.60		
3.20	3.20		

Casing Details

To (m)	Diameter

Water Added

From (m)	To (m)

Chiselling Details

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

Remarks

Hand pit excavated to 1.20m.

Groundwater at 2.90m on completion.

Termination Reason	Last Updated
Terminated on possible boulder/bedrock	01/10/2020

AGS

CAUSEWAY GEOTECH

Project No.	Project Name:	Borehole ID
20-0749A	Elm Grove	BH02
	Client: Cavan County Council	
	Client's Rep: Alan Traynor Consulting Engineers Ltd.	

Method	Plant Used	Top (m)	Base (m)	Coordinates
Light Percussion	Dando Terrier	0.00	5.00	242129.02 E 305269.45 N

Final Depth:	5.00 m	Start Date:	25/08/2020	Driller:	PL	Sheet 1 of 1 Scale: 1:40
Elevation:	mOD	End Date:	25/08/2020	Logger:	SF	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
0.00 - 0.50	B3							MADE GROUND: Brownish grey slightly sandy slightly clayey subangular fine to coarse GRAVEL. Sand is fine to coarse.		
0.50	ES1					0.50				
0.50 - 1.20	B4							MADE GROUND: Firm greyish brown slightly sandy very gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to medium.		
1.00	ES2									
1.20	D9					1.20				
1.20 - 2.00	B5							Possible MADE GROUND: Soft brownish grey slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to medium.		
1.20 - 1.65	SPT (S)	N=5 (1,1/1,1,1,2) Hammer SN = 0267		Dry						
2.00	U13	Ublow=36 0%		Dry		2.00				
2.00 - 3.00	B6							Firm brownish grey sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to medium.		
3.00	D10					3.00				
3.00 - 3.80	B7							Soft to firm grey slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to medium.		
3.00 - 3.45	SPT (S)	N=8 (1,1/1,2,3,2) Hammer SN = 0267		Dry						
3.80 - 5.00	B8	Water strike at 3.80m				3.80		Firm orangish brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subrounded fine to medium.	▼	
4.00	D11									
4.00 - 4.45	SPT (S)	N=11 (1,2/1,2,3,5) Hammer SN = 0267		Dry						
5.00	D12					5.00				
5.00 - 5.42	SPT (S)	N=50 (10,12/50 for 275mm) Hammer SN = 0267		3.60				End of Borehole at 5.00m		

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
3.80	3.80		

Casing Details

To (m)	Diameter

Water Added

From (m)	To (m)

Chiselling Details

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

Remarks

Hand pit excavated to 1.20m.

Groundwater at 3.0m on completion.

Termination Reason

Terminated on possible boulder/bedrock

Last Updated

01/10/2020

AGS

CAUSEWAY GEOTECH

Project No.	Project Name: Elm Grove	Borehole ID
20-0749A	Client: Cavan County Council	BH03
	Client's Rep: Alan Traynor Consulting Engineers Ltd.	

Method	Plant Used	Top (m)	Base (m)	Coordinates
Light Percussion	Dando Terrier	0.00	5.00	242122.15 E 305289.74 N

Final Depth:	5.00 m	Start Date:	25/08/2020	Driller:	PL	Sheet 1 of 1 Scale: 1:40
Elevation:	mOD	End Date:	25/08/2020	Logger:	SF	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
0.10 - 1.30	B3					0.10		TOPSOIL		
0.30	ES1							MADE GROUND: Greyish brown slightly sandy clayey subangular fine to coarse GRAVEL with bitmac. Sand is fine to coarse.		
1.00	ES2									
1.20	D8									
1.20 - 1.65	SPT (S)	N=10 (6,4/3,2,2,3) Hammer SN = 0267		Dry		1.30		Firm brown slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to medium.		
1.30 - 2.00	B4									
2.00	D9					2.00		Soft to firm orangish brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to medium.		
2.00 - 3.00	B5									
2.00 - 2.45	SPT (S)	N=8 (1,1/2,2,2,2) Hammer SN = 0267		Dry						
3.00	D10					3.00		Soft greyish brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to medium.		
3.00 - 4.00	B6									
3.00 - 3.45	SPT (S)	N=6 (1,2/1,2,1,2) Hammer SN = 0267		Dry						
		Water strike at 3.80m							▼	
4.00	D11					4.00		Soft to firm brown slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to medium.		
4.00 - 5.00	B7									
4.00 - 4.45	SPT (S)	N=6 (1,1/1,1,2,2) Hammer SN = 0267		3.80						
		Water strike at 4.40m							▼	
5.00	D12					5.00		End of Borehole at 5.00m		
5.00 - 5.42	SPT (S)	N=50 (9,11/50 for 275mm) Hammer SN = 0267		4.40						

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
3.80	3.80		
4.40	4.40		

Chiselling Details

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

Casing Details

To (m)	Diameter

Water Added

From (m)	To (m)

Remarks

Hand pit excavated to 1.20m.

Groundwater at 4.00m on completion.

Termination Reason

Terminated on possible boulder/bedrock

Last Updated

01/10/2020

AGS

CAUSEWAY GEOTECH

Project No.	Project Name:	Borehole ID
20-0749A	Elm Grove	BH04
	Client: Cavan County Council	
	Client's Rep: Alan Traynor Consulting Engineers Ltd.	

Method	Plant Used	Top (m)	Base (m)	Coordinates
Light Percussion	Dando Terrier	0.00	4.00	242154.06 E 305301.62 N

Final Depth:	Start Date:	Driller:	Sheet 1 of 1
4.00 m	24/08/2020	PL	Scale: 1:40
Elevation: mOD	**End Date:** 24/08/2020	**Logger:** SF	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
								MADE GROUND: CONCRETE		
0.19 - 0.35	B3					0.19		MADE GROUND: Grey subangular fine to coarse GRAVEL.		
0.30 - 1.00	B4					0.35		MADE GROUND: Very soft to soft brown with traces of orange sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to coarse.		
0.50	ES1									
1.00	ES2					1.00		Firm orangish brown slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular fine to coarse.		
1.00 - 3.00	B5									
1.20	U7	Ublow=37 0%		Dry						
2.00 - 2.45	SPT (C)	N=14 (2,2/3,4,3,3,4) Hammer SN = 0267		Dry						
3.00 - 4.00	B6					3.00		Stiff grey slightly sandy very gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is angular fine to coarse.		
3.00 - 3.45	SPT (C)	N=16 (2,4/4,4,4,4) Hammer SN = 0267		Dry						
4.00 - 4.44	SPT (C)	N=50 (9,12/50 for 290mm) Hammer SN = 0267 Seepage at 4.00m		4.00		4.00		End of Borehole at 4.00m		

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
4.00	4.00		

Casing Details

To (m)	Diameter

Water Added

From (m)	To (m)

Chiselling Details

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

Remarks

Hand pit excavated to 1.20m.

Termination Reason

Terminated on possible boulder/bedrock

Last Updated

01/10/2020

AGS

CAUSEWAY GEOTECH

Project No.	Project Name:	Borehole ID
20-0749A	Elm Grove	BH05
	Client: Cavan County Council	
	Client's Rep: Alan Traynor Consulting Engineers Ltd.	

Method	Plant Used	Top (m)	Base (m)	Coordinates
Light Percussion	Dando Terrier	0.00	4.00	242159.16 E 305282.36 N

Final Depth:	4.00 m	Start Date:	24/08/2020	Driller:	PL	Sheet 1 of 1 Scale: 1:40
Elevation:	mOD	End Date:	24/08/2020	Logger:	SF	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
								MADE GROUND: CONCRETE		
0.18 - 0.30	B3					0.18		MADE GROUND: Grey subangular coarse GRAVEL.		
0.30 - 1.20	B4					0.30		MADE GROUND: Very soft light brown sandy gravelly CLAY with medium cobble content and fragments of plastic. Sand is fine to coarse. Gravel is subangular fine to coarse.		
0.50	ES1									
1.00	ES2									
1.20 - 2.50	B5					1.20		Firm to stiff orangish brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to medium.		
1.20 - 1.65	SPT (C)	N=15 (2,2/4,4,5,2) Hammer SN = 0267		Dry						
2.00	U7	Ublow=63 50%		Dry						
2.50 - 4.00	B6					2.50		Stiff grey slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to coarse.		
3.00 - 3.45	SPT (C)	N=23 (2,3/3,3,4,13) Hammer SN = 0267		Dry						
4.00 - 4.44	SPT (C)	N=50 (7,8/50 for 295mm) Hammer SN = 0267		Dry		4.00		End of Borehole at 4.00m		

Water Strikes				Chiselling Details		
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)

Remarks

Hand pit excavated to 1.20m.

Groundwater at 3.70m on completion.

Termination Reason	Last Updated
Terminated on possible boulder/bedrock	01/10/2020

AGS

CAUSEWAY GEOTECH

Project No.	Project Name:	Borehole ID
20-0749A	Elm Grove	BH06
	Client: Cavan County Council	
	Client's Rep: Alan Traynor Consulting Engineers Ltd.	

Method	Plant Used	Top (m)	Base (m)	Coordinates
Light Percussion	Dando Terrier	0.00	4.00	242161.53 E 305272.55 N

Final Depth:	Start Date:	Driller:	Sheet 1 of 1
4.00 m	24/08/2020	PL	Scale: 1:40
Elevation: mOD	**End Date:** 24/08/2020	**Logger:** SF	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
0.17 - 0.80	B3					0.17		MADE GROUND: CONCRETE		
0.50	ES1							MADE GROUND: Light brown sandy slightly clayey subangular fine to coarse GRAVEL with medium cobble content. Sand is fine to coarse.		
0.80 - 2.00	B4					0.80		Soft orangish brown slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular fine to medium.		
1.00	ES2									
1.20	U7	Ublow=56 50%	1.20	Dry						
2.00 - 2.70	B5					2.00		Firm to stiff light brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to medium.		
2.00 - 2.45	SPT (C)	N=15 (2,3/2,4,4,5) Hammer SN = 0267		Dry						
2.70 - 4.00	B6					2.70		Stiff grey slightly sandy gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is angular fine to coarse.		
3.00 - 3.45	SPT (C)	N=15 (2,2/2,3,5,5) Hammer SN = 0267		Dry						
3.95 - 3.98	SPT (C)	N=50 (25 for 15mm/50 for 20mm) Hammer SN = 0267		Dry		4.00		End of Borehole at 4.00m		

Water Strikes

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

Chiselling Details

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

Casing Details

To (m)	Diameter

Water Added

From (m)	To (m)

Remarks

Hand pit excavated to 1.20m.

Borehole dry on completion.

Termination Reason

Terminated on possible boulder/bedrock

Last Updated

01/10/2020

AGS

CAUSEWAY GEOTECH

Project No.	Project Name:	Borehole ID
20-0749A	Elm Grove	BH07
	Client: Cavan County Council	
	Client's Rep: Alan Traynor Consulting Engineers Ltd.	

Method	Plant Used	Top (m)	Base (m)	Coordinates
Light Percussion	Dando Terrier	0.00	5.00	242160.95 E 305240.07 N

Final Depth:	5.00 m	Start Date:	26/08/2020	Driller:	PL	Sheet 1 of 1 Scale: 1:40
Elevation:	mOD	End Date:	26/08/2020	Logger:	SF	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
						0.15		TOPSOIL		
0.30 - 1.20	B2					0.30		MADE GROUND: Soft brownish grey sandy gravelly CLAY with fragments of brick. Sand is fine to coarse. Gravel is subangular fine to coarse.		
0.50	ES1							Soft orangish brown sandy gravelly CLAY with medium cobble content. Sand is fine to coarse. Gravel is subangular fine to medium.		
1.20	U10	Ublow=34 40%		Dry		1.20		Soft orangish brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to medium.		
2.00	D6					2.00		Very soft orangish brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is subangular fine to medium.		
2.00 - 3.00	B3									
2.00 - 2.45	SPT (S)	N=3 (1,1/1,0,1,1) Hammer SN = 0267		Dry						
3.00	D7					3.00		Stiff brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is subangular fine to medium.		
3.00 - 3.90	B4									
3.00 - 3.45	SPT (S)	N=27 (2,3/4,9,8,6) Hammer SN = 0267		Dry						
3.90 - 5.00	B5					3.90		Very stiff grey slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to coarse.		
4.00	D8									
4.00 - 4.45	SPT (S)	N=35 (3,8/9,8,7,11) Hammer SN = 0267		Dry						
4.50 - 4.80	SPT (S)	N=50 (6,12/50 for 150mm) Hammer SN = 0267		Dry						
5.00	D9					5.00		End of Borehole at 5.00m		

Water Strikes

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

Casing Details

To (m)	Diameter

Water Added

From (m)	To (m)

Chiselling Details

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

Remarks

Hand pit excavated to 1.20m.

Borehole dry on completion.

Termination Reason

Terminated on possible boulder/bedrock

Last Updated

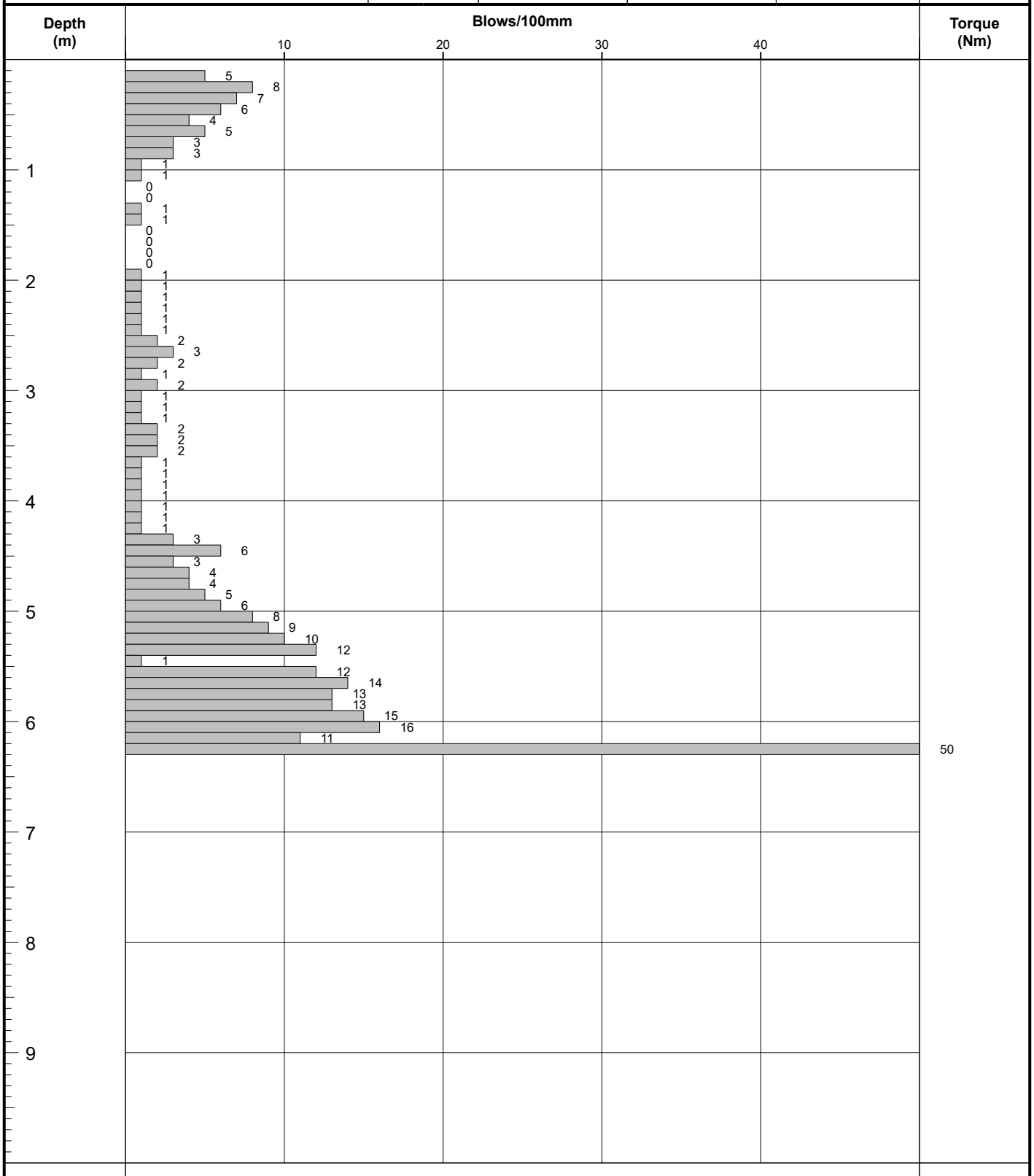
01/10/2020

AGS

CAUSEWAY GEOTECH

Project No.	Project Name:	Probe ID
20-0749A	Elm Grove	DP01
Coordinates	**Client:**	
242134.28 E	Cavan County Council	
305251.59 N	**Client's Representative:** Alan Traynor Consulting Engineers Ltd.	Sheet 1 of 1
		Scale: 1:50

Method:	Elevation	Final Depth:	Date:	Operator:	
Dynamic Probing	mOD	6.20	25/08/2020		FINAL
Probe Type: DPSH-B					



Fall Height:	Remarks:
750 mm	
Hammer Mass: 64 kg	
Cone Diameter: 51 mm	

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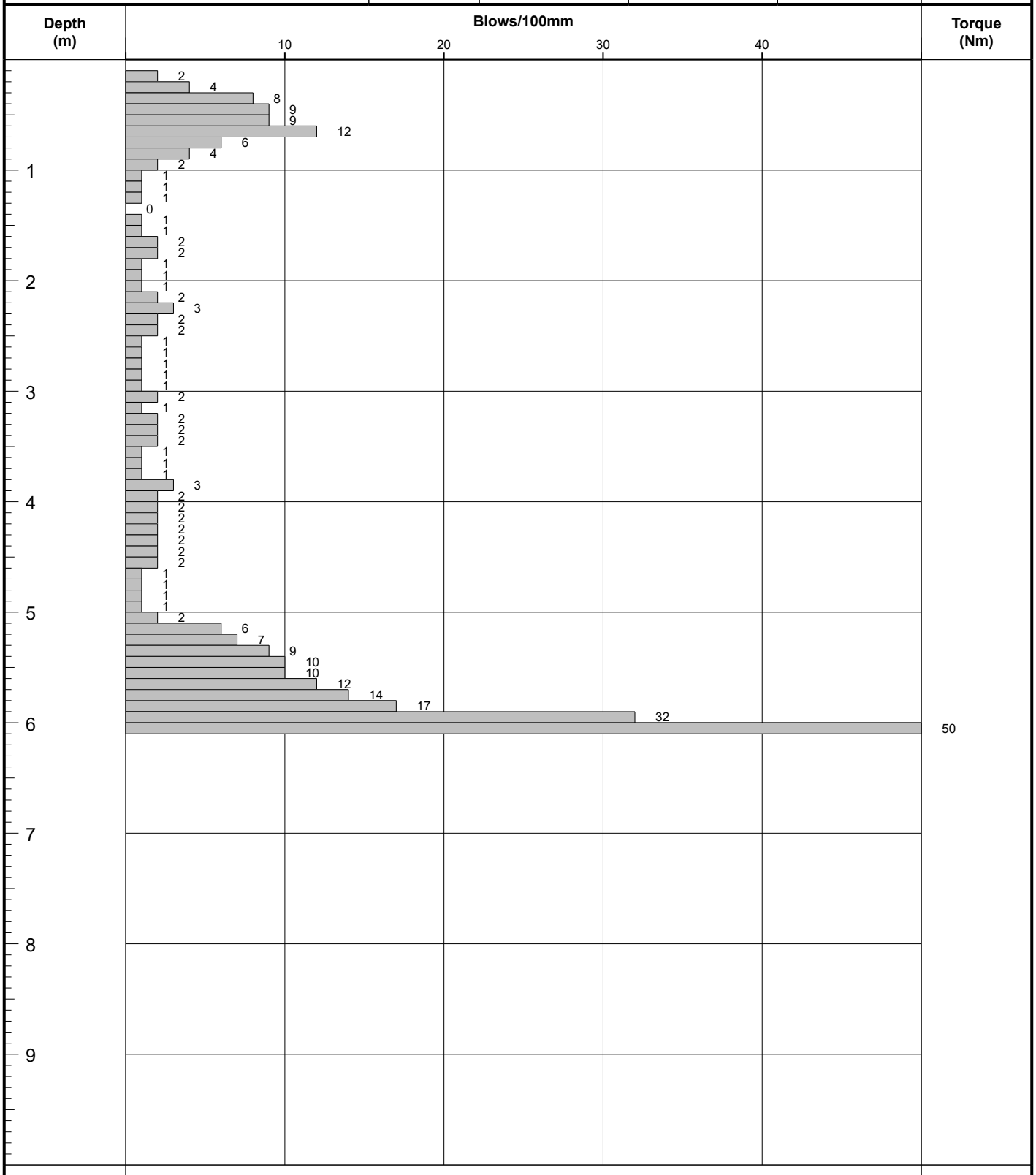
CAUSEWAY GEOTECH

Project No.	Project Name:	Probe ID
20-0749A	Elm Grove	DP02
Coordinates	**Client:**	
242137.39 E	Cavan County Council	
305296.90 N	**Client's Representative:** Alan Traynor Consulting Engineers Ltd.	Sheet 1 of 1
		Scale: 1:50

Method:	Elevation	Final Depth:	Date:	Operator:	
Dynamic Probing	mOD	6.00	26/08/2020		FINAL
Probe Type: DPSH-B					



Fall Height:	Remarks:
750 mm	
Hammer Mass: 64 kg	
Cone Diameter: 51 mm	

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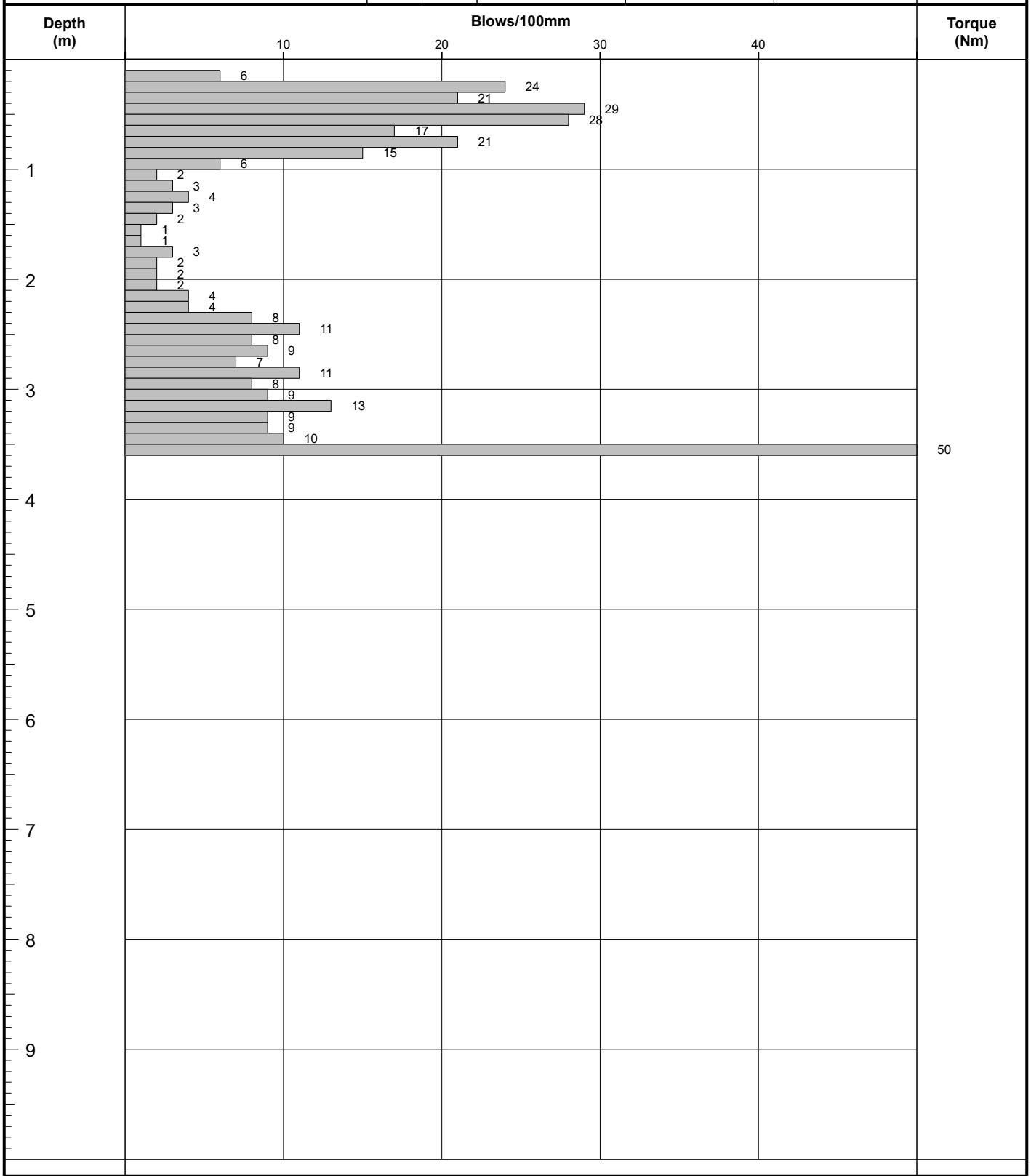
CAUSEWAY GEOTECH

Project No.	Project Name:	Probe ID
20-0749A	Elm Grove	DP03
Coordinates	**Client:**	
242163.64 E	Cavan County Council	
305254.58 N	**Client's Representative:** Alan Traynor Consulting Engineers Ltd.	Sheet 1 of 1
		Scale: 1:50

Method:	Elevation	Final Depth:	Date:	Operator:	
Dynamic Probing	mOD	3.60	26/08/2020		FINAL
Probe Type: DPSH-B					



Fall Height:	Remarks:
750 mm	
Hammer Mass: 64 kg	
Cone Diameter: 51 mm	

AGS

CAUSEWAY GEOTECH

APPENDIX C

INDIRECT IN-SITU CBR TEST RESULTS

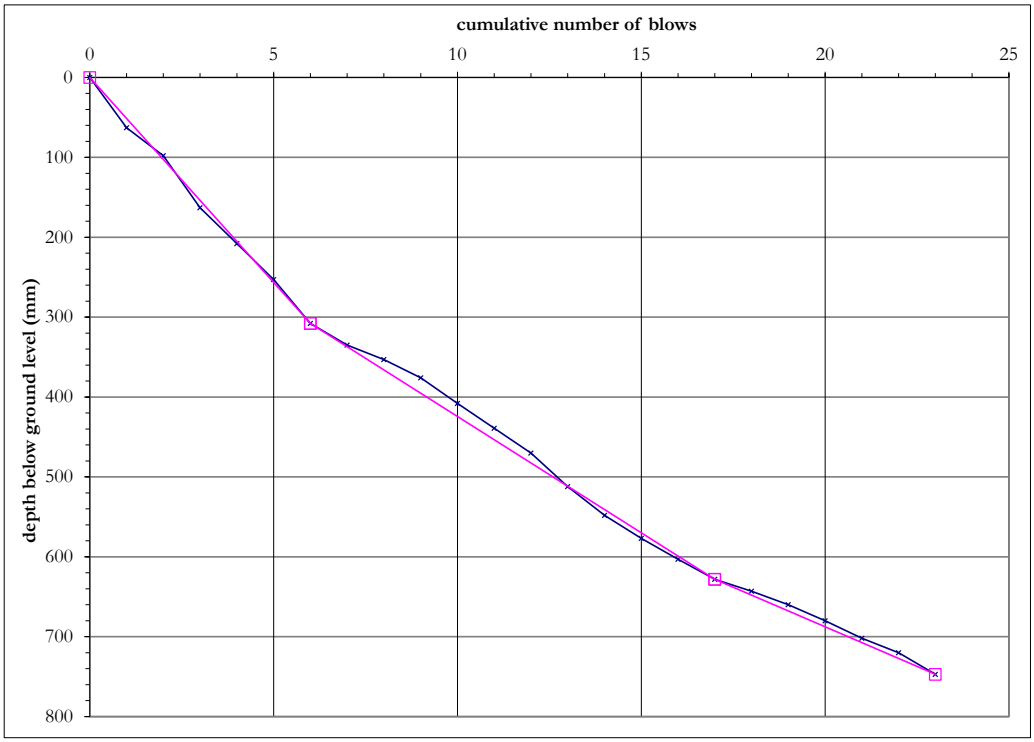
Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project Number	20-0749A
Project Name	Elm Grove
Site Location	Cavan

Test Number	CBR01	**Date Tested**	26/08/2020
Depth bgl (m)		**Weather**	Dry

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4.
CBR calculated using the TRL equation: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) iaw IAN 73/06 Rev 1 2009.

Surface preparation	Description of surface material
N/A	



top / base of layer (mm)	mm/ blow	CBR (%)
0	51	4.7
308		
308	29	8.6
628		
628	20	13
747		

CBR Range	Min: 4.7 Max: 13	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	

Approved Name and Appointment		
Darren O'Mahony Director		October 2020

UKAS TESTING 10122

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

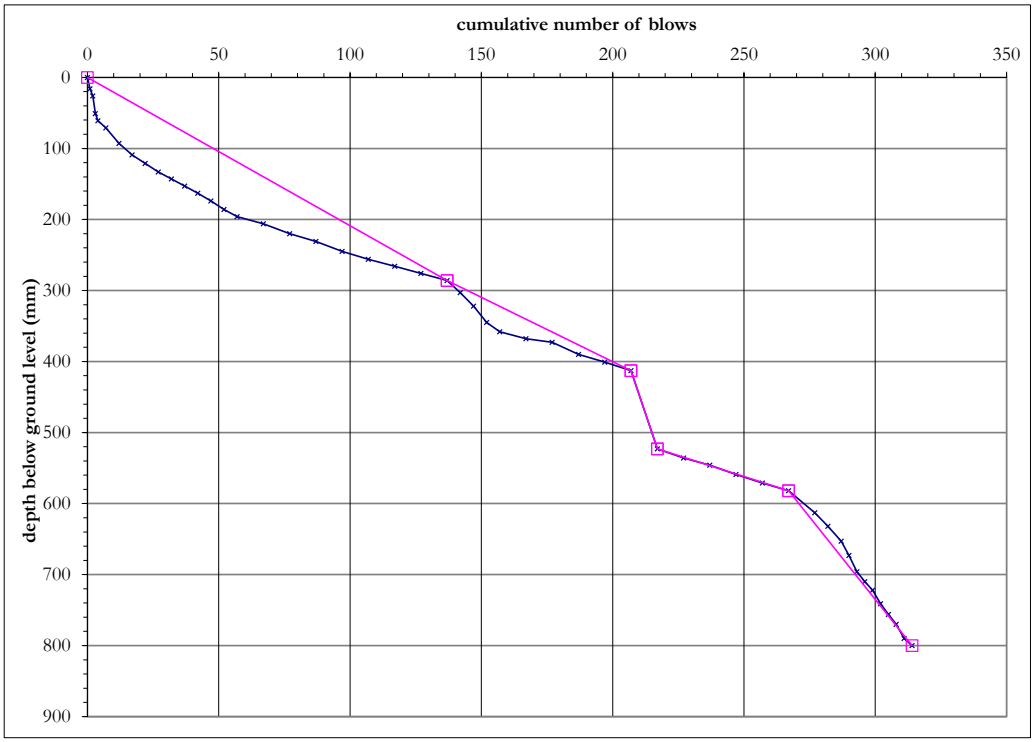
Project Number	20-0749A
Project Name	Elm Grove
Site Location	Cavan

Test Number	CBR02
Depth bgl (m)	

Date Tested	26/08/2020
Weather	Dry

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4.
CBR calculated using the TRL equation: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) iaw IAN 73/06 Rev 1 2009.

Surface preparation	Description of surface material
N/A	



top / base of layer (mm)	mm/ blow	CBR (%)
0	2.1	>100
286		
286	1.8	>100
413		
413	11	24
523		
523	1.2	>100
582		
582	4.6	60
800		

CBR Range	Min: 24 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.

Deviation(s) from standard procedure	None

Observations and comments	

Approved Name and Appointment		
Darren O'Mahony Director		October 2020

UKAS TESTING 10122

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

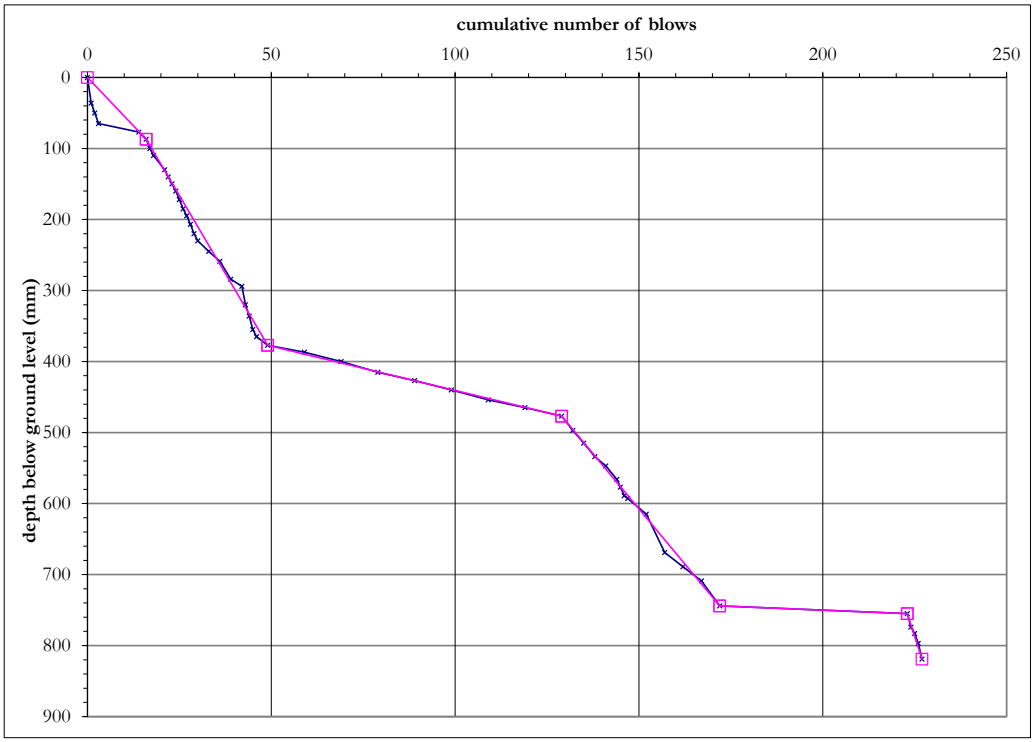
Project Number	20-0749A
Project Name	Elm Grove
Site Location	Cavan

Test Number	CBR03
Depth bgl (m)	

Date Tested	26/08/2020
Weather	Dry

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4.
CBR calculated using the TRL equation: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) iaw IAN 73/06 Rev 1 2009.

Surface preparation	Description of surface material
N/A	



top / base of layer (mm)	mm/ blow	CBR (%)
0	5.4	50
87		
87	8.8	30
377		
377	1.3	>100
477		
477	6.2	44
744		
744	0.2	>100
755		
755	16	16
819		

CBR Range	Min: 16 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.

Deviation(s) from standard procedure	None

Observations and comments	

Approved Name and Appointment		
Darren O'Mahony Director		October 2020

UKAS TESTING 10122

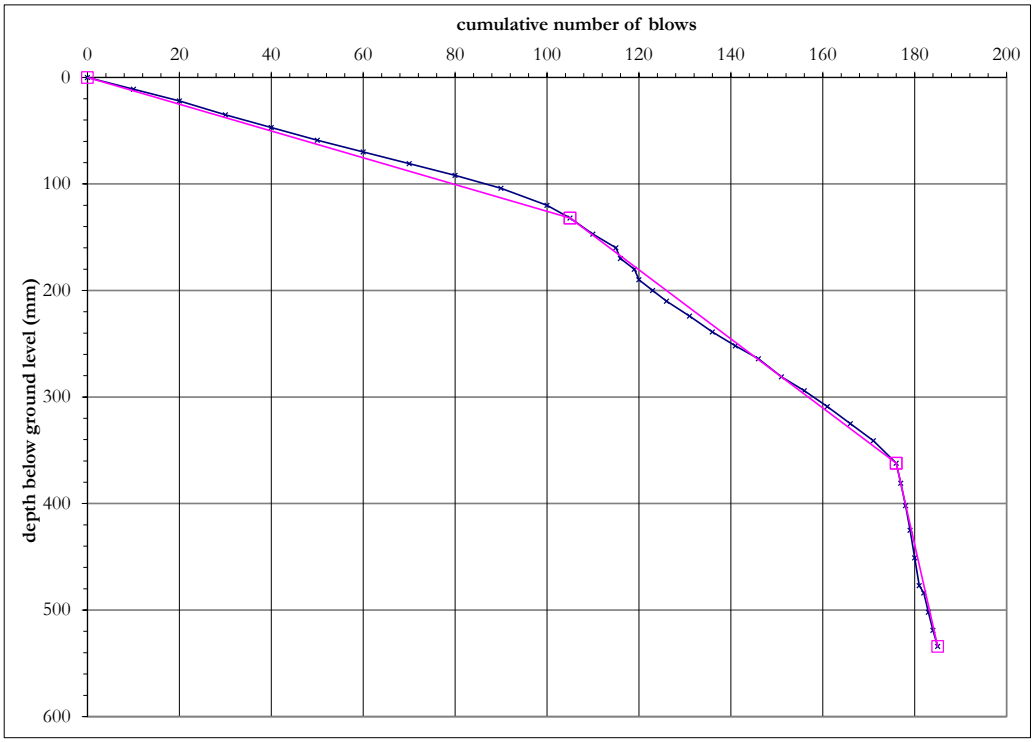
Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project Number	20-0749A
Project Name	Elm Grove
Site Location	Cavan

Test Number	CBR04	**Date Tested**	26/08/2020
Depth bgl (m)		**Weather**	Dry

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4.
CBR calculated using the TRL equation: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) iaw IAN 73/06 Rev 1 2009.

Surface preparation	Description of surface material
N/A	



top / base of layer (mm)	mm/ blow	CBR (%)
0	1.3	>100
132		
132	3.2	87
362		
362	19	13
534		

CBR Range	Min: 13 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.

Deviation(s) from standard procedure	None

Observations and comments	

Approved Name and Appointment		
Darren O'Mahony Director		October 2020

UKAS TESTING 10122

CAUSEWAY GEOTECH

APPENDIX D

LABORATORY TEST RESULTS

CAUSEWAY GEOTECH

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Company Number: 633786

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SOIL AND ROCK SAMPLE ANALYSIS
LABORATORY TEST REPORT

30 September 2020

Project Name:	Elm Grove
Project No.:	20-0749a
Client:	Cavan County Council
Engineer:	Alan Traynor Consulting Engineers Ltd

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: Elm Grove

Report Reference: Schedule 1

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

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

Material tested	Type of test/Properties measured/Range of measurement	Standard specifications	No. of results included in the report
SOIL	Moisture Content of Soil	BS 1377-2: 1990: Cl 3.2	7
SOIL	Liquid and Plastic Limits of soil-1 point cone penetrometer method	BS 1377-2: 1990: Cl 4.4, 5.3 & 5.4	7
SOIL	Particle size distribution - wet sieving	BS 1377-2: 1990: Cl 9.2	7
SOIL	Particle size distribution - sedimentation hydrometer method	BS 1377-2: 1990: Cl 9.5	7
SOIL	Undrained shear strength – triaxial compression without measurement of pore pressure (loads from 0.12 to 24 kN)	BS 1377-7: 1990: Cl 8	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 Chemtest Ltd *(UKAS 2183)*	pH Value of Soil		7
SOIL – Subcontracted to Chemtest Ltd *(UKAS 2183)*	Sulphate Content water extract		7

Summary of Classification Test Results

Project No.	Project Name
20-0749a	Elm Grove

Hole No.	Sample				Soil Description	Density bulk	Density dry	w	Passing 425µm	LL	PL	PI	Particle density	Casagrande Classification
	Ref	Top	Base	Type		Mg/m3		%	%	%	%	%	Mg/m3	
BH01	10	1.20		U	Grey sandy gravelly silty CLAY.			13.0	67	32 -1pt	16	16		CL
BH02	10	3.00		D	Grey sandy gravelly silty CLAY.			21.0	78	32 -1pt	16	16		CL
BH03	9	2.00		D	Grey sandy slightly gravelly silty CLAY.			20.0	84	37 -1pt	19	18		CI
BH04	5	1.00		B	Greenish grey sandy gravelly silty CLAY.			18.0	76	33 -1pt	15	18		CL
BH05	7	2.00		U	Brownish grey sandy gravelly silty CLAY.			18.0	72	37 -1pt	17	20		CI
BH06	7	1.20		U	Brownish grey sandy gravelly silty CLAY.			15.0	78	40 -1pt	18	22		CI
BH07	7	3.00		D	Greenish grey sandy gravelly silty CLAY.			11.0	70	32 -1pt	15	17		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

30/09/2020

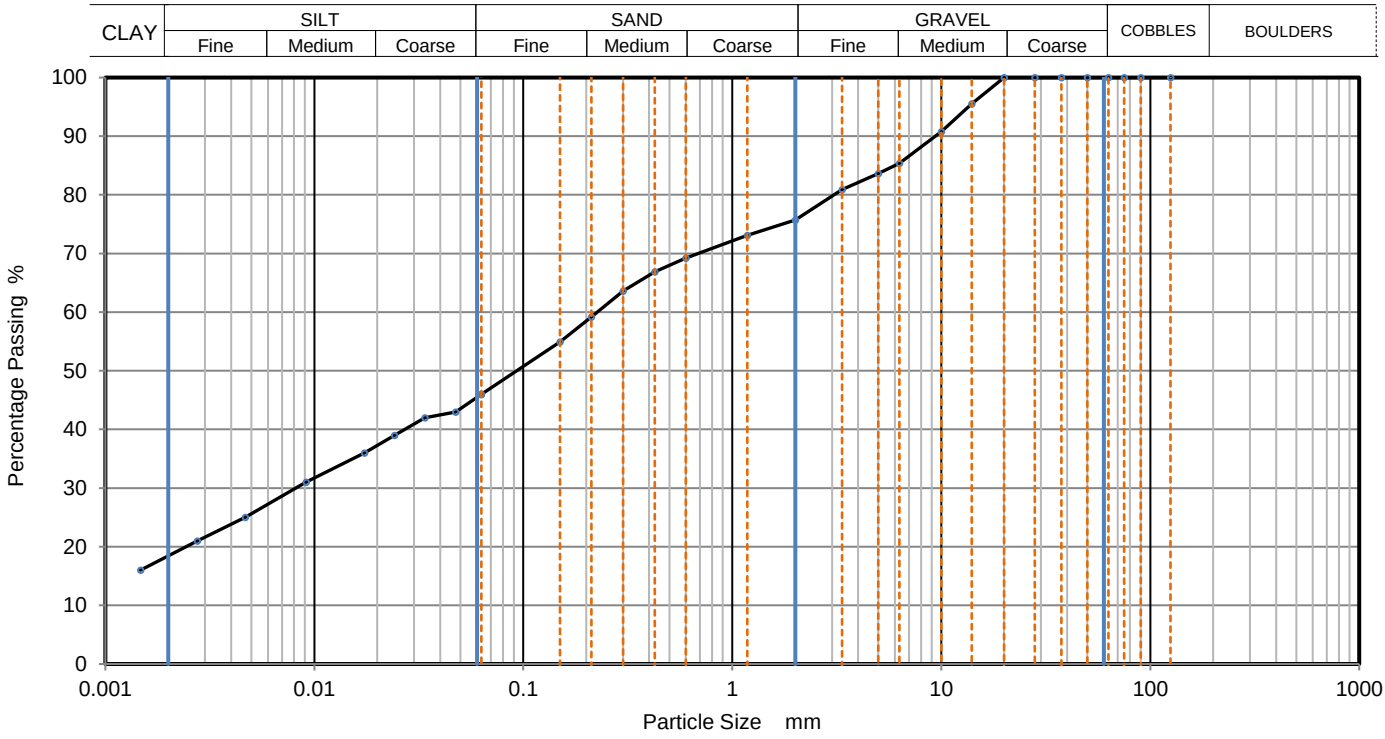
Approved By

Stephen.Watson

UKAS TESTING

10122

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**20-0749a**
				Borehole/Pit No.	BH01
Site Name	Elm Grove			Sample No.	5
Soil Description	Grey sandy gravelly silty CLAY.			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	Caus20200827120



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06290	46
90	100	0.04744	43
75	100	0.03378	42
63	100	0.02421	39
50	100	0.01735	36
37.5	100	0.00913	31
28	100	0.00468	25
20	100	0.00275	21
14	96	0.00147	16
10	91		
6.3	85		
5	84		
3.35	81		
2	76		
1.18	73		
0.6	69	Particle density	(assumed)
0.425	67	2.65	Mg/m3
0.3	64		
0.212	59		
0.15	55		
0.063	46		

Dry Mass of sample, g	541

Sample Proportions	% dry mass
Cobbles	0
Gravel	24
Sand	30
Silt	28
Clay	19

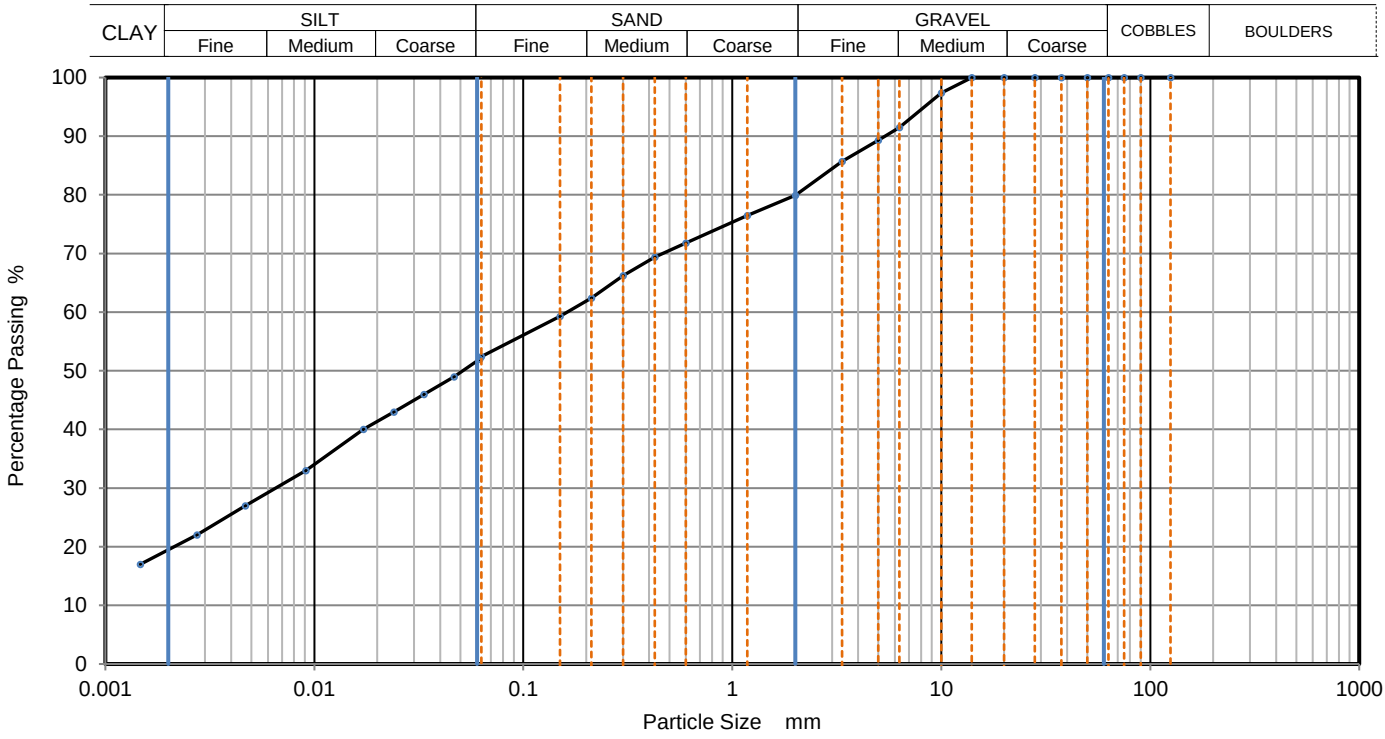
Grading Analysis		
D100	mm	
D60	mm	0.226
D30	mm	0.00801
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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

Approved
Stephen.Watson

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**20-0749a**
				Borehole/Pit No.	BH02
Site Name	Elm Grove			Sample No.	7
Soil Description	Grey sandy gravelly silty CLAY.			Depth, m	3.00
Specimen Reference	2	Specimen Depth	3 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus20200827121



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06181	52
90	100	0.04664	49
75	100	0.03345	46
63	100	0.02398	43
50	100	0.01719	40
37.5	100	0.00911	33
28	100	0.00467	27
20	100	0.00274	22
14	100	0.00147	17
10	97		
6.3	92		
5	89		
3.35	86		
2	80		
1.18	77		
0.6	72	Particle density	(assumed)
0.425	69	2.65	Mg/m3
0.3	66		
0.212	62		
0.15	59		
0.063	52		

Dry Mass of sample, g	516

Sample Proportions	% dry mass
Cobbles	0
Gravel	20
Sand	28
Silt	33
Clay	20

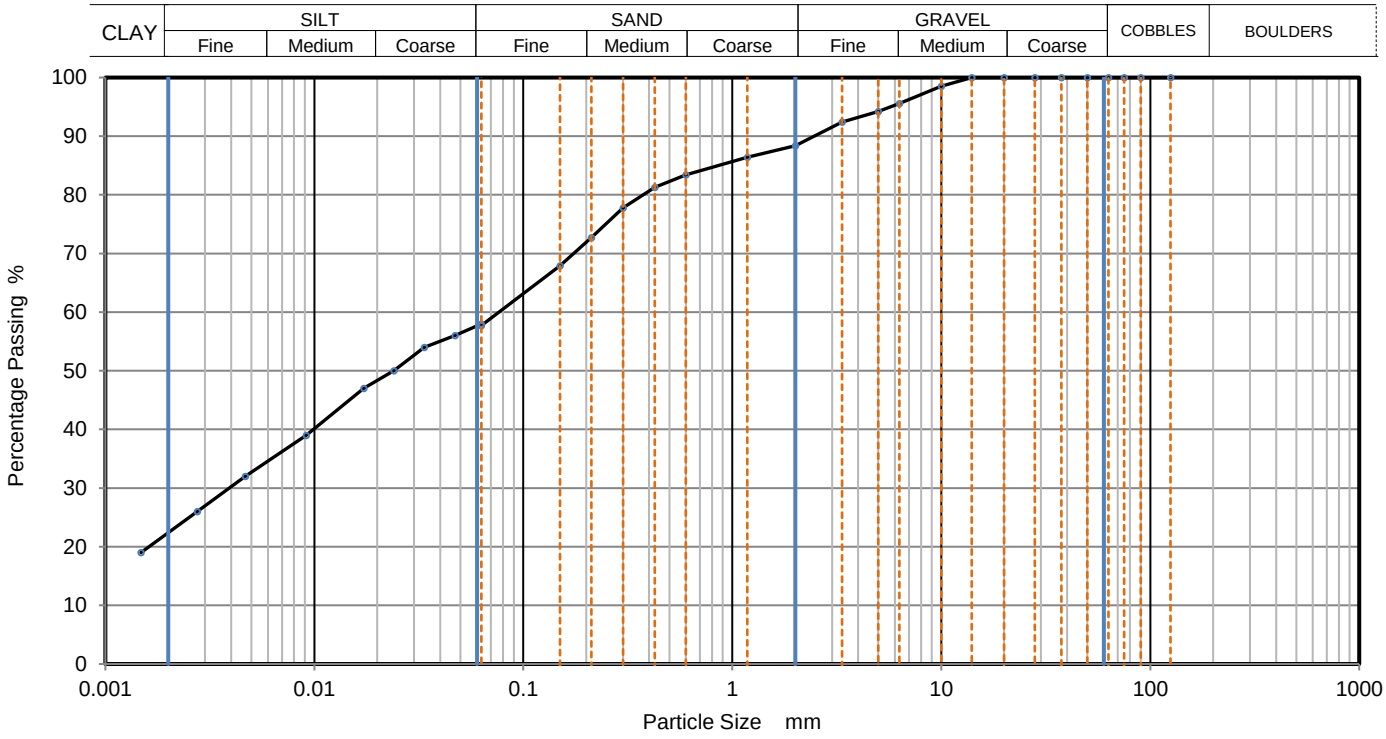
Grading Analysis		
D100	mm	
D60	mm	0.163
D30	mm	0.00641
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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

Approved
Stephen.Watson

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION				Job Ref	20-0749a
					Borehole/Pit No.	BH03
Site Name	Elm Grove				Sample No.	5
Soil Description	Grey sandy slightly gravelly silty CLAY.				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	Caus20200827123



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06290	58
90	100	0.04711	56
75	100	0.03355	54
63	100	0.02405	50
50	100	0.01724	47
37.5	100	0.00913	39
28	100	0.00468	32
20	100	0.00275	26
14	100	0.00148	19
10	99		
6.3	96		
5	94		
3.35	92		
2	88		
1.18	86		
0.6	83	Particle density	(assumed)
0.425	81	2.65	Mg/m3
0.3	78		
0.212	73		
0.15	68		
0.063	58		

Dry Mass of sample, g	520

Sample Proportions	% dry mass
Cobbles	0
Gravel	12
Sand	31
Silt	36
Clay	22

Grading Analysis		
D100	mm	
D60	mm	0.0766
D30	mm	0.004
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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

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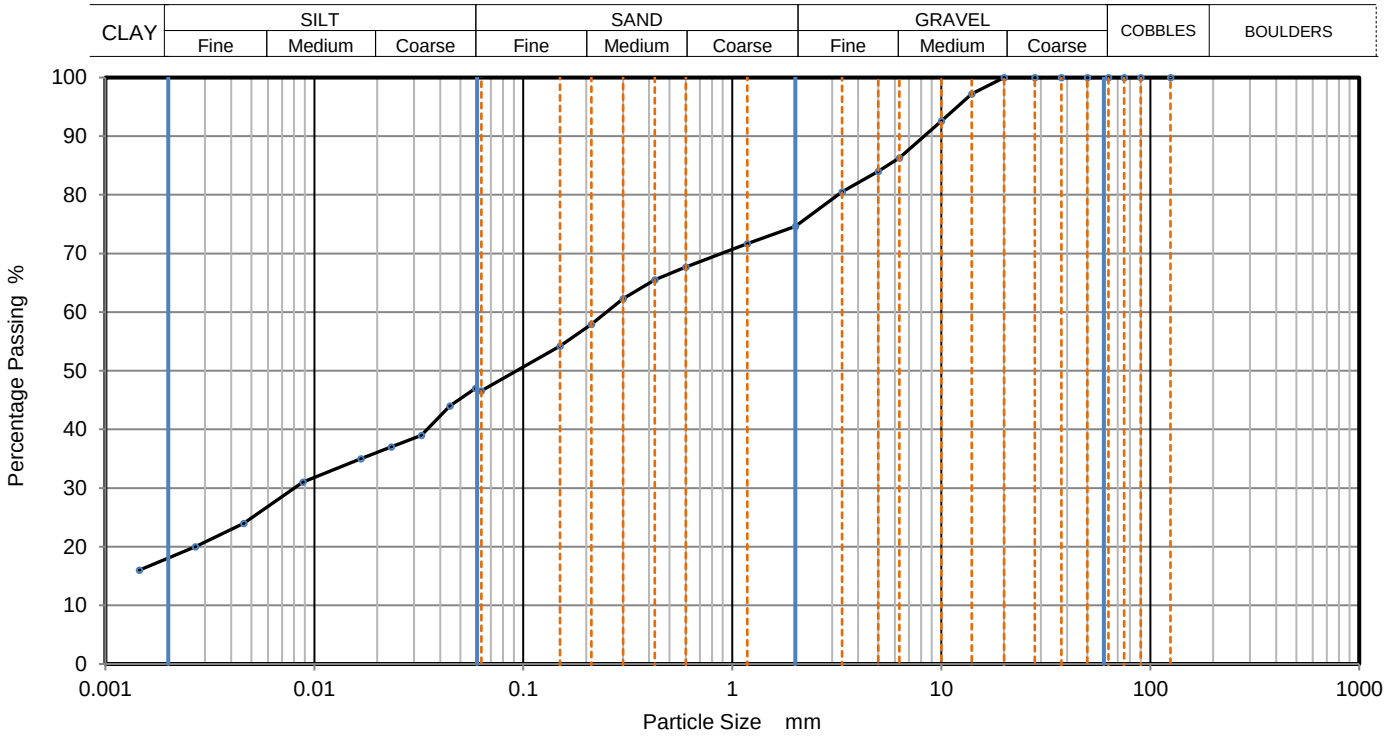
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION				Job Ref	20-0749a
					Borehole/Pit No.	BH04
Site Name	Elm Grove				Sample No.	5
Soil Description	Greenish grey sandy gravelly silty CLAY.				Depth, m	1.00
Specimen Reference	6	Specimen Depth	1	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5				KeyLAB ID	Caus20200827125



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.05898	47
90	100	0.04457	44
75	100	0.03250	39
63	100	0.02332	37
50	100	0.01673	35
37.5	100	0.00882	31
28	100	0.00458	24
20	100	0.00270	20
14	97	0.00145	16
10	93		
6.3	86		
5	84		
3.35	81		
2	75		
1.18	72		
0.6	68	Particle density	(assumed)
0.425	66	2.65	Mg/m3
0.3	62		
0.212	58		
0.15	54		
0.063	47		

Dry Mass of sample, g	529

Sample Proportions	% dry mass
Cobbles	0
Gravel	25
Sand	28
Silt	29
Clay	18

Grading Analysis		
D100	mm	
D60	mm	0.25
D30	mm	0.008
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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

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Stephen.Watson

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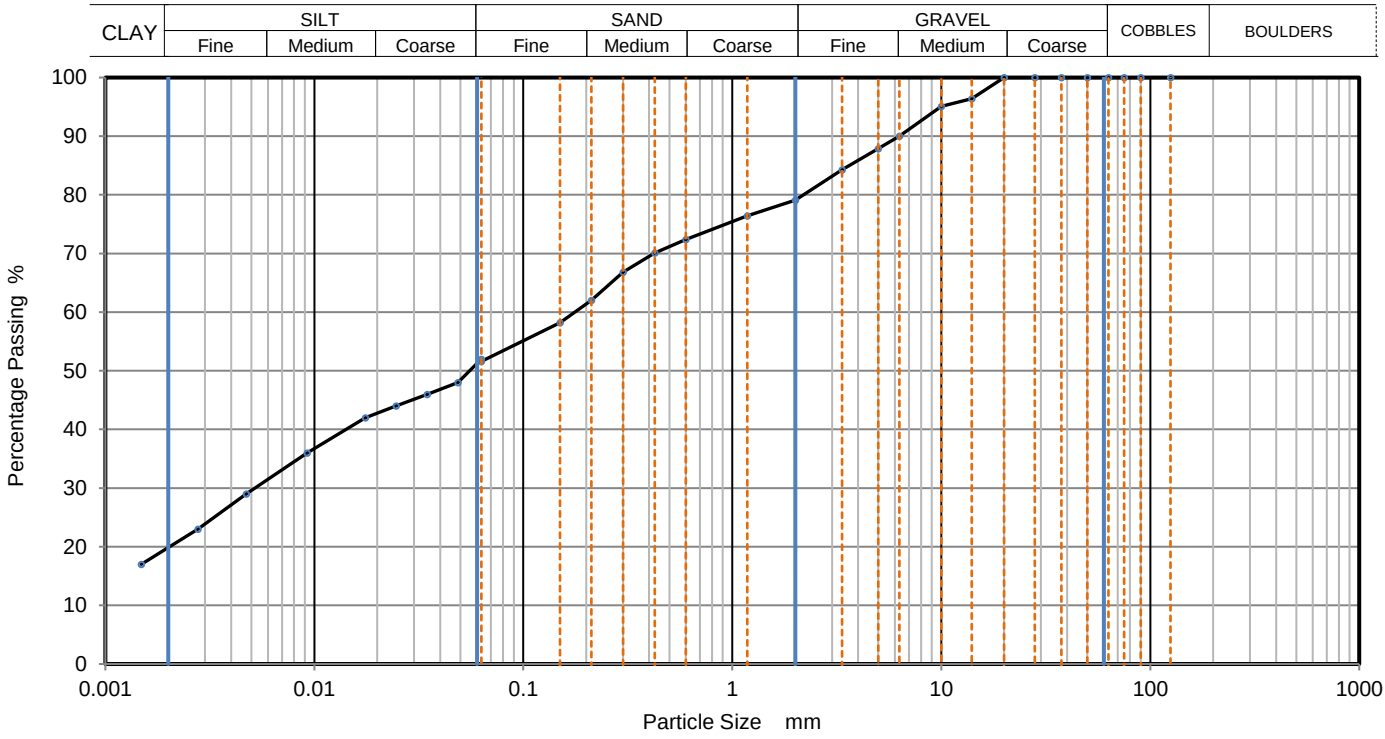
CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION				Job Ref	20-0749a
					Borehole/Pit No.	BH05
Site Name	Elm Grove				Sample No.	5
Soil Description	Brownish grey sandy gravelly silty CLAY.				Depth, m	1.20
Specimen Reference	2	Specimen Depth	1.2	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5				KeyLAB ID	Caus20200827126



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	52
90	100	0.04862	48
75	100	0.03461	46
63	100	0.02463	44
50	100	0.01753	42
37.5	100	0.00922	36
28	100	0.00472	29
20	100	0.00278	23
14	96	0.00149	17
10	95		
6.3	90		
5	88		
3.35	84		
2	79		
1.18	76		
0.6	72	Particle density	(assumed)
0.425	70	2.65	Mg/m3
0.3	67		
0.212	62		
0.15	58		
0.063	52		

Dry Mass of sample, g	503

Sample Proportions	% dry mass
Cobbles	0
Gravel	21
Sand	28
Silt	32
Clay	20

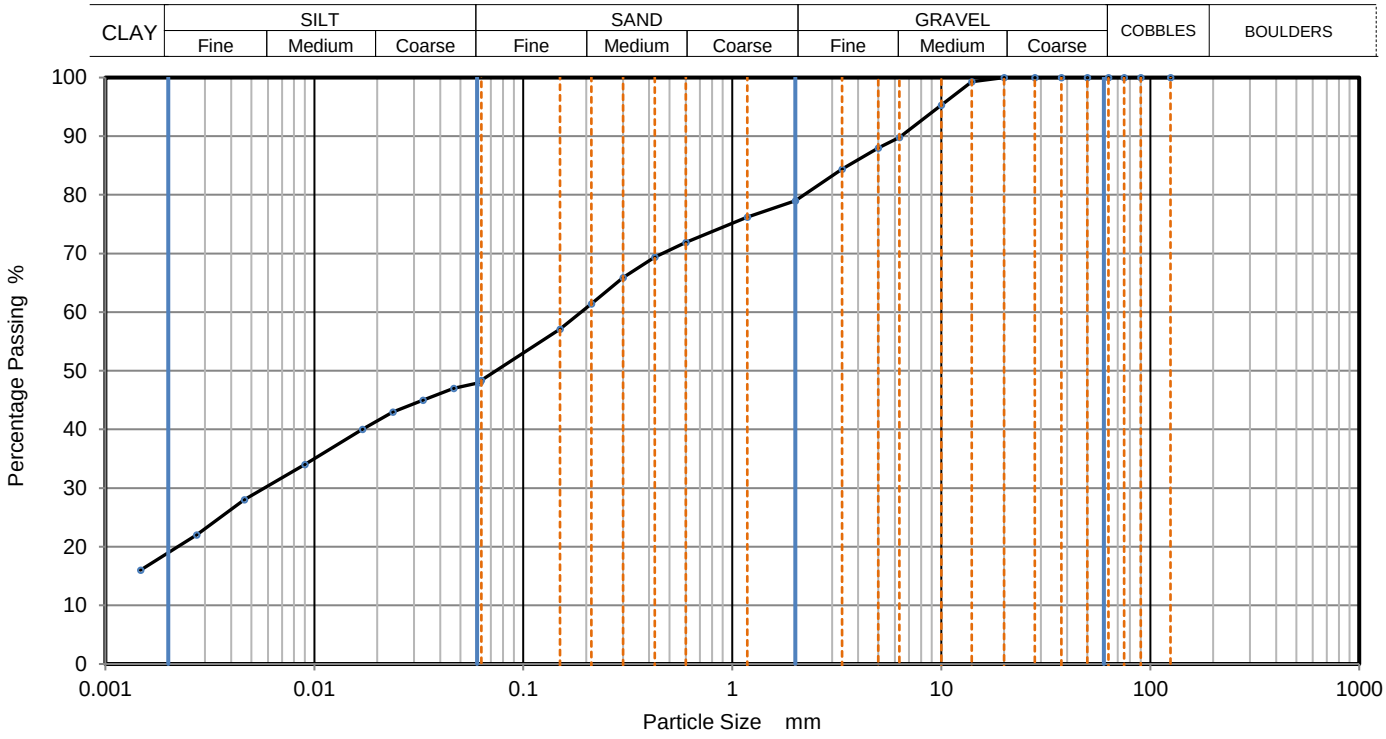
Grading Analysis		
D100	mm	
D60	mm	0.176
D30	mm	0.00531
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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

Approved
Stephen.Watson

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION				Job Ref	20-0749a
					Borehole/Pit No.	BH06
Site Name	Elm Grove				Sample No.	4
Soil Description	Brownish grey sandy gravelly silty CLAY.				Depth, m	0.80
Specimen Reference	2	Specimen Depth	0.8	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5				KeyLAB ID	Caus20200827128



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06199	48
90	100	0.04644	47
75	100	0.03307	45
63	100	0.02372	43
50	100	0.01701	40
37.5	100	0.00902	34
28	100	0.00462	28
20	100	0.00273	22
14	99	0.00147	16
10	95		
6.3	90		
5	88		
3.35	84		
2	79		
1.18	76		
0.6	72	Particle density	(assumed)
0.425	69	2.65	Mg/m3
0.3	66		
0.212	61		
0.15	57		
0.063	48		

Dry Mass of sample, g	514

Sample Proportions	% dry mass
Cobbles	0
Gravel	21
Sand	31
Silt	29
Clay	19

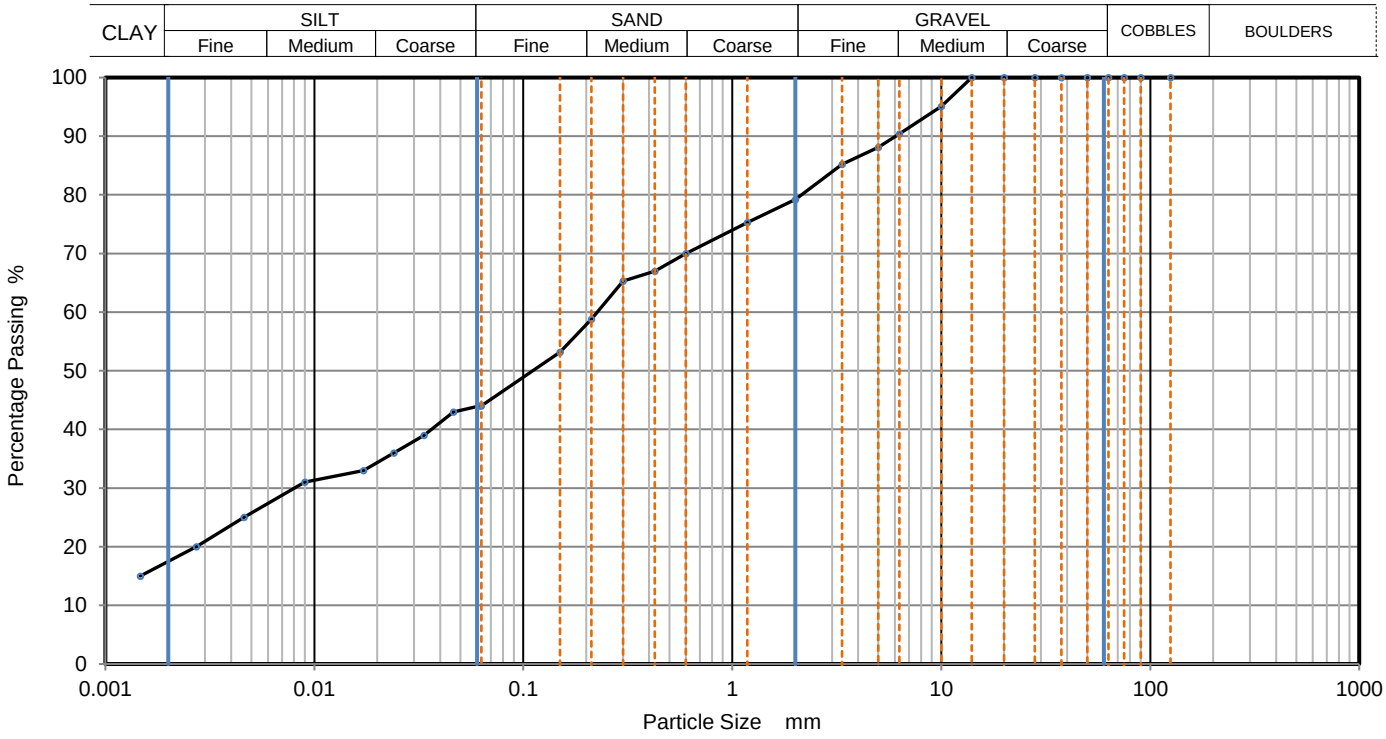
Grading Analysis		
D100	mm	
D60	mm	0.19
D30	mm	0.00589
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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

Approved
Stephen.Watson

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION				Job Ref	20-0749a
					Borehole/Pit No.	BH07
Site Name	Elm Grove				Sample No.	4
Soil Description	Greenish grey sandy gravelly silty CLAY.				Depth, m	3.00
Specimen Reference	2	Specimen Depth	3	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5				KeyLAB ID	Caus20200827130



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06181	44
90	100	0.04630	43
75	100	0.03345	39
63	100	0.02398	36
50	100	0.01719	33
37.5	100	0.00899	31
28	100	0.00461	25
20	100	0.00273	20
14	100	0.00147	15
10	95		
6.3	90		
5	88		
3.35	85		
2	79		
1.18	75		
0.6	70	Particle density	(assumed)
0.425	67	2.65	Mg/m3
0.3	65		
0.212	59		
0.15	53		
0.063	44		

Dry Mass of sample, g	511

Sample Proportions	% dry mass
Cobbles	0
Gravel	21
Sand	35
Silt	27
Clay	17

Grading Analysis		
D100	mm	
D60	mm	0.226
D30	mm	0.00827
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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

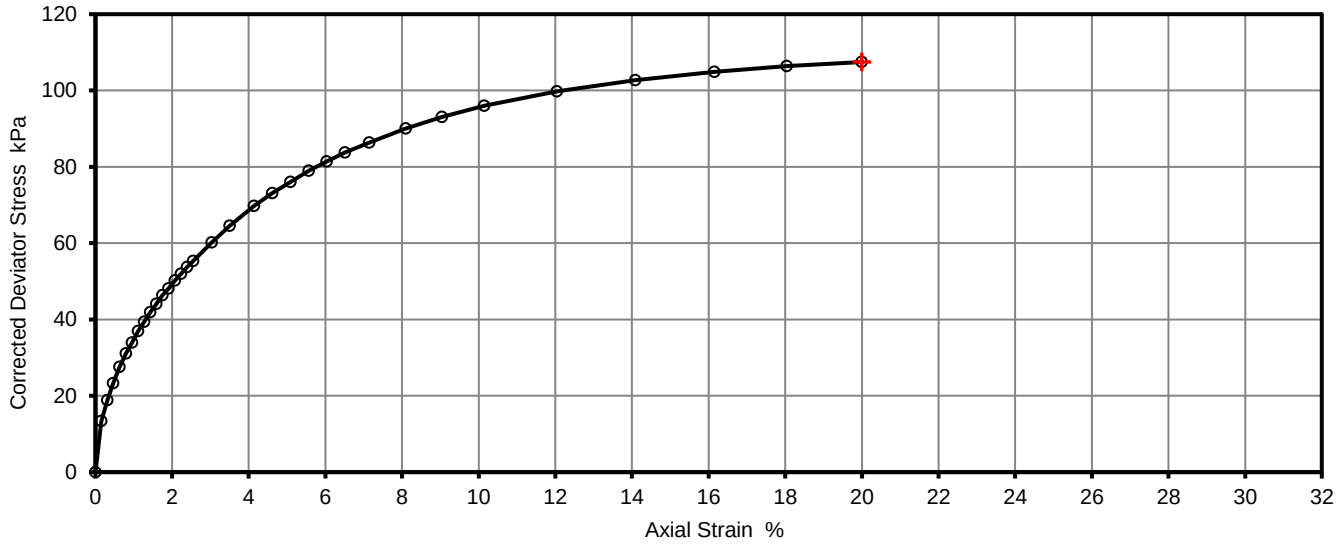
Approved
Stephen.Watson

UKAS TESTING 10122

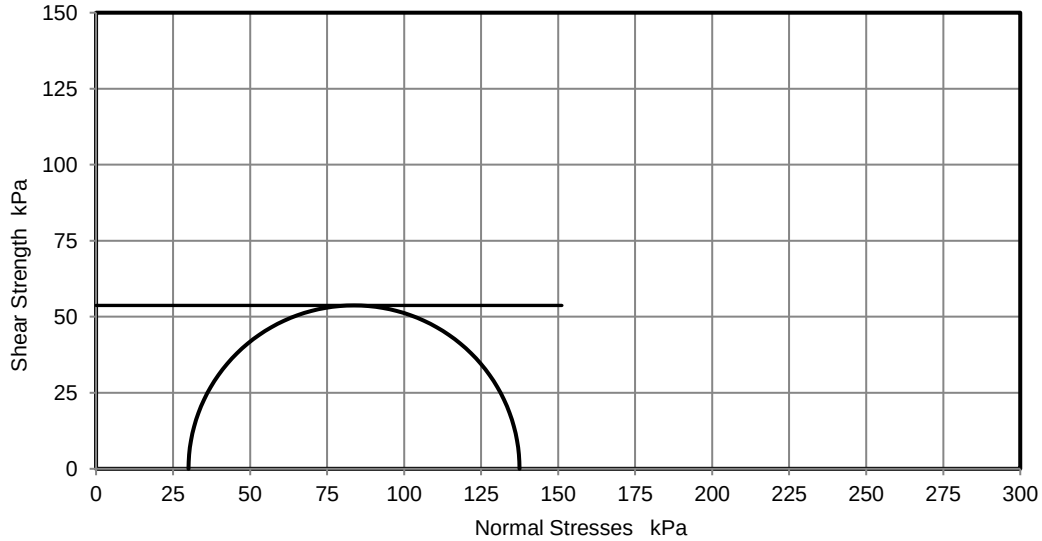
CAUSEWAY GEOTECH	**Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen**				Job Ref	20-0749a
					Borehole/Pit No.	BH01
Site Name	Elm Grove				Sample No.	10
Soil Description	Grey sandy gravelly silty CLAY.				Depth	1.20
Specimen Reference	6	Specimen Depth	1.25	m	Sample Type	U
Specimen Description	Firm grey sandy gravelly silty CLAY.				KeyLAB ID	Caus20200827119
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen				Date of test	17/09/2020

Test Number		1	
Length		210.8	mm
Diameter		104.5	mm
Bulk Density		1.93	Mg/m3
Moisture Content		26.7	%
Dry Density		1.52	Mg/m3
Rate of Strain		2.0	%/min
Cell Pressure		30	kPa
At failure	Axial Strain	20.0	%
	Deviator Stress, (σ1 - σ3)f	107	kPa
	Undrained Shear Strength, cu	54	kPa ½(σ1 - σ3)f
	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

Testing terminated at 20% axial strain.

Approved	Printed
Stephen.Watson	30/09/2020 16:51

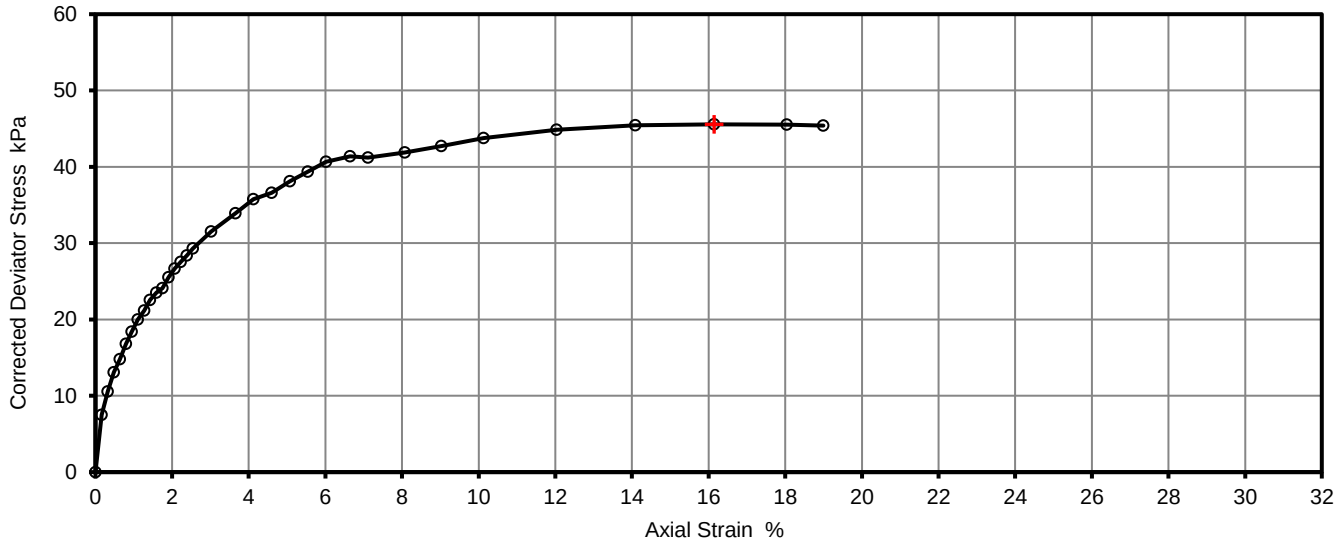
LAB 15R Version 4

UKAS TESTING
10122

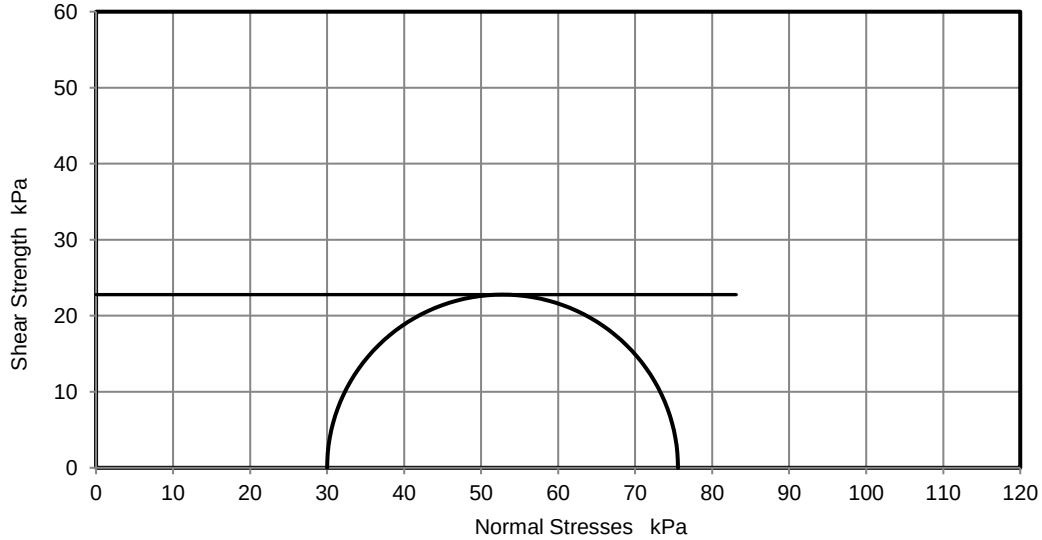
CAUSEWAY GEOTECH	**Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen**				Job Ref	20-0749a
					Borehole/Pit No.	BH06
Site Name	Elm Grove				Sample No.	7
Soil Description	Brownish grey sandy gravelly silty CLAY.				Depth	1.20
Specimen Reference	6	Specimen Depth	1.25	m	Sample Type	U
Specimen Description	Soft brownish grey sandy gravelly silty CLAY.				KeyLAB ID	Caus20200827129
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen				Date of test	17/09/2020

Test Number		1	
Length		210.6	mm
Diameter		104.7	mm
Bulk Density		2.14	Mg/m3
Moisture Content		18.5	%
Dry Density		1.80	Mg/m3
Rate of Strain		2.0	%/min
Cell Pressure		30	kPa
At failure	Axial Strain	16.1	%
	Deviator Stress, (σ1 - σ3)f	46	kPa
	Undrained Shear Strength, cu	23	kPa ½(σ1 - σ3)f
	Mode of Failure	Plastic	

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects 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	Printed
Stephen.Watson	30/09/2020 16:51

UKAS TESTING
10122

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

Final Report

Report No.:	20-22669-1
Initial Date of Issue:	03-Sep-2020
Client	Causeway Geotech Ltd
Client Address:	8 Drumahiskey Road Balnamore Ballymoney County Antrim BT53 7QL
Contact(s):	Carin Cornwall Colm Hurley Darren O'Mahony Gabriella Horan Joe Gervin John Cameron Lucy Newland Martin Gardiner Matthew Gilbert Neil Haggan Paul Dunlop Sean Ross Stephen Franey Stephen McCracken Stephen Watson Stuart Abraham Thomas McAllis
Project	20-0749A Elm Grove

Quotation No.:		**Date Received:**	26-Aug-2020
Order No.:		**Date Instructed:**	28-Aug-2020
No. of Samples:	1		
Turnaround (Wkdays):	5	**Results Due:**	04-Sep-2020
Date Approved:	03-Sep-2020		

Approved By:

Details: Glynn Harvey, Technical Manager

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

Results - Soil

Project: 20-0749A Elm Grove

Client: Causeway Geotech Ltd			**Chemtest Job No.:**		20-22669
Quotation No.:			**Chemtest Sample ID.:**		1054539
Order No.:			Client Sample Ref.:		1
			Sample Location:		BH05
			Sample Type:		SOIL
			Top Depth (m):		0.50
			Date Sampled:		25-Aug-2020
			Asbestos Lab:		COVENTRY
Determinand	**Accred.**	**SOP**	**Units**	**LOD**	
ACM Type	U	2192		N/A	-
Asbestos Identification	U	2192	%	0.001	No Asbestos Detected
ACM Detection Stage	U	2192		N/A	-
Moisture	N	2030	%	0.020	11
pH	U	2010		4.0	8.5
Boron (Hot Water Soluble)	U	2120	mg/kg	0.40	0.59
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	0.46
Cyanide (Free)	U	2300	mg/kg	0.50	< 0.50
Cyanide (Total)	U	2300	mg/kg	0.50	< 0.50
Thiocyanate	U	2300	mg/kg	5.0	< 5.0
Sulphide (Easily Liberatable)	N	2325	mg/kg	0.50	1.7
Sulphate (Total)	U	2430	%	0.010	0.32
Arsenic	U	2450	mg/kg	1.0	14
Cadmium	U	2450	mg/kg	0.10	0.29
Chromium	U	2450	mg/kg	1.0	40
Copper	U	2450	mg/kg	0.50	29
Mercury	U	2450	mg/kg	0.10	< 0.10
Nickel	U	2450	mg/kg	0.50	60
Lead	U	2450	mg/kg	0.50	23
Selenium	U	2450	mg/kg	0.20	< 0.20
Zinc	U	2450	mg/kg	0.50	80
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50
Organic Matter	U	2625	%	0.40	1.7
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	U	2680	mg/kg	1.0	< 1.0
Aliphatic TPH >C10-C12	U	2680	mg/kg	1.0	< 1.0
Aliphatic TPH >C12-C16	U	2680	mg/kg	1.0	< 1.0
Aliphatic TPH >C16-C21	U	2680	mg/kg	1.0	< 1.0
Aliphatic TPH >C21-C35	U	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	U	2680	mg/kg	1.0	< 1.0
Aromatic TPH >C10-C12	U	2680	mg/kg	1.0	< 1.0
Aromatic TPH >C12-C16	U	2680	mg/kg	1.0	< 1.0

Results - Soil

Project: 20-0749A Elm Grove

Client: Causeway Geotech Ltd			**Chemtest Job No.:**		20-22669
Quotation No.:			**Chemtest Sample ID.:**		1054539
Order No.:			Client Sample Ref.:		1
			Sample Location:		BH05
			Sample Type:		SOIL
			Top Depth (m):		0.50
			Date Sampled:		25-Aug-2020
			Asbestos Lab:		COVENTRY
Determinand	**Accred.**	**SOP**	**Units**	**LOD**	
Aromatic TPH >C16-C21	U	2680	mg/kg	1.0	< 1.0
Aromatic TPH >C21-C35	U	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
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
Total Of 16 PAH's	U	2700	mg/kg	2.0	< 2.0
Benzene	U	2760	µg/kg	1.0	< 1.0
Toluene	U	2760	µg/kg	1.0	< 1.0
Ethylbenzene	U	2760	µg/kg	1.0	< 1.0
m & p-Xylene	U	2760	µg/kg	1.0	< 1.0
o-Xylene	U	2760	µg/kg	1.0	< 1.0
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	Allkaline 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.
2625	Total Organic Carbon in Soils	Total organic Carbon (TOC)	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
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
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.
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
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"

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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

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

Sample Deviation Codes

A - Date of sampling not supplied

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

C - Sample not received in appropriate containers

D - Broken Container

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

Sample Retention and Disposal

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

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

Charges may apply to extended sample storage

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

customerservices@chemtest.com

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

Final Report

Report No.:	20-22998-1
Initial Date of Issue:	03-Sep-2020
Client	Causeway Geotech Ltd
Client Address:	8 Drumahiskey Road Balnamore Ballymoney County Antrim BT53 7QL
Contact(s):	Carin Cornwall Colm Hurley Darren O'Mahony Gabriella Horan Joe Gervin John Cameron Lucy Newland Martin Gardiner Matthew Gilbert Neil Haggan Paul Dunlop Sean Ross Stephen Franey Stephen McCracken Stephen Watson Stuart Abraham Thomas McAllis
Project	20-0749a Elm Grove

Quotation No.:		**Date Received:**	28-Aug-2020
Order No.:		**Date Instructed:**	28-Aug-2020
No. of Samples:	1		
Turnaround (Wkdays):	5	**Results Due:**	04-Sep-2020
Date Approved:	03-Sep-2020		

Approved By:

Details: Glynn Harvey, Technical Manager

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

Results - Soil

Project: 20-0749a Elm Grove

Client: Causeway Geotech Ltd			**Chemtest Job No.:**		20-22998
Quotation No.:			**Chemtest Sample ID.:**		1056036
Order No.:			Client Sample Ref.:		1
			Sample Location:		BH02
			Sample Type:		SOIL
			Top Depth (m):		0.50
			Date Sampled:		26-Aug-2020
			Asbestos Lab:		COVENTRY
Determinand	**Accred.**	**SOP**	**Units**	**LOD**	
ACM Type	U	2192		N/A	-
Asbestos Identification	U	2192	%	0.001	No Asbestos Detected
ACM Detection Stage	U	2192		N/A	-
Moisture	N	2030	%	0.020	19
pH	U	2010		4.0	7.3
Boron (Hot Water Soluble)	U	2120	mg/kg	0.40	0.62
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	0.040
Cyanide (Free)	U	2300	mg/kg	0.50	< 0.50
Cyanide (Total)	U	2300	mg/kg	0.50	< 0.50
Thiocyanate	U	2300	mg/kg	5.0	< 5.0
Sulphide (Easily Liberatable)	N	2325	mg/kg	0.50	5.6
Sulphate (Total)	U	2430	%	0.010	0.10
Arsenic	U	2450	mg/kg	1.0	7.8
Cadmium	U	2450	mg/kg	0.10	0.39
Chromium	U	2450	mg/kg	1.0	39
Copper	U	2450	mg/kg	0.50	31
Mercury	U	2450	mg/kg	0.10	0.20
Nickel	U	2450	mg/kg	0.50	45
Lead	U	2450	mg/kg	0.50	74
Selenium	U	2450	mg/kg	0.20	0.34
Zinc	U	2450	mg/kg	0.50	89
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50
Organic Matter	U	2625	%	0.40	2.6
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	U	2680	mg/kg	1.0	< 1.0
Aliphatic TPH >C10-C12	U	2680	mg/kg	1.0	< 1.0
Aliphatic TPH >C12-C16	U	2680	mg/kg	1.0	< 1.0
Aliphatic TPH >C16-C21	U	2680	mg/kg	1.0	< 1.0
Aliphatic TPH >C21-C35	U	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	U	2680	mg/kg	1.0	< 1.0
Aromatic TPH >C10-C12	U	2680	mg/kg	1.0	< 1.0
Aromatic TPH >C12-C16	U	2680	mg/kg	1.0	< 1.0

Results - Soil

Project: 20-0749a Elm Grove

Client: Causeway Geotech Ltd			**Chemtest Job No.:**		20-22998
Quotation No.:			**Chemtest Sample ID.:**		1056036
Order No.:			Client Sample Ref.:		1
			Sample Location:		BH02
			Sample Type:		SOIL
			Top Depth (m):		0.50
			Date Sampled:		26-Aug-2020
			Asbestos Lab:		COVENTRY
Determinand	**Accred.**	**SOP**	**Units**	**LOD**	
Aromatic TPH >C16-C21	U	2680	mg/kg	1.0	< 1.0
Aromatic TPH >C21-C35	U	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
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
Total Of 16 PAH's	U	2700	mg/kg	2.0	< 2.0
Benzene	U	2760	µg/kg	1.0	< 1.0
Toluene	U	2760	µg/kg	1.0	< 1.0
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m & p-Xylene	U	2760	µg/kg	1.0	< 1.0
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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	Allkaline 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.
2625	Total Organic Carbon in Soils	Total organic Carbon (TOC)	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
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
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.
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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I/S	Insufficient Sample
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N/E	not evaluated
<	"less than"
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Comments or interpretations are beyond the scope of UKAS accreditation

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Sample Deviation Codes

A - Date of sampling not supplied

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D - Broken Container

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All soil samples will be retained for a period of 45 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

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

UKAS TESTING
2183

Final Report

Report No.:	20-23522-1
Initial Date of Issue:	08-Sep-2020
Client	Causeway Geotech Ltd
Client Address:	8 Drumahiskey Road Balnamore Ballymoney County Antrim BT53 7QL
Contact(s):	Carin Cornwall Colm Hurley Darren O'Mahony Gabriella Horan Joe Gervin John Cameron Lucy Newland Martin Gardiner Matthew Gilbert Neil Haggan Paul Dunlop Sean Ross Stephen Franey Stephen McCracken Stephen Watson Stuart Abraham Thomas McAllis
Project	20-0749A Elm Grove

Quotation No.:		**Date Received:**	03-Sep-2020
Order No.:		**Date Instructed:**	03-Sep-2020
No. of Samples:	7		
Turnaround (Wkdays):	5	**Results Due:**	09-Sep-2020
Date Approved:	08-Sep-2020		

Approved By:

Details: Glynn Harvey, Technical Manager

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

Results - Soil

Project: 20-0749A Elm Grove

Client: Causeway Geotech Ltd			**Chemtest Job No.:**		20-23522	20-23522	20-23522	20-23522	20-23522	20-23522	20-23522
Quotation No.:			**Chemtest Sample ID.:**		1058597	1058598	1058599	1058600	1058601	1058602	1058603
Order No.:			Client Sample Ref.:		10	7	5	5	7	7	7
			Sample Location:		BH01	BH02	BH03	BH04	BH05	BH06	BH07
			Sample Type:		SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Top Depth (m):		1.20	3.00	2.00	1.00	2.00	1.20	3.00
			Date Sampled:		02-Sep-2020	02-Sep-2020	02-Sep-2020	02-Sep-2020	02-Sep-2020	02-Sep-2020	02-Sep-2020
Determinand	**Accred.**	**SOP**	**Units**	**LOD**							
Moisture	N	2030	%	0.020	16	14	17	13	13	14	9.8
pH	U	2010		4.0	7.6	8.6	8.0	8.7	8.5	8.7	8.7
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	0.020	< 0.010	< 0.010	< 0.010	0.028	0.028	< 0.010

Test Methods

SOP	Title	Parameters included	Method summary
2010	pH Value of Soils	pH	pH Meter
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2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES

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

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customerservices@chemtest.com

CAUSEWAY GEOTECH

APPENDIX E

SPT HAMMER ENERGY MEASUREMENT REPORT

Southern Testing
Environmental & Geotechnical

SPT Hammer Energy Test Report

in accordance with BSEN ISO 22476-3:2005

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

SPT Hammer Ref: .T1
Test Date: 22/02/2020
Report Date: 03/03/2020
File Name: .T1.spt
Test Operator: NPB

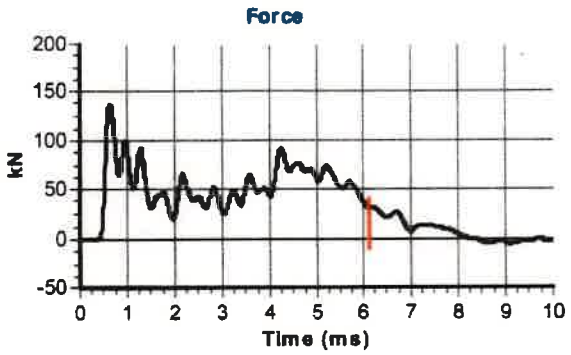
Instrumented Rod Data

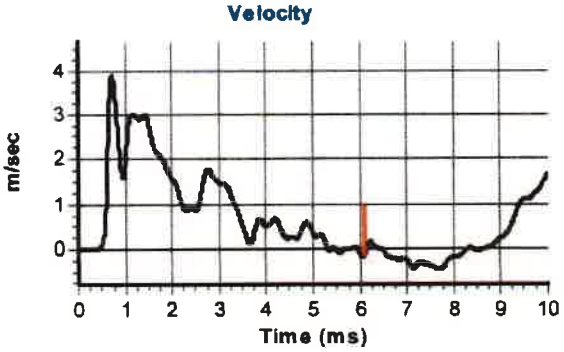
Diameter d_r (mm):	54
Wall Thickness t_r (mm):	6.0
Assumed Modulus E_a (GPa):	200
Accelerometer No.1:	6458
Accelerometer No.2:	9607

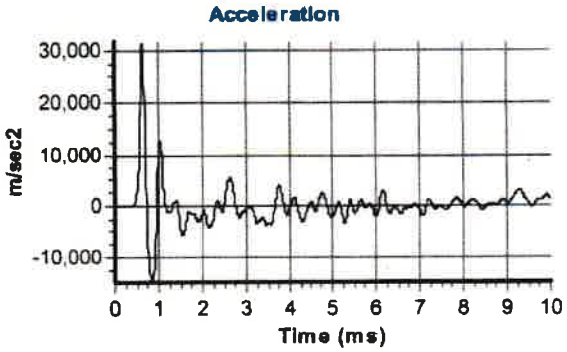
SPT Hammer Information

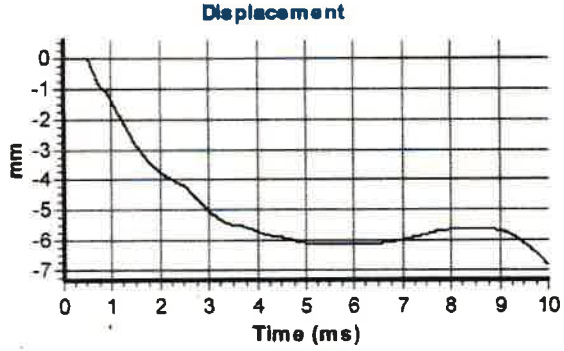
Hammer Mass m (kg):	63.5
Falling Height h (mm):	760
SPT String Length L (m):	10.0

Comments / Location
BALLEYMONEY









Calculations

Area of Rod A (mm2):	905
Theoretical Energy E_{theor} (J):	473
Measured Energy E_{meas} (J):	366

Energy Ratio E_r (%): **77**

Signed: Neil Burrows
Title: Field Operations Manager

The recommended calibration interval is 12 months