

Final For Issue

Greater Dublin Drainage – Offshore Site Investigation of Outfall Pipeline

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Document Control Sheet

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Revision	Status	Report prepared by:	Report reviewed by:	Report approved by:	Issue date
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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 (2010) BS 5930:1999 + A2: 2010, Code of practice for site investigations. Incorporating Amendment Nos. 1 and 2, as partially replaced by:

- BS EN 1997-2:2007: Eurocode 7. Geotechnical design. Ground investigation and testing
- BS EN ISO 22475-1:2006: Geotechnical investigation and testing. Sampling methods and groundwater measurements. Technical principles for execution
- BS EN ISO 14688-1:2002/Amd 1:2013: Geotechnical investigation and testing. Identification and classification of soil. Identification and description
- BS EN ISO 14688-2:2004/Amd 1:2013: Geotechnical investigation and testing. Identification and classification of soil. Principles for a classification
- BS EN ISO 14689-1:2003: Geotechnical investigation and testing. Identification and classification of rock. Identification and description
- BS EN ISO 22476-2:2005/Amd 1:2011: Geotechnical investigation and testing. Field testing. Dynamic probing
- BS EN ISO 22476-3:2005/Amd 1:2011: Geotechnical investigation and testing. Field testing. Standard penetration test





METHODS OF DESCRIBING SOILS AND ROCKS

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 The amendments revised the Standard to remove text superseded by BS EN ISO 14688-1:2002, BS EN ISO 14688-2:2004 and EN ISO 14689-1:2003 and refers to the relevant standard for each affected subclause.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

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

Abbreviations used on	exploratory hole logs
U	Nominal 100mm diameter undisturbed open tube sample
Р	Nominal 100mm diameter undisturbed piston sample
В	Bulk disturbed sample
D	Small disturbed sample
W	Water sample
ES / EW	Soil sample for environmental testing / Water sample for environmental testing
SPT	Standard penetration test using a split spoon sampler (small disturbed sample obtained)
SPT (C)	Standard penetration test using 60 degree solid cone
x,x/x,x,x,x	Blows per increment during the standard penetration test. The initial two values relate to the seating drive (150mm) and the remaining four to the 75mm increments of the test length. The length achieved is stated (mm) for any test increment less than 75mm
N=X	SPT blow count 'N' given by the summation of the blows 'X' required to drive the full test length (300mm)
N=X/Z	Incomplete standard penetration test where the full test length was not achieved. The blows 'X' represent the total blows for the given test length 'Z' (mm)
V VR	Shear vane test (borehole)Hand vane test (trial pit)Shear strength stated in kPaV: undisturbed vane shear strengthVR: remoulded vane shear strength
<u>dd/mm/yy: 1.0</u> dd/mm/yy: dry	Date & water level at the borehole depth at the end of shift and the start of the following shift
Abbreviations relating	to rock core – reference Clause 44.4.4 of BS 5930: 1999
TCR (%)	Total Core Recovery: Ratio of rock/soil core recovered (both solid and non-intact) to the total length of core run.
SCR (%)	Solid Core Recovery: Ratio of solid core to the total length of core run. Solid core has a full diameter, uninterrupted by natural discontinuities, but not necessarily a full circumference and is measured along the core axis between natural fractures.
RQD (%)	Rock Quality Designation: Ratio of total length of solid core pieces greater than 100mm to the total length of core run.
FI	Fracture Index: Number of natural discontinuities per metre over an indicated length of core of similar intensity of fracturing.
NI	Non Intact: Used where the rock material was recovered fragmented, for example as fine to coarse gravel size particles.
AZCL	Assessed zone of core loss: The estimated depth range where core was not recovered.
DIF	Drilling induced fracture: A fracture of non-geological origin brought about by the rock coring.





Greater Dublin Drainage Scheme – Offshore Site Investigation of Outfall Pipeline

1 AUTHORITY

On the instructions of Consulting Engineers, Tobin Arup Joint Venture ("the Client's Representative"), acting on the behalf of Irish Water ("the Client"), a ground investigation was undertaken at the above location to provide an overview of the ground conditions across the site for input to the design of a proposed offshore outfall pipeline. Abco Marine (Ireland) Limited provided the marine plant for the project.

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.

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

2 SCOPE

The extent of the investigation, as instructed by the Client's Representative, included overwater and land based boreholes, soil and rock core sampling, 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 around Portmarnock, northeast Dublin. The site is along the route of the proposed outfall running from Portmarnock strand in an easterly direction, extending some 6km offshore to the site of the proposed diffuser.

The existing site is presented on the site and exploratory hole location plans in Appendix A.





4 SITE OPERATIONS

4.1 Overview of site operations

Site operations were completed in two distinct phases: overwater operations, and then land-based works. Overwater works were carried out over the period 30 July to 22 August 2015. Land-based works were carried out over 30 September to 5 October 2015.

The scope of works comprised:

- 3 no. overwater boreholes, drilled off a jack-up barge (BH03, BH05 and BH08):
 - Cable percussion boring through overburden.
 - Rotary follow-on drilling by Geobor S wireline coring techniques to target completion depths within bedrock strata.
- 10 no. vibrocore seabed sediment sampling locations, completed off a jack-up barge.
- 1 no borehole drilled on the land at Portmarnock beach by cable percussion boring with rotary follow-on drilling (BH01).

4.2 Marine operations

Boreholes BH03, BH05 and BH08 were put down at overwater locations using a jack-up barge as a working platform.

The marine plant used was a C5 modular type jack-up barge (*Emotion*), supplied and operated by Abco Marine (Ireland) Limited.

All site works were supervised by a Geotechnical Engineer from Causeway Geotech.

The jack-up platform was some 12m x 15m in deck area and equipped with 27m long jack legs. The jackup was manoeuvred to the locations using a workboat (Island Kestrel). A safety boat provided a watching brief and also provided access to the platform for the crew and Engineer's representatives.

The locations of the exploratory holes were set out from co-ordinates supplied by the Client's representative. Surveying operations were completed by a Site Engineer from Abco Marine, who was equipped with a GPS rover unit employing VRS techniques.

Seabed elevation at each position was recorded by subtracting the measured distance from (static) deck to seabed from the deck elevation as recorded using the GPS. The distance from deck to seabed level was measured using a weighted dip tape lowered down through the outer drill string, thus precluding the effects of the tide. By subtracting the deck to seabed length from the deck elevation, seabed elevation was hence calculated. The as-built survey information relative to each position is presented on the relevant borehole logs.





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

4.3 Boreholes

A total of four boreholes were put down as part of the works scope.

- Boreholes BH03, BH05, BH08 were overwater boreholes put down along the route of the outfall
- Borehole BH01 was drilled at the beach at Portmarnock near the launch point for the outfall pipe.

4.3.1 Boreholes by combined cable percussion boring and rotary follow-on drilling

The boreholes were put down by a combination of light cable percussion boring and rotary follow-on drilling techniques with core recovery. The overwater boreholes were drilled to depths of up to 58.3m below seabed level. Borehole BH01 on the beach was drilled to a completion depth of 59.9m below ground level.

Cable percussion boring techniques were employed to advance the boreholes to virtual refusal in the very stiff Glacial Till, after which rotary follow-on drilling by means of Geobor S triple-tube wireline coring was employed to recover core samples of the Glacial Till and bedrock strata.

Cable percussion boring was carried out using a Dando 3000 light cable percussion boring rig, with rotary follow-on drilling then carried out by a Comacchio 405 tracked rotary drilling rig.

Disturbed (bulk bag and small jar) samples were taken of the encountered strata at regular intervals or change of strata.

Standard penetration tests were carried out through overburden strata in accordance with EC7 at standard depth intervals using the split spoon sampler (SPT) or solid cone attachment (SPTc). The penetrations are stated for those tests for which the full 150mm seating drive or 300mm test drive was not possible. The *N*-values provided on the borehole logs are uncorrected and no allowance has been made for energy ratio corrections.

The core was extracted in up to 1.6m lengths using a metric SK6L (Geobor S) core barrel, which produced core of nominal 102mm diameter, and was placed in single channel wooden core boxes. The core was extracted in semi-rigid plastic liners.

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

Core logging was carried out both on and off site by the Causeway Geotech Engineering Geologist. Appendix B presents the borehole logs, with core photographs presented in Appendix C.





4.4 Vibrocores

A total of ten vibrocores (BHVC02 to BHVC11) were put down using a SonicSamp pneumatic vibrocore sampling rig, which was lowered onto the seabed at the sampling points using a crane mounted on the C5 jack-up barge, acting in spud-leg mode.

The vibrocores penetrated to a maximum depth of 1.7m below bed level, at which point they encountered refusal on stiff/dense soils. The cores were retrieved and logged on the barge deck, before being sub-sampled into appropriate containers for dispatch to the chemical testing laboratory.

The logs for the vibrocores are presented in Appendix D. Results of laboratory testing carried out on the samples are presented in Appendix F.

4.5 Surveying

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

The plan coordinates and ground elevation at each location are recorded on the individual exploratory hole logs. The exploratory hole plan presented in Appendix A takes these as-built positions into account.

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, particle size distribution and particle density analysis.
- **shear strength** (total stress): lab vane, unconsolidated undrained triaxial and shear box tests
- soil chemistry: pH, organic matter and sulfate content

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

The geotechnical laboratory test results are presented in Appendix E.





5.2 Geotechnical laboratory testing of rock

Laboratory testing of rock sub-samples comprised:

- Uniaxial Compressive Strength Testing
- Point Load Testing

The above tests were carried out by Causeway Geotech Limited at their geotechnical testing laboratory in accordance with the following standards:

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

More advanced rock testing was carried out in subcontracted testing labotatories.

GSTL in Llanelli, Wales, carried out the following tests:

- Indirect tensile strength testing
- Cerchar abrasivity
- Porosity
- Thin section petrographic analysis
- X-ray diffraction.

SINTEF, based in Trondheim, Norway, carried out the following specialised tunnelling/drillability testing:

• Norweigan Abrasion Cutter Steel Test, Swedish Brittleness Test and Sievers' J Value Test

The geotechnical laboratory test results for rock core sub-samples are presented to the rear of Appendix E.

5.3 Environmental laboratory testing of soils

In addition, environmental testing by way of the Marine Institure of Ireland suite relating to the testing of dredged materials for disposal at sea critera, was carried out by RPS at their laboratories at Mountainheath. Testing was carried out on 13 samples selected from the vibrocore locations.

The test results are presented in Appendix F.





6 GROUND CONDITIONS

6.1 General geology of the area

Due to the offshore location of the exploratory holes, the superficial deposits consist of marine deposits overlying glacial till. The underlying bedrock consists of Carboniferous argillaceous limestone ('Calp'), with the possibility of faulting towards the east of the site and the presence of Cambrian greywacke and quartzite.

6.2 Ground types encountered during investigation of the site

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

- **Marine Deposits:** granular deposits, extending from seabed level to up to 6.2m depth, comprising sands and gravels ranging from medium dense to very dense.
- **Glacial Till:** stiff to very stiff grey sandy gravelly clay, frequently with low cobble content and occasional bands of sand or gravel. Found beneath marine deposits, immediately overlying bedrock.
- **Bedrock:** bedrock generally comprised medium strong to strong grey Limestone of the Calp Formation. Borehole BH05 encountered a faulted zone, with a sequence of sandstone interbedded with layers of mudstone and limestone (locally dolomotised). The bedrock here was typically highly fractured and weaker than encountered at the other boreholes.

7 **REFERENCES**

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

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

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

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

Appendix A Site and exploratory hole location plans





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APPENDIX B

Borehole logs

					Project No.:		Project Name:				Borehole No.:				
	CAL	IC	E \		15-664		GDD Overwater SI Client:				1				
		-0	E	TECH	Coordi	nates:					of 6				
	-	G	EO	TECH	32507	3.98 E	Irish W			010					
Method:					24224	0.04 N	Client'	Scale: 1:50							
Cable Percuss	ion+Sym	metr	ix+G	eobor S Coring	24231	9.94 N	Tobin A	Arup JV	Driller: BN						
Plant:					Groun	d Level:	Dates:				450				
Dando 2000+	Comacch	10 40)5	1	2.2	9 mOD		30/09/2015 - 15/10/2015	Logger:		VIFG				
(m)	Tests	Depth (m)	Water Depth (m)	Field Records	(mOD)	(Thickness)	Legend	Description	Wate	Backfil	۱				
0.10	D1					- (0.50)		Grey fine to coarse SAND.			-				
					1 70	0.50					-				
					1.79	0.50	××××	Medium dense grey slightly silty fine to coarse SAND with many gravel]		0.5 -				
1.00						-	×××× ××××				-				
1.00	D2						x × ^				1.0				
1.00 - 1.45	SPT (S) N=16	1.00		N=16 (2,2/3,4,4,5)		-	×× x x				-				
						_	××`×				1.5 -				
						-	× × ×				-				
2.00 2.00	B15 D3						× × ×				2.0 -				
2.00 - 2.45	SPT (S)	2.00		N=22 (3,4/4,5,6,7)		(3.50)	×`××				-				
	11-22						× × ×				2.5 -				
						-	× × ×				-				
3.00 3.00	B16 D4					-	$_{\times}$ $^{\times}$ $_{\times}$				3.0				
3.00 - 3.45	SPT (S)	3.00		N=28 (3,4/5,7,7,9)		-	$_{\times}$ $^{\times}$ $^{\times}$				-				
	N=28					-	$_{\times}$ $_{\times}$ $_{\times}$				3.5 -				
							× × × × ×				-				
4.00	B17				-1.71	- 4.00	× × × × ×	Dense grey slightly silty fine to coarse SAND with many gravel sized shells	1		4.0				
4.00 - 4.45	SPT (S)	4.00		N=36 (4,6/7,8,9,12)			$_{\times}$ $_{\times}$ $_{\times}$	and shell fragments			-				
	N=36					[$_{\times}$ $_{\times}$ $_{\times}$				4.5				
						-	$\times \times \times \times \times \times \times \times$				-				
5.00	B18					(2.00)	× × × × ×				5.0				
5.00 5.00 - 5.45	SPT (S)	5.00		N=42		-	× × × × ×				-				
	N=42			(4,4/6,11,12,13)			×				5.5 -				
						-	× × × ×				-				
6.00	B19				-3.71	6.00	×××	Medium dense grey slightly silty fine to coarse SAND with many gravel	-		6.0 -				
6.00 - 6.45	SPT (S)	6.00		N=18 (2,2/3,4,5,6)		-	^x ×^	sized shells and shell fragments			-				
	N=18					-	x ×				6.5 -				
						(1.60)	x ×				-				
7.00	B20					-	××× ××××				7.0				
7.00 7.00 - 7.45	D8 SPT (S)	7.00		N=16 (2,2/3,4,4,5)		-	× × ×				_				
	N=16				-5 21	7.60	× × × * × ×				7.5 —				
					5.51			Medium dense grey very gravelly fine to coarse SAND. Gravel is fine to coarse, subrounded to rounded.			-				
8.00	B21					-					8.0				
8.00 8.00 - 8.45	D9 SPT (S)	8.00		N=18 (2,3/4,4,5,5)		-		4			-				
	N=18					F		4			8.5				
						-		4			-				
9.00	B22					(3.60)		4			9.0				
9.00 9.00 - 9.45	D23 SPT (S)	9.00		N=23 (5,6/5,6,6,6)		-					-				
-	N=23										9.5 —				
						-									
10.00	B24					-					10.0 —				
10.00	D10					-			\square						
Darra 1								Continued on Next Page	Strike	General					
Kemarks SPT's carried o	ut using SI	PT ha	mme	r CC1				From (m) To (m) Struck at (m) Casing 0.20 13.60	to (m)	Time (min)	Rose to (m				
Water added fi	om 0.20m	۱						5.20 15.00							
								Casing Details Chis	elling [To (m	Details	e (hh:mm)				
								15.00 200		, , , , , , , , , , , , , , , , , , , ,	, <i>i</i> iii)				
L															

				Project No.:		Projec	Borehole No.:				
AA.			IC	E\		15-664	÷	GDD O	B	H01	
		10	-G	FO	TECH	Coordi	nates:	Client:		Shee	t 2 of 6
			0		TECH	32507	3.98 E	Irish W			
Method:						2/221		Client'	Scale: 1:50		
Cable Percussi	on+S	Symr	netr	ix+G	eobor S Coring	212313.3111		Tobin A	Arup JV	Driller: BM+S	
Plant:			40			Ground Level:		Dates:			
Darido 2000+Corriaccino 405						2.2	9 mOD		30/09/2015 - 15/10/2015	Logger	
(m)	Te	sts	Depth (m)	Depth (m)	Field Records	(mOD)	(Thickness)	Legend	Description	Bac	:kfill
10.00 - 10.45	SPT N=2	(S) 4	10.0 0		N=24 (6,6/6,5,6,7)		-				10.5 —
											-
11.00	B26						-				11.0
11.00	D27	(6)	11.0		N-20	-8.91	11.20		Dense grey sandy fine to coarse subrounded GRAVEL Sand is fine to	-	-
11.00 - 11.45	N=3	(3) 9	0		(8,10/9,10,10,10)		-		coarse.		
							- (0.80)				-
				1 70	30-09-2015	-9 71	[- 12.00				12.0
				2.70	05-10-2015	5.71	-		Dense greyish brown gravelly fine to coarse SAND. Gravel is fine to coarse subangular to subrounded.		-
12.00	D11						(0.90)				- 12.5
12.00 - 12.45	SPT	(S) 0	12.0		N=40 (10.10/9.11.10.10)		-				-
12.90 - 13.60	B13	0	Ŭ		(10,10, 5,11,10,10)	-10.61	12.90		Stiff brownish grey slightly sandy gravelly CLAY with cobbles and boulders.	-	-
13.00 13.00 - 13.35	D12 SPT	(S)	13.0	7.10	50 (9,12/50 for		(0.70)		Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		-
			0		200mm)		[(0.70)				- 125
						-11.31	13.60		Grey sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to	-	-
							-		subrounded fine to coarse. (Drillers description)		-
							(0.90)		-		-
						12.21	14.50		-		-
						-12.21	- 14.50		Medium strong, massive (indistinctly laminated in places), dark grey	1	14.5 -
							-		closer fracture		-
							-		spacing.		
	100	100	44				-		Discontinuity Set 1: 10-30 degree joints, medium to widely spaced, planar,		-
							-		becoming undulating below 17.30m, rough, occasionally with <1mm calcite mineralisation		15.5 -
15.80							-		Discontinuity Set 2: 50,70 degree joints widely spaced undulating rough		-
				-					stained black		16.0 -
				3			-		J Discontinuity Set 3: 80-90 degree joints at 15.00m - 15.40m and 18.60m -		-
	100	100	100				[19.20m, undulating, rough, stained black		16.5 -
							-		-		-
							-				17.0 -
17.30							-				-
							- (5.50) [17.5 -
							-				
	100	98	90				<u> </u>]		18.0 -
							-		1		-
											18.5 -
18.80				5			-				-
							-				19.0 -
							-				-
	96	96	54				-				19.5 -
							-		4		-
						-17.71	20.00		Medium strong to strong, indistinctly thickly laminated dark grey	1	20.0 -
20.30									argillaceous LIMESTONE. Unweathered		-
							-		-		20.5
Dame of t	TCR	SCR	RQD	FI					Continued on Next Page Water Added Water 9	Strike - Gen	eral
Kemarks SPT's carried ou	t usin	ng SP	T har	nme	r CC1				From (m) To (m) Struck at (m) Casing	to (m) Time (r	nin) Rose to (m
Water added fro	om 0.	20m									
									Casing Details Chise	elling Detail	s Time (hh:mm)
									15.00 200		
L											

			Project No.:		Projec	Borehole No.:						
			IC	E\		15-664		GDD O	verwater SI	B	H01	
			-G	FO	TECH	Coordi	nates:	Client:		Shee	et 3 of 6	
	>		0	20		32507	3.98 E	Irish W	Irish Water			
Method:	. ,	_				242319 94 N		Client'	s Representative:	Scale:	1:50	
Cable Percuss	Cable Percussion+Symmetrix+Geobor S Coring						242319.94 N		Arup JV	Driller: BM-		
Plant:	Come	acchi	io 10	5		Ground Level:		Dates:				
Danuo 2000+						Z.Z.	Depth (m)		30/09/2015 - 15/10/2015	5		
(m)	TCR	SCR	RQD	FI	Field Records	(mOD)	(Thickness)	Legend	Description	be Ba	ckfill	
							-		spaced (occasionally medium spaced above 26.30m), planar, occasionally			
							-		undulating, rough, typically stained black, occasionally with patches of brownish grey		21.0 -	
	100	100	100				-					
							-				21.5	
21.80				-			-					
							-				22.0 -	
							-					
	100	100	100				-				22.5	
									-			
							-		-		23.0 -	
23.30				-			-		-			
				2			-				23.5	
							-					
	100	100	95				-				24.0 -	
							-					
							-				24.5	
24.80				-			-					
							-				25.0 -	
							-					
	100	100	96				-				25.5	
							-		-			
							-		-		26.0 -	
26.30							-					
							-				26.5	
							-					
	100	100	100				-				27.0 -	
							-					
							-				27.5	
27.80							-					
							-				28.0 -	
							-					
	100	100	100	1			[4		28.5	
							-		-			
							-				29.0 -	
29.30							-					
							-				29.5	
							-					
	100	100	100				-				30.0 -	
							-					
							-		1		30.5	
30.80							-		1			
	TCR	SCR	RQD	FI					Continued on Next Page			
Remarks	.+:		ть-						Water Added Water S From (m) To (m) Struck at (m) Casing	trike - Ger to (m) Time	neral (min) Rose to (
Water added fr	om 0.	ıg SP 20m	i nar	iimei					0.20 13.60			
									Casing Details Chise	Iling Deta	ils	
									To (m) Diam (mm) From (m) 15.00 200	To (m)	Time (hh:mn	

						Projec	t No.:	Projec	t Name:	Bor	rehole	No.:
AA.			IC	E)		15-664	ļ	GDD O	verwater SI		BH0	1
		-	-G	FO	TECH	Coordi	nates:	Client:		S	heet 4	of 6
						32507	3.98 E	Irish Water				
Method:					acher C Caring	24231	9.94 N	Client'	s Representative:	Sca	le: 1	.:50
	on+:	Syrni	netr	IX+G	eobor 5 Coring			Tobin A	Tobin Arup JV			
Dando 2000+Comacchio 405						2 29 mOD		Dates:	30/09/2015 - 15/10/2015	Logger: MFG		
Depth	TCR	SCR	ROD	FI	Field Records	Level	Depth (m)	Legend		ater	Backfil	
(m)		Jen	ind b		Tield Netorus	(mOD)	(Thickness)	Legend	lanar. occasionally undulating, rough, typically stained black, occasionally	Š	Dackin	31.0
							-		with patches of brownish grey			-
							-					31.5 -
	100	100	100				-					-
							-		-			32.0
22.20							-					-
32.30							-					32.5
							-					-
	00	0E	70				-		From 32.80m - 33.40m: 70-90 degree undulating vein/joint, mostly closed, partly incipient, up to 10mm of anastomosing calcite mineralisation, some			33.0
	30	05	/0	4			-		drilling induced fracturing			-
							-		_] -			33.5 —
33.80									-			
55.00							-					34.0
							-					
	100	100	100				-		-			34.5 —
	100	100	100				-					
							-					35.0 —
							-		-			
35.40												35.5 —
							-					
							(39.90)					36.0
	100	100	100				-					
												36.5 —
25.00							-					=
36.90							-		-			37.0
							-					-
	100	100	100	1			-					37.5 —
	100	100	100				-					
							-		-			38.0
38.40							-					-
50.40							-					38.5 -
							-					-
	100	100	100				E		1			39.0
							-					-
							-		-			39.5 -
39.90							-					
							-					40.0 -
							-					
	100	100	100				-		-			40.5 -
							- -		4			-
							-					41.0
	TCR	SCR	RQD	FI					Continued on Next Page	Ctril -	Correct'	
Remarks SPT's carried out	t usir	ng SP	T har	nme	r CC1				Water Added Water . From (m) To (m) struck at (m)	to (m)	Time (min)	lose to (m
Water added fro	om 0.	20m							0.20 13.60			
									Casing Details Chis	elling f	Details	a (hh.m.m.)
									15.00 200	10 (M	, time	. (m.mm)

				Project No.:		Project	t Name:	Borehole No.:						
			10			15-664	Ļ	GDD O		вн01				
	CA	AC	12	E		Coordi	nates:	Client:		She	ot E /	of C		
			-G	EO	TECH	32507	3.98 E	Irish W	Irish Water					
Method:								Client's	Scale: 1:		50			
Cable Percussion+Symmetrix+Geobor S Coring					eobor S Coring	242319.94 N		Tobin A	Arup JV		D.	4.0		
Plant:	Plant:						Ground Level:		Dates:					
Dando 2000+	Coma	acchi	io 40)5		2.29 mOD			30/09/2015 - 15/10/2015			Logger: MFG		
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level	Depth (m)	Legend	Description	Vater	ackfill			
(m)						(mod)	-		Discontinuity Set 1: 10-40 degree joints (often parallel to bedding), widely	5		-		
41.50				-			-		spaced (occasionally medium spaced above 26.30m), planar, occasionally			41.5 —		
							E		brownish grey					
							-		From 41.95m - 42.70m: 70-90 degree undulating joint, rough, stained black			42.0		
	100	96	47				-		and dark brownish grey			-		
	100	50					-					425		
							-					+2.3 -		
							-					=		
43.00							-					43.0		
							[
							-					43.5 —		
	100	100	100				-					-		
							F					44.0		
							-					-		
44.50							-					44.5 —		
							-		-		I			
							-					45.0 —		
	100	100	100				-					-		
												455		
							-					- 1		
10.00							-							
46.00							-				I	46.0		
							-				I	-		
							-				I	46.5 —		
	100	100	100				-				I			
							-				I	47.0		
							Ę				I			
47.60							-					47.5 —		
							-					-		
				10			-		From 51.10m - 51.30m: Weak black carbonaceous limestone with white			48.0		
	100	100	100				-		calcite veining			-		
	100	100	100				-		-			48.5 —		
									-			=		
							-		-		ĺ	49.0		
49.10				1			ŀ				ĺ			
				1			E				ĺ	49.5		
							ŀ				ĺ			
	100	100	100				-							
							Ē					50.0		
							ŀ				ĺ	_		
50.60							-					50.5 -		
				2										
	100	100	100	2			-					51.0		
				8			-				I	-		
	TCP	sc¤	RUD	FI			-			\vdash		51.5		
Remarks		30K	וייפט	ri			1	1	Continued on Next Page Water Added Water S	strike - G	eneral			
SPT's carried o	ut usir	ng SP	T hai	mme	r CC1				From (m) To (m) Struck at (m) Casing 0.20 13.60	to (m) Tim	≥ (min) Ros	se to (m)		
Water added fi	om 0.	20m												
									Casing Details Chise	Illing Det	ails Time (hh:mm)		
									15.00 200	- ()				

						Project	t No.:	Project	t Name:	Boreho	ole No.:
			IC	E\		15-664	Ļ	GDD O	verwater SI	BI	H01
		40	-6	FO	TECH	Coordi	nates:	Client:		Shee	t 6 of 6
			U	LO	TECH	32507	3.98 E	Irish W	/ater		
Method:						24221	0.04 N	Client's	s Representative:	Scale:	1:50
Cable Percuss	ion+S	Symr	netr	ix+G	eobor S Coring	24231	9.94 N	Tobin A	Arup JV	Driller	: BM+SJ
Plant:	~			-		Ground	d Level:	Dates:		.	
Dando 2000+0	Loma	acchi T	10 4U)5		2.29	9 mOD		30/09/2015 - 15/10/2015	Logger	: MFG
(m)	TCR	SCR	RQD	FI	Field Records	(mOD)	(Thickness)	Legend	Description	Bac	kfill
							-		lanar, occasionally undulating, rough, typically stained black, occasionally with patches of brownich gray.		-
							-				-
52.10				-			-				52.0
							-				-
							-				52.5 -
	100	100	100				-				-
							[-		53.0
							-		-		=
53.60											53.5 -
							-				=
							-				54.0
	100	100	100								-
							-				54.5 — —
							-				-
55.10				-			-				55.0 -
				1							-
							-		-		55.5 —
	100	100	100				-				-
	100	100	100				-				56.0
							-				-
							-				56.5 —
56.70							-				-
							-				57.0
							-				-
	100	100	80				-				57.5
							-				-
									From 57.95m - 58.65m: 80 degree white calcite vein, open, planar to slightly		58.0
58.30				-			-		undulaung, rough, up to Tomm mineralisation		-
							-				58.5 -
							-				-
	100	100	77				-				59.0
	100	100	<i>"</i>				-		From 59.20m - 59.40m: Two 65 degree joints/veins, undulating, rough, up to		-
				9					<u>1mm, white calcite mineralisation with patchy brown staining on surface</u>		59.5 —
				1			-				
59.90						-57.61	59.90		End of borehole at 59.900m	1	60.0
							ŀ				
							ŧ				- 60.5 —
							E				-
							-				61.0
							Ē				
							ļ				61.5 —
							-				
	TCR	SCR	RQD	FI							
Remarks	t uci		The	mme					Water Added Water 4 From (m) To (m) Struck at (m)	to (m) Time (n	≥ral nin)Rose to (m
Water added fr	om 0.	ig SP 20m	i nai	me					0.20 13.60		
									Casing Details Chise	elling Details	s
									To (m) Diam (mm) From (m) 15.00 200	To (m)	Time (hh:mm)

						Project	t No.:	Projec	t Name:	Bor	ehole	No.:
			IC			15-664		GDD O	verwater SI		BH0	3
	CA		5			Coordi	nates:	Client:		ci	noot 1	off
	-		G	EO	TECH	32605	2.50 E	Irish W	'ater		leet 1	010
Method:						1		Client'	s Representative:	Sca	le: 1	L:50
Cable Percuss	ion+G	eob	or S	Cor	ing	24231	9.55 N	Tobin A	Arup JV	Dri		
Plant:						Ground	d Level:	Dates:			ner: c	
Dando 3000+	Comad	chi	o 40)5		-5.00	0 mOD		30/07/2015 - 07/08/2016	Log	ger: N	ИFG
Depth (m)	Samp	le /	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Nater	Backfil	n
0.00 - 0.50	ES1		(,			(1100)	-	×××	Medium dense grey slightly gravelly silty fine to coarse SAND with shells.	-		-
0.00 - 1.00	B4							×××	Gravel is subrounded fine to coarse.			-
							- (1.00)	×				0.5 —
							-	× ^ ×				-
1.00 - 1.50	ES2					-6.00	- 1.00	××××	Medium dense silty fine to medium SAND with occasional fine subrounded	-		1.0
1.00 - 2.00	B5						[× × × × ×	gravel.			-
1.20 - 1.65	SPT (5)			N=16 (1,3/3,4,4,5)		-	× × × × ×				1.5 -
	N=16						(1.50)	× × × × ×				-
2.00	010							$_{\times}$ $_{\times}$ $_{\times}$				20-
2.00 - 2.45	SPT (S	5)			N=29 (3,4/6,6,7,10)		-	$_{\times}$ $_{\times}$ $_{\times}$				-
2 00 - 2 50	N=29						-	$\times \times \times \times \times \times$				-
2.00 - 3.00	B6					-7.50	- 2.50	× × ×	Dense grey silty fine to coarse SAND with occasional fine gravel.			2.5 -
							-	× × ×				-
3.00	D11	5)			N-44		-	×, × ×				3.0
5.00 5.45	N=44	,			(6,6/8,11,12,13)		(1.50)	×, × ×				-
3.00 - 4.00	B7							×`×`×				3.5
							-	×`×`×				-
4.00	D12					-9.00	4.00	× ~~~~	Very stiff grow slightly growelly slightly sondy silty CLAV with occasional	-		4.0
4.00 - 4.45	SPT (5)			N=47			$(\times \times $	shells. Sand is fine to coarse. Gravel is subangular to subrounded fine to			-
4.00 - 5.00	B8				(5,7/5,10,13,13)		-	$\times \times $	coarse, of limestone.			4.5 -
							-	$\times \times $				-
5.00	13						_	$\times \times \times \times$				5.0 -
5.00 - 5.45	SPT (5)			N=50		-	$\times \times \times \times$				-
5.00 - 6.00	N=50 B14				(6,9/13,15,15,7)		(2.90)	$\times \times \times \times$				-
								$\times \times \times \times$				5.5
							-	$\times \times \times \times$				-
6.00 6.00 - 6.38	D15 SPT (5)			N=50 (9,10/50 for			$\times \times \times \times$				6.0 -
C 00 7 00	DIC				230mm)		-	$\times \times \times \times$				-
6.00 - 7.00 6.40 - 7.50	B16 B18						-	$\times \times \times \times$				6.5 —
						11.00	600	$\times \times $				-
7.00	D17	-)			50 /5 12 /50 fee	-11.50	- 0.50	نغہ: مثنی ہے موج جی م	Very stiff brown slightly sandy slightly gravelly CLAY with occasional			7.0 -
7.00 - 7.35	SPT (:	5)			200mm)		-	ه. مد و موجود	subangular to subrounded fine to coarse, of limestone and sandstone.			-
								نغ م <u>ن</u> م				7.5 —
							(1.60)					-
8.00 - 8.50	B19						- -					8.0
												-
8.50	D20,						8.50			\parallel		8.5
8:50 8:50 - 8:75 8:50 - 8:75	SPT (5)			D20 50 (25 for 50 (25 for	-13.50	-	÷ • • •	Very dense medium to coarse subrounded GRAVEL of dark grey limestone, with one cobble.			-
					125mm/50 for 125mm/50 for 125mm)		-	÷ • • •				-
	50	_	0		125mm)		(1.50)	÷ • • •				
	50	U	U				- (1.50)	000				
								÷ • • •				9.5
							-					
10.00						-15.00	- 10.00 (0.30)		Dark grey very sandy fine to coarse subrounded GRAVEL of dark grey	1		10.0
	705					-15.30	10.30			+		
Romarka		JUK	κųD	FI	I				Continued on Next Page Water Added Water 5	Strike ·	General	
SPT's carried or	ut using	g SP⁻	Т Наі	mme	er SPT CC1				From (m) To (m) Struck at (m) Casing	to (m)	Time (min)	Rose to (m
									Casing Details Chise	elling [Details	e (hhimmi)
									8.50 250 km	10 (M	, (ime	- (mum)

							No.:	Project	t Name:	Bore	hole	No.:
			IC	E۱		15-664		GDD O	verwater SI		BH03	}
			-G	FO	TECH	Coordi	nates:	Client:		She	eet 2	of 6
			0		len	32605	2.50 E	Irish W	/ater			
Method:			_			2/221	9 55 N	Client's	s Representative:	Scale	e: 1:	:50
Cable Percussi	on+(Geob	or S	Cori	ng	24231	9.93 N	Tobin A	Arup JV	Drill	er: C	C+SS
Plant:	·	- :	- 40			Ground	d Level:	Dates:	20/07/2015 07/02/2016	1000		450
Dando 3000+0	.oma T	ccni	0 40			-5.00	J MOD		30/07/2015 - 07/08/2016	LUgg	er. 10	T
(m)	TCR	SCR	RQD	FI	Field Records	(mOD)	(Thickness)	Legend	Description	B ste	ackfill	
	100	44	0	20			-		Vimestone. Sand is fine to coarse. Weak dark grev argillaceous LIMESTONE. Partially weathered: much closer			10.5 —
10.80	100		-	20					fracture spacing.			-
10.00							- (1.50)		Discontinuities: 10-60° joints, very closely to closely spaced, planar to			11.0
	0	0	0	ND			[(1.50)		irregular/undulating, rough, stained black.			-
	0	U	0				-					11.5 —
11.00						16.90	11.00		No recovery at 10.80-11.80m.			-
11.80						-10.80			Weak to medium strong medium bedded (locally indistinctly laminated)			12.0
	90	80	0	20			-		fracture spacing.			-
12.50							-		Discontinuity sets:			12.5 —
				NI			-		1 0.20° is into your closely to closely speed planar smeeth to rough			=
	100	25	0				-		L. 0-20 Joints, very closely to closely spaced, planar, smooth to rough.			13.0
							-		2. 20-60° joints, medium spaced, planar to irregular, smooth to rough.			-
13.30							- (3.00)		Weak carbonaceous limestone from 12.2-12.6m, destructured at 12.5-12.6m and recovered as soft dark grey sandy carbonaceous clay.			- 13.5
				20			-					-
				20			-					-
	90	73	7				-					- 14.0
							-					-
							-					14.5
14.80						-19.80	14.80		Medium strong medium bedded (thinly to thickly laminated in places) dark			-
	100	70	30	10					grey argillaceous LIMESTONE. Largely unweathered.			15.0 -
15.30							-		Discontinuity sets:			-
							-		2. 20-40° bedding fractures, medium spaced, planar to irregular, rough.			15.5 -
	100	100	64				-		65° joint at 15.2m, planar with polished surface, stained black.			=
							-		70° vein at 15.65-15.95m, 1-2mm thick (white calcite), partially open/closed, rough.			16.0
16.30		-		°			-					
							-		Very closely spaced fractures at 16.45-16.55m, planar, polished surfaces, stained black, 20mm calcite mineralisation at the bottom.			16.5 —
							-					
	100	95	90				-					17.0
							-					
							-					17.5 —
17.80							- (9.90)		75° joint at 17.8-18.3m, closed/incipient, planar to undulating, filled with			
				3			 -		1-3mm hard dark grey clay.			18.0
							-					-
	100	100	73				-					18.5 —
							-		60° fracture, undulating, smooth, polished in parts with faint slickensides.			-
							-		stained black.			19.0
19.30				6			-					-
							-					19.5 —
							-					=
	100	100	87						-			20.0 —
				4			-		-			=
							-					20.5 —
	TCR	SCR	RQD	FI					Continued on Next Page			
Remarks	t neir	σCD	тца	mme	SPT CC1				Water Added Water S From (m) To (m) struck at (m) Casing	trike - G	eneral	ose to (m)
Si i s carrieu du	c usif	ig Jr	ı iidl	milel	STICCI					T	T	
									Casing Details Chise	elling De	tails	
									To (m) Diam (mm) From (m) 8.50 250	To (m)	Time	(hh:mm)

							t No.:	Project	t Name:	Bor	ehole	No.:
A-A			IC	E)		15-664	÷	GDD O	verwater SI		BH0	3
		40	-6	E	TECH	Coordi	nates:	Client:		Sł	neet 3	of 6
	-		G	LO		32605	2.50 E	Irish W	/ater			010
Method:						24221		Client's	s Representative:	Sca	le: 1	L:50
Cable Percuss	sion+(Geob	or S	Cor	ing	24231	9.55 N	Tobin A	Arup JV	Dri	ler (`C+SS
Plant:						Ground	d Level:	Dates:		E		
Dando 3000+	Coma	acchi	o 40)5		-5.00	0 mOD		30/07/2015 - 07/08/2016	Log	ger: N	ЛFG
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfil	"
20.80							-					-
20.00							-		60-80° joint from 20.80-21.20m, irregular, smooth to rough.			21.0
							-		-			
	100	05	C 7				[21.5
	100	95	67	6			-		45° 5mm white calcite vein at 21 70m open on downhole side planar			=
							_		smooth, stained black.			-
							-					-
22.30							-					-
									Weak black carbonaceous LIMESTONE at 22.60-23.10m, with very closely to			
				20			-		closely spaced 0-15° fractures (planar, smooth to rough).			-
	100	95	57				[23.0
							-					=
							-					23.5 —
23.80				7								-
							-		55-75° joints at 24.00-24.20m ad 24.40-24.70m, undulating, rough, stained			24.0
												-
	100	87	53				-					24.5 —
						-29.70	24.70		Medium strong to strong medium bedded (locally indistinctly laminated)			=
									dark grey argillaceous LIMESTONE. Unweathered.			25.0
25.30							-		Discontinuity sets:			-
							-		1. 10-40° joints, close to medium spaced (locally widely spaced in parts			25.5 —
							-		below 31.0m), planar, occasionally slightly irregular or slightly undulating,			-
	100	100	100				-					26.0
	100	100	100	3			-					-
							-					26.5 —
26.80							-					-
20.80												27.0
							-					-
												27.5
	100	100	100				-					-
							- (11.10)					-
												28.0 -
28.30							-					:
												28.5 -
							-					
	100	100	100	2			E					29.0 -
							[
							-					29.5 —
29.80												
							-					30.0 -
	100	100	92				-					-
				<u> </u>			F					30.5 —
							-					-
	TCR	SCR	RQD	FI					Continued on Next Page	\square		+
Remarks									Water Added Water S From (m) To (m) Struck at (m) Casing	Strike -	General	Rose to (m
SPT's carried o	ut usir	ng SP	Г Наі	mme	r SPT CC1							
									Caring Dataile Chief	elling F)etaile	
									To (m) Diam (mm) From (m)	To (m)	Time	e (hh:mm)
									o.su 250			

						Project	t No.:	Project	t Name:	Bor	ehole	No.:
			IC	E)		15-664		GDD O	verwater SI		BH03	3
			-G	FO	TECH	Coordi	nates:	Client:		S	neet 4	of 6
			0			32605	2.50 E	Irish W	/ater	<u> </u>		
Method:		~ 1	6	6		24231	9 55 N	Client's	s Representative:	Sca	le: 1	:50
Cable Percuss	ion+(Jeop	or S	Cor	ing	24231	5.55 N	Tobin A	Arup JV	Dri	ller: C	C+SS
Plant:	Com	hochi	io 10	5		Groun	d Level:	Dates:	20/07/2015 07/09/2016		ger N	AEG
Danuo 5000+			10 40			-5.0	Depth (m)		50/07/2015 - 07/08/2016	100	.501.10	
(m)	TCR	SCR	RQD	FI	Field Records	(mOD)	(Thickness)	Legend	Description	Wat	Backfill	
							-					31.0
31.30				1			-					=
				1								31.5 —
							-					=
	100	100	93				-		-			32.0
									-			
				4			-		-			32.5 —
32.80							-					
							-					33.0
							-					
	100	100	87				-					33.5 -
				1								
							-					34.0
34.30									Two 75-80° calcite veins at 34.25-34.55m and 35.40-35.70m, 1-5mm thick,			
							-		planar, rough.			34.5 —
							-		60° joint at 35.70-35.80m, planar, smooth to polished, stained black.			=
	100	96	53	5			-					35.0
							-					-
												35.5 —
35.80						-40.80	- 35.80		Medium strong to strong medium hadded (locally indistingtly laminated)	-		=
							-		dark grey argillaceous LIMESTONE. Unweathered.			36.0
							-		Discontinuity sets:			=
	100	100	100						1. 0.20° joints madium to widely spaced planar to irregular associanally			36.5 —
							-		slightly undulating, rough, typically stained black.			=
							-					37.0
37.30							-		-			=
							-		60° joint at 37.55-37.75m half open/closed planar rough stained black			37.5 —
				2			-					-
	100	100	100	2								38.0
							-					-
												38.5
38.80							-					-
							-					39.0
							-					=
	100	100	100				-					39.5 —
							-		Two 55-65° joints at 40.0m and 40.2m, planar to undulating, rough, stained			40.0 —
40.30							-					
				3			-		75° 1-3mm calcite vein at 40.30–40.85m, open, planar to undulating, rough, stained brown.			40.5 —
	100	100	100						4			
							-					41.0
	TCR	SCR	RQD	FI					Continued on Next Page	$\left \right $		+
Remarks	1		1	1		1	1	<u>I</u>	Water Added Water S	trike -	General	
SPT's carried o	ıt usir	ng SP	Т Наі	mme	r SPT CC1					(11)		
									Cacing Datails Chica	elling (Details	
									To (m) Diam (mm) From (m)	To (m) Time	(hh:mm)

						Project	t No.:	Project	t Name:	Borehole	e No.:
			IC	E\		15-664	÷	GDD O	verwater SI	BHC)3
			-G	FO	TECH	Coordi	nates:	Client:		Sheet 5	5 of 6
			0			32605	2.50 E	Irish W	ater		
Method:	ionu	Cook		Car	ing	24231	9.55 N	Client's	s Representative:	Scale:	1:50
	51011+0	Jeor	001.5	COL	ing			Tobin A	Arup JV	Driller:	CC+SS
Plant: Dando 3000+	Coma	acchi	io 40)5		-5 0	a Levei:	Dates:	30/07/2015 - 07/08/2016	Logger:	MFG
Depth	тср	SCP	ROD	E1	Field Pacards	Level	Depth (m)	Logond	Description	be Backfi	
(m)		JCK	ind b		Field Records	(mOD)	(Thickness)	Legenu	Description	> Dacki	"
							-				41.5 —
41.80							-				-
41.00							-				42.0
							-				-
	100	100	100				-				42.5 —
	100	100	100								-
							-				43.0
43.30				2			-				-
							-				43.5 —
							-				-
	100	100	100				-				44.0
							-				-
							-				44.5 —
44.80				-			-				-
							-				45.0
							-				-
	100	100	100				-				45.5 -
							-				-
							-				46.0
46.30				1			(22.50)				-
											46.5 -
							-				-
	100	100	100				-				47.0
											-
							-				47.5 —
47.80							-				-
							-				48.0 -
							-		30° fracture at 48.25m, planar, smooth, partly polished with faint slickensides, stained black.		-
	100	100	100	2			E				48.5 —
							-				
							-				49.0
49.30	\vdash						-				-
							-				49.5 -
							-				-
	100	100	100				-				50.0 -
				1			-				-
							-				
50.80							-				51.0 -
							-				-
							-				-
	TCR	SCR	RQD	FI					Continued on Next Page		
Remarks SPT's carried o	ut usir	ng SP	T Hai	mme	r SPT CC1				Water Added Water St From (m) To (m) Struck at (m)	o (m) Time (min)	Rose to (m
	2.011										
									Casing Details Chise	lling Details) (hh)
									10 (m) Viam (mm, From (m) 8.50 250		e (unanm)

							t No.:	Project	t Name:	Bor	ehole	No.:
AA)			IC	E۱		15-664		GDD O	verwater SI		BH0	3
			-G	FO	TECH	Coordi	nates:	Client:		S	neet 6	of 6
	6					32605	2.50 E	Irish W	ater	_		
Method:		~ h	C	Cari	n	24231	9.55 N	Client's	s Representative:	Sca	le: 1	L:50
	01+0	seor	01 5	Cori	ng			Tobin A	Arup JV	Dri	ler: (CC+SS
Dando 3000+0	Coma	icchi	o 40)5		-5.0	o mOD	Dates:	30/07/2015 - 07/08/2016	Log	ger: 1	MFG
Depth	TCR	SCR	RQD	FI	Field Records	Level	Depth (m)	Legend	Description	ater	Backfi	
(m)						(mOD)	(Thickness)			3		-
	100	100	100				-					-
	100	100	100				-					52.0
52.30	<u> </u>											-
							-					52.5 —
							-					-
	100	100	90				-					53.0
							-					
							-		10° vein at 53.45m, 10mm white calcite, open on downhole side, smooth, stained black.			53.5 —
53.80												1 -
							-					54.0
				2			-					
	100	100	100				-					54.5 —
							-					-
							-					55.0 -
55.30							-					
							-					55.5 —
							-					-
	100	100	100	1			-					56.0
							-					-
							-					56.5 -
56.80							-					-
							[65° joint at 57.00-57.20m, undulating, smooth and polished in parts, stained black.			57.0
				20			-		At 57.20-57.60m, closely spaced 55-75° joints, planar, polished, possible faint slickensides. Also very closely spaced 10-20° joints at 57.30-57.50m,			-
	100	100	100				-		planar, smooth.			57.5 -
				3			-					58.0 -
							-					-
58.30			-			-63.30	58.30		End of borehole at 58.300m			58.5
							-					-
							-					59.0
							-					-
												59.5
							-					=
							_					60.0
							-					-
												60.5 —
							-					-
							-					61.0
												-
							-					61.5
							-					
	TCR	SCR	RQD	FI								
Remarks SPT's carried ou	t usir	ig SP	Т Нач	mme	r SPT CC1				Water Added Water From (m) To (m) Struck at (m) Casing	strike - g to (m)	General Time (min)	Rose to (m)
	- 431	.6.01	u									
									Casing Details Chis	elling [etails	a (http://
									10 (m) Diam (mm, From (m) 8.50 250	10 (m) Time	e (nn:mm)

					Project	t No.:	Project	t Name:	Bor	ehole	No.:
		ICI			15-664		GDD O	verwater SI		BH0	5
	CAU	121			Coordi	nates:	Client:		C F	oot 1	off
	-	GL	0	TECH	32698	1.50 E	Irish W	'ater			010
Method:					24224	0.04 N	Client's	s Representative:	Scal	e: 1	:50
Cable Percuss	ion+Geol	bor S (Cori	ng	24231	0.94 N	Tobin A	Arup JV	Dril	ler: () C
Plant:					Groun	d Level:	Dates:				
Dando 3000+	Comacch	io 405	5		-7.7	6 mOD		15/08/2015 - 18/08/2015	Log	ger: ℕ	ЛFG
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill	ı
0.00 - 1.00	B1						. × × ×	Medium dense grey silty fine to medium SAND with occasional shells.	\square		-
0.00 - 1.00	E29					-	x ×				-
						-	x ×				0.5 -
							$\hat{x} \times \hat{x}$				
1.00	D12 FS10					-	$\mathbf{x} \mathbf{x} \mathbf{x}$				1.0
1.00 - 1.45	SPT (S)			N=25 (3,3/4,5,7,9)			× × × ×				-
	N=25					(3.10)	× × × ×				1.5 -
						-	××××				-
2.00	D13			N-26 (3 4/5 5 8 8)		-	××××				2.0 -
2.00 2.45	N=26			14-20 (3,4/3,3,6,6)			××××				
2.00 - 3.00 2.00 - 3.00	B2 ES11					-	××`×``×				2.5 —
							×× ^×				-
3.00	D14			N-20 (4 C/8 0 11 11)	-10.86	- 3.10	XXXX				3.0
5.00 - 5.45	N=39			N-39 (4,0/8,9,11,11)		-	$\mathcal{O}_{\mathcal{X}}$	coarse grey slightly silty very sandy subangular to subrounded fine to coarse GRAVEL with occasional cobbles and boulders with some shells.			-
3.10 - 3.50	B3					[$\mathcal{O}_{\mathcal{X}}$	Sand is fine to coarse.			3.5
						(1.50)	$\mathcal{O}_{\mathcal{X}}$				
4.00	D15						$\mathcal{O}_{\mathcal{X}}$				4.0
4.00 - 4.45	SPT (S) N=43			N=43 (6,8/10,10,11,12)		-	$\mathcal{O}_{\mathcal{X}}$				=
4.60 5.00	D4				12.26	4.60	$\mathcal{O}_{\mathcal{X}}$				4.5 -
4.00 - 5.00	04				-12.30	4.00		Firm to stiff grey slightly sandy gravelly silty CLAY with occasional cobbles and boulders. Gravel is fine to coarse subangular to subrounded. Sand is			-
5.00	D16					-		fine to coarse.			5.0
5.00 - 5.45	SPT (S) N=12			N=12 (2,2/2,3,3,4)		-					-
						-	$\sim \times \rightarrow \times^{-}$				5.5 —
6.00 - 7.00	В5					-	$\sim \times \sim \times -$				6.0
							<u>~</u> × ~ ×-				
						-	<u>~</u> × ~ ×-				6.5 —
						(4.30)	XXXX XXXX				-
						-	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~				7.0
							××××××				
7.50 - 8.50	B6					-	XŎXŎ;				7.5 —
							\times \times \times \times				-
8.00 - 8.45	SPT (S)			N=15 (2,3/3,4,4,4)		-	$\frac{\times}{\times}$ $\frac{\times}{\times}$ $\frac{\times}{\times}$ $\frac{\times}{\times}$ $\frac{\times}{\times}$ $\frac{\times}{\times}$				8.0
	N=15					t L	$\frac{\times}{\times}$ \times				
						Ĺ	$\frac{\times}{\times}$ \times				8.5
						-	\times \times \times \times \times \times \times				-
8.90 - 9.30	В7				-16.66	8.90		Stiff to very stiff greyish brown slightly sandy slightly gravelly CLAY with			9.0
						-	\dot{O}	cobbles and boulders. Sand is fine to coarse. Gravel is subangular to			-
9 50	D17					-	\dot{O}				9.5
9.50 - 10.00	B8					- (1.80)	\dot{O}				-
9.50 - 9.88	SPT (S)			50 (14,11/50 for 225mm)		-	\dot{O}				10.0
						-	0-0-				-
							-0	Continued on Next Page	$\uparrow \uparrow$		1
Remarks								Water Added Water	Strike -	General	lose to (m)
Deck to bed 13m Chiseling:											
6.60m to 7.80m = 0 10.30m to 10.70m	01:00hr = 01:00hr							Casing Details Chic	ellinø D	etails	
								To (m) Diam (mm) From (m)	To (m)	Time	e (hh:mm)

						Project	t No.:	Project	Name:	Boreh	ole No.:
AH.			IC	E)		15-664		GDD O	verwater SI	B	H05
		10	-G	FO	TECH	Coordi	nates:	Client:		Shee	et 2 of 6
			0		TECH	32698	1.50 E	Irish W	ater		
Method:			_	_		2/221		Client's	s Representative:	Scale:	1:50
Cable Percussi	on+(Geob	oor S	Cor	ing	24231	0.94 N	Tobin A	Vrup JV	Driller	r: CC
Plant:		:	- 10			Groun	d Level:	Dates:		10000	
Dando 3000+0	.oma		Casing	/5 ///////////////////////////////////		-/./	5 mOD		15/08/2015 - 18/08/2015	LUgge	I. IVIFG
(m)	Те	sts	Depth (m)	Depth (m)	Field Records	(mOD)	(Thickness)	Legend	Description	jte ≯ Ba	ckfill
							-	0-0-			10.5 -
18:78	D18				D18	-18.46	10.70		Firm to stiff dark brown slightly sandy gravelly CLAY with rare cobbles and	$\left \right $	
18:78 - 11:88	SPT	(C)			50 (20,5/50 tor 50 (20,5/50 tor 150mm)		-		one boulder. Sand is fine to coarse. Gravel is fine to coarse, subangular,		11.0
					150mm)		-		predominantiy of dark grey limestone.		-
	56	0	0				-				
											-
							_	$\Omega^{+}O^{+}O^{+}O^{+}O^{+}O^{+}O^{+}O^{+}O$			12.0
12.20							-				-
12.30								0-0-			12.5 —
							(3.90)	0-0-			-
							-	0.0			13.0
	81	0	0				-	0.0			-
							-	0-0-	13.40-13.90m: Dark grey limestone BOULDER.		
							-	0-0-			-
13.90							-	\mathcal{O}			14.0
							-	\dot{O}			-
							-	Ô.			
	90	0	0			-22.36	14.60		Stiff dark brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse.		-
	50	Ŭ	Ŭ				-		Gravel is fine to coarse, subrounded, predominantly of limestone.		
							-				-
							-				-
15.60							(2.20)				-
							-				16.0
							-				-
	100	3	0								16.5 -
							-				-
						-24.56	- 16.80 - (0.20)		Firm light orangey brown CLAY.		
17.20						24.70	(0.60)		Weak black fractured carbonaceous MUDSTONE.		-
				20			(0.60)		Discontinuities: 20-40°, very closely spaced, planar.		17.5 —
						-25.36	17.60		Firm light brown slightly sandy slightly gravelly CLAY. (Highly weathered		-
	85	13	0				-		MUDSIONE.) Sand is fine to coarse. Gravel is fine to coarse, subangular, of mudstone lithorelics.		18.0 -
				NI			(1.10)				-
							-				18.5 —
18.70						-26.46	18.70		No recovery. (Probably highly weathered sandstone siltstone or		-
							-		mudstone.)		19.0
							-				-
	0	0	0	NR			(1.40)				19.5 -
							-				-
							-				20.0 —
20.10						-27.86	20.10	× × × × × × × × × × × × × × ×	Stiff to very stiff light brown and yellowish brown slightly sandy to sandy		-
							-	× × × × × × × × × × × × × × ×	gravening CLAY. (Highly weathered SILTSTONE and SANDSTONE.) Sand is fine to coarse. Gravel is fine to coarse, subangular to angular of siltstone and		20.5 —
	TCR	SCR	RQD	FI				~ ~ ~ ~ ~ ~	Continued on Next Page		
Remarks									Water Added Water S From (m) To (m) Struck at (m) Casing	trike - Ger	neral (min) Rose to (m
Deck to bed 13m Chiseling:											
6.60m to 7.80m = 0 10.30m to 10.70m =	1:00hi = 01:0(r Dhr							Casing Details Chise	elling Deta	ils
									To (m) Diam (mm) From (m) 23.70 200	To (m)	Time (hh:mm)

	1					Projec	t No.:	Project	t Name:	Bor	ehole	No.:
			IC			15-664	ļ	GDD O	verwater SI		BH05	5
		40	-6	EV	TECH	Coordi	nates:	Client:		Sł	neet 3	of 6
			U	10	len	32698	1.50 E	Irish W	ater			
Method:						24231	0 94 N	Client's	s Representative:	Scal	l e: 1	:50
Cable Percuss	ion+(Geob	oor S	Cori	ng	24231	0.94 N	Tobin A	Arup JV	Dril	ler: C	C
Plant:	^ om /	hachi	0.40			Groun	d Level:	Dates:	15/00/2015 10/00/2015	Log	ger: N	AEG
Dariuo S000+0						-/./	Depth (m)		15/08/2015 - 18/08/2015	108		T
(m)	TCR	SCR	RQD	FI	Field Records	(mOD)	(Thickness)	Legend	Description	Wat	Backfill	í l
							-	* * * * * *	sandstone lithorelics.			-
	0.2	25					-	× × × × × × ×				21.0
	82	25	0				-	× × × × × × × × × × × × × × × × × × ×				=
							-	× × × × × × × × × × × ×				21.5
21.70							-	× × × × × × × × × × × ×				=
							-	× × × × × × × × × × × × × × × × × × ×				22.0
							-	× × × × × × × × × × × × × × × × × × ×				=
	80	3	0					× × × × × × × × × × × × × × × × × × ×				22.5 —
				NI			-	× × × × × × × × × × × × × × × × × × ×				=
							-	× × × × × × × × × × × × × × × × × × ×				23.0
23.20							-	× × × × × × × × × × × × × × × × × × ×				
							-	* * * * * *				23.5 —
								* * * * * *				-
	100	10	0				-	* * * * * *				24.0
							-	× × × × × × ×				-
							-	× × × × × × × × × × × ×				24.5 —
24.70							(8.60)	× × × × × × × × × × × × × × × × × × ×				-
							-	× × × × × × × × × × × × × × × × × × ×	Medium strong grey and light orange (possibly dolomitised) LIMESTONE at			25.0
				15				× × × × × × × × × × × × × × × × × × ×	24.90-25.05m and 25.25-25.60m.			=
	100	38	23				[× × × × × × × × × × × × × × × × × × ×				25.5 —
							-	× × × × × × × × × × × × × × × × × × ×				=
							[× × × × × × × × × × × ×				26.0
26.20							-	× × × × × × × × × × × × × × × × × × ×				=
							-	× × × × × × × × × × × × × × × × × × ×				26.5
							-	* * * * * * *				-
	93	0	0				-	× × × × × × ×				27.0 -
				NI			-	× × × × × × ×				-
							-	× × × × × × × × × × × ×				-
27.70							-	× × × × × × × × × × × × × × × × × × ×	Becomes slightly figured at 07.70.99.70m, with sabble sized litheralise of			-
							-	× × × × × × × × × × × × × × × × × × ×	grey dolomitised LIMESTONE.			-
							-	× × × × × × × × × × × × × × × × × × ×				28.0 -
	87	33	0				-	× × × × × × × × × × × × × × × × × × ×				-
	0.					-36 46	- 28 70	× × × × × × × × × × × × × × × × × × ×				28.5 -
						50.10	-	· · · · · ·	Dark brown slightly gravelly very clayey fine to coarse SAND with one sandstone cobble at 29.30-29.45m. (Highly weathered SANDSTONE.)			=
29.20							-		Gravel is fine to coarse, subangular, of sandstone lithorelics.			29.0 -
25.20				NI			(1.20)					=
							Ľ					29.5 —
	0.2	27	0			-37.66	29.90	· · · · · · · · · · · · · · · · · · ·				
	93	21						× × × × × × ×	stm to very stm light brown and yellowish brown slightly sandy slightly gravely to gravelly CLAY with occasional cobble-sized lithorelics. (Highly			30.0 —
				NI				× × × × × × × × × × × ×	weathered SILTSTONE and SANDSTONE.) Sand is fine to coarse. Gravel is			
							-	× × × × × × × × × × × ×				30.5 —
30.70							-	× × × × × × × × × × × × × × × × × × ×				-
	TCR	SCR	RQD	FI					Continued on Next Page			
Remarks									Water Added Water 1 From (m) To (m) Struck at (m)	Strike -	General ime (min) R	ose to (m)
Chiseling:	1 00											
ט.סטוזו נט 7.80m = 0 10.30m to 10.70m	= 01:0	0hr							Casing Details Chis	elling D	etails	
									To (m) Diam (mm) From (m) 23.70 200	To (m)	Time	(hh:mm)

							t No.:	Projec	t Name:	Bor	ehole	No.:
			IC	E\		15-664	÷	GDD O	verwater SI		BHOS	5
		-	-G	FO	TECH	Coordi	nates:	Client:		Sh	eet 4	of 6
			0	- 0		32698	1.50 E	Irish W	/ater			
Method:	ionu	~ .		Car	ing	24231	0.94 N	Client'	s Representative:	Scal	e: 1	:50
	1011+0	Jeor	501.5		ling	Current	d 1 aal.	Iobin A	Arup JV	Dril	ler: C	.C
Plant: Dando 3000+	Coma	acch	io 40)5		Groun	6 mOD	Dates:	15/08/2015 - 18/08/2015	Log	ger: N	ЛFG
Depth	TCP	SCP.	POD	E1	Field Peserds	Level	Depth (m)	Logond	Description	fer		
(m)		JCK	NQD		Field Records	(mOD)	(Thickness)	×××××		Š	Dackini	21.0
							-	* * * * * *				-
							-	* * * * * *				31.5 -
	100	20	7				-	× × × × × × × × × × × × × × × × × × ×	Locally intact at 31 70.32 20m Medium strong dolomoitised LIMESTONE			-
				10			-	$\begin{smallmatrix} \times & \times & \times & \times \\ \times & \times & \times & \times \\ \times & \times &$	Closely spaced fractures, typically 5-20°, planar, rough.			32.0
32.20							(3.50)	× × × × × × × × × × × × × × × × × ×				-
							-	* * * * * * *				32.5 —
				NI			-					-
	100	23	7				-	\times				33.0
							-	× × × × × × × × × × × × × × × × × ×				-
						-41.16	- 33.40	* * * * *	Weak black and dark grey carbonaceous, locally calcareous, MUDSTONE			33.5 —
33.70							-		grading to argillaceous limestone at base.			-
							-		Discontinuities:			34.0
							-		1. 0-20° fractures, probably subparallel to bedding, closely spaced, planar			-
	100	87	10	8			(2.20)		to slightly undulating, smooth to rough.			34.5 —
							-		2. 80-90° open vein at 34.70-35.60m, planar, rough, 5mm of calcite mineralisation			
							-					35.0 —
35.20							-					-
						-42.26	25.60					35.5 —
						-43.30	- 33.00		Weak to medium strong dark grey thinly to thickly laminated argillaceous			=
	100	93	12				-		beds of black carbonaceous mudstone.			36.0
							-		Discontinuities:			=
									1. 0-20° fractures, often parallel to bedding, very closely to closely spaced,			36.5 —
36.70							-		planar to undulating, smooth to rough, stained black.			=
							-		2.80-90° discontinuous fractures at 35.85-36.30m, 36.50-36.70m and			37.0
									. 37.65-37.80m, planar to irregular, rough, stained black.			-
	100	90	10				-					37.5 —
				15			(4.30)		-			=
20.20							-					38.0
38.20							-					-
							ŀ		4			38.5 -
	100	02	27				-		1			
	100	33					-					39.0 -
							-					-
39.70							Ę					39.5 -
				$\left - \right $		-47.66	39.90		Firm to stiff light brown, locally dark brown, slightly candy slightly are sally			-
							F	~ ~ ~ × × × × × × × × × × × × × × ×	to gravelly CLAY with occasional cobble-sized lithorelics. (Highly weathered			40.0 -
	80	23	0				-	* * * * * * * * * * * * * * * * * * * *	SILISIONE and SANDSIONE.) Sand is fine to coarse. Gravel is fine to coarse, angular to subangular, of siltstone and sandstone lithorelics.			40.5 -
							-	× × × × × × × × × × × × × × ×				
							-	× × × × × × × × × × × × × × × × × ×				41.0
							-	* * * * * * *		\square		
Down 1	TCR	SCR	RQD	FI					Continued on Next Page	Strike -	General	
Deck to bed 13m									From (m) To (m) Struck at (m) Casing	to (m) T	me (min) R	ose to (m
Chiseling: 6.60m to 7.80m = 0	01:00hi	r										
10.30m to 10.70m	= 01:00	Dhr							Casing Details Chise To (m) Diam (mm) From (m)	lling D To (m)	etails Time	(hh:mm)
									23.70 200			
•												

						Project	t No.:	Projec	t Name:	Bor	rehole	No.:
AA			IC	E)		15-664	÷	GDD O	verwater SI		BH0	5
		40	-G	FO	TECH	Coordi	nates:	Client:		S	heet 5	of 6
			U	20	leen	32698	1.50 E	Irish W	ater			
Method:						24221	0.04 N	Client'	s Representative:	Sca	l e: 1	.:50
Cable Percussi	on+(Geob	or S	Cori	ing	24251	0.94 N	Tobin A	Arup JV	Dri	ller: (
Plant:				-		Ground	d Level:	Dates:				45.0
Dando 3000+0	.oma I	acchi T	o 40)5 I I		-7.70	6 mOD		15/08/2015 - 18/08/2015	LOg	ger: N	/IFG
(m)	TCR	SCR	RQD	FI	Field Records	(mOD)	(Thickness)	Legend	Description	Wate	Backfil	1
41.20							-	× × × × × × × × × × × × × × ×				=
							Ē	× × × × × × × × × × × × × × × × × ×				41.5 —
		20					-	× × × × × × × × × × × × × × × × × ×				
	80	20	0				-	× × × × × × × × × × × × × × × × × × ×				42.0
							[*****				
42.70							-	*****				42.5 —
42.70				NI			(4.55)	× × × × × × × × × × × × × × × × × × ×				
							-	× × × × × × × × × × × × × × ×				43.0
								$\begin{smallmatrix} \times & \times & \times & \times \\ \times & \times & \times & \times \\ \times & \times &$				
	80	13	0				-	$\begin{smallmatrix} \times & \times & \times & \times \\ \times & \times & \times & \times \\ \times & \times &$				43.5 —
							-	$\begin{smallmatrix} \times & \times & \times & \times \\ \times & \times & \times & \times \\ \times & \times &$				-
							-	× × × × × × × × × × × × × × × × × ×				44.0
44.20								× × × × × × × × × × × × × × × × × ×				-
				4		-52.21	44.45 (0.25)		Medium strong grey and pinkish grey massive LIMESTONE.			44.5 —
						-52.46	44.70		Firm orangey brown mottled dark brown slightly sandy slightly gravelly			
	100	33	27	NI			(0.70)		fine to coarse, subangular of mudstone lithorelics.			45.0 —
						F2 16	45.40					-
				4		-53.10	- (0.20) - 45.60		Medium strong light grey massive LIMESTONE.			45.5
45.70				NI				· · · · · ·	Extremely weak to very weak (locally weak) yellowish brown, light brown and pinkish orange, fine to coarse grained SANDSTONE probably with			-
							-	· · · · · ·	minor siltstone. Regularly non-intact and recovered as sandy gravelly clay			46.0
							-	· · · · · ·				-
	100	27	0	5			-					46.5 —
									46.00-47.20m: Intact, but extremely weak.			
							-	· · · · · ·				47.0
47.20								· · · · · ·				
				NI			-	· · · · · ·				47.5 —
				10			-					-
	93	20	7				-		47.95-48.70m: Recovered as clayey sandy GRAVEL of very weak sandstone.			48.0 -
				NI				· · · · · ·				
							(6.40)	· · · · · ·				48.5 —
48.70							-	· · · · · ·	48.70-49.60m: Very weak to weak.			
				10			-					49.0
	100		47									
	100	60	1/				-	· · · · · ·				49.5 —
							-	· · · · · ·				
50.20				20			-	· · · · · ·				50.0 —
50.20							-	· · · · · ·				-
							-		50.60-51.20m: Intact. but extremely weak.			50.5 -
	80	7	0	5			-					
							-	· · · · · ·				51.0
							-	· · · · · ·				
	TCR	SCR	RQD	FI				· · · · ·	Continued on Next Page			51.5
Remarks				I					Water Added Water S From (m) To (m) Struck at (m) Casing	trike - to (m)	General	Rose to (m
Chiseling:												
ь.60m to 7.80m = 0 10.30m to 10.70m =	1:00hi 01:00	r Ohr							Casing Details Chise	elling (Details	
									To (m) Diam (mm) From (m) 23.70 200	To (m) Time	: (hh:mm)

						Project	t No.:	Project Name:				No.:			
CALISEWAY						15-664	Ļ	GDD Overwater SI				5			
GEOTECH							nates:	Client:				of 6			
							1.50 E	Irish Water			- Carla d				
Method:						24231	0.94 N	Client's	s Representative:	Sca	.:50				
Cable Percuss	ion+(seop	or S	Cor	ing	-		Tobin A	Arup JV	Dri	C				
Plant: Dando 3000+	Coma	ecchi	o 40	15		Groun	d Level:	Dates:	15/09/2015 19/09/2015	Logger: MFr					
Danido Socor			0 40			Level	Depth (m)			100	, <u>s</u> en -				
(m)	TCR	SCR	RQD	FI	Field Records	(mOD)	(Thickness)	Legend	Description	Wat	Backfil	1			
51.70				NI			-	· · · · · ·				-			
				10		-59.76	- 52.00	::::	Weak to madium strong light grou and dark group INTETONE (probably			52.0			
									dolomitised).						
	100	77	67				-		Discontinuities: 10-30° fractures, occasionally subparallel to bedding, close			52.5 -			
							-		to medium spaced, planar to stepped, rough.						
							-					53.0			
53.30							-								
				6			- (3.00)					53.5 —			
							-		53.90-54.00m: Weak light brown SANDSTONE.						
	94	82	48				-								
							-								
									54.60-54.90m: Medium strong light greyish brown SANDSTONE.						
55.00						-62.76	- 55.00		End of borehole at 55 000m			55.0			
							-								
							-								
							-								
							-					56.0			
							-					- 56.5 —			
							-					-			
							-					57.0			
							-								
							-					- 57.5 -			
							-					58.0			
							-								
							-					58.5 —			
												-			
							-								
							-								
							Ę					59.5 —			
							-								
							-					60.0			
							-								
							-					60.5 —			
							-								
							-					61.0			
							Ę								
							-					61.5 —			
	TCR	SCR	RQD	FI											
Remarks Deck to bed 13m									Water Added Water S From (m) To (m) Struck at (m) Casing	to (m)	General Time (min)	Rose to (m)			
Chiseling:)1·00b.														
10.30m to 10.70m	= 01:00	Dhr							Casing Details Chise	elling	Details				
									To (m) Diam (mm) From (m) 23.70 200	To (m) Time	2 (hh:mm)			

						Project	t No.:	Project Name:				e No.:		
CALICENAAY						15-664	ł	GDD Overwater SI				08		
GEOTECH						Coordi	nates:	Client:				1 of F		
GLOTECH						32828	8.30 E	Irish Water				1013		
Method:								Client'	s Representative:	Sci	1:50			
Cable Percussion+Geobor S Coring						24230	1.90 N	Tobin A	Arup JV	Drillor: CC				
Plant:						Ground Level:		Dates:						
Dando 3000+Comacchio 405							0 mOD		08/08/2015 - 14/08/2016	Logger: MFG				
Depth	TCR	SCR	RQD	FI	Field Records	Level	Depth (m)	Legend	Description	/ater	Back	fill		
(m) 0.00 - 0.50					ES2	(mOD)	(Thickness)	a 9 9	Medium dense grey very sandy fine to coarse subrounded GRAVEL with	5		-		
0.00 - 1.00					B1		-	a ° °	many shells and occasional cobbles. Sand is fine to coarse.					
							-	, e . e . e	- - 9			0.5 —		
							(1.50)	°°°°°°				-		
1.00					03							1.0 -		
1.00 - 1.45					N=12 (2,2/2,3,3,4)		-					-		
1.00 - 1.50					ES5		-					-		
1.50 - 2.50					B4	-15.50	- 1.50	÷ • 0	Very dense grey very gravelly fine to coarse SAND with many shells and	1		1.5 -		
							[° ° 0	occasional cobbies. Gravel is subangular to subrounded fine to coarse.					
2.00					D6		-	a 6 0 0				2.0		
2.00 - 2.33					180mm)		(1.50)	a ° ° ,	P					
2.00 - 2.50					ES7		-	a ° ° °	P			2.5 —		
												-		
3.00 - 3.45					N=15 (3.3/4.4.4.3)	-17.00	- 3.00	a • • •	-			3.0		
3.00 - 3.50					В8		-	a • • •	GRAVEL with medium cobble content. Sand is fine to coarse.			-		
							-	a • ¢	- 9 -			-		
								a . c	- P			3.5 -		
							-	a ° °				-		
4.00 - 4.45					N=10 (4,3/3,3,2,2)		-	° ° ° °	- - 9			4.0		
4.00 - 4.50					69		-	ά ο ο α ο ά	- P			-		
							(2 20)	°°°°°	- - 2			4.5 —		
							(3.20)					-		
5.00 - 5.45					N=17 (3,3/2,3,5,7)		-					5.0		
5.00 - 5.50					B10		-					-		
							_					5.5		
							-	÷ • • •				-		
C 00					D11		-	÷ • • •				-		
6.00 - 6.45					N=31 (5,6/7,8,7,9)	-20.20	- 620	÷ • •				6.0 -		
6.20 - 7.20					B12	20.20	-	×	Stiff to very stiff greyish brown slightly sandy silty CLAY. Sand is fine to coarse.					
							-	×				6.5 —		
							- (1.00)	×				-		
7.00					D13		-	×				7.0		
7.30 - 7.80					B14	-21.20	7.20	X	Very stiff greyish brown slightly sandy slightly gravelly silty CLAY. Sand is	1		-		
							[×	nne to coarse. Gravel is subangular to subrounded fine to coarse.			7.5		
							- (1.20)	×						
							-	×				8.0		
							-	×				-		
8.40 - 8.65					50 (25 for	-22.40	8.40		Very dense dark grey fine to coarse subangular GRAVEL of limestone.	-		8.5		
					135mm/50 for 135mm)	-22.70	_ (0.30) - 8.70		(Possibly weathered bedrock.)	4		-		
8.40 - 8.70					B15		-		Partially weathered: closer fracture spacing, slightly weathered.					
				16			-		Discontinuity sets:			9.0		
	97	50	0				(2.00)							
				NI			-		 1. 0-30° joints, closely spaced, planar, rough, occasionally with <1mm calcite mineralisation. 			9.5 —		
				20			-					-		
	TCR	SCR	RQD	FI					Continued on Next Page					
Remarks									Water Added Water S From (m) To (m) Struck at (m) Casing	trike	- Gener	ral Rose to (m)		
SPT's carried o	ut usir	ng SP	ГНа	mme	r SPT CC1									
									Cacing Datails Chica	lling	Details			
									To (m) Diam (mm) From (m)	To (n	n) Tir	me (hh:mm)		
									0.70 230					

						Project No.:		Project Name:				No.:
CALISEWAY				15-664		GDD Overwater SI				8		
		40	12			Coordi	nates:	Client:	Client:			
			-G	EO	TECH	328288.30 E		Irish Water				01.5
Method:						1		Client'	s Representative:	Sca	l e: 1	:50
Cable Percussion+Geobor S Coring						24230	1.90 N	Tobin A	Arup JV	D	llor (
Plant:						Ground	d Level:	Dates:		Driller: CC+SS		
Dando 3000+Comacchio 405							0 mOD	08/08/2015 - 14/08/2016			Logger: MF	
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level (mOD)	Depth (m)	Legend	Description	Vater	Backfil	1
(11)						(1100)	-		2. 40-60° joints, closely spaced (very closely spaced at 10.0-10.2m), planar,	-		_
10.20				NI			-		smooth to rough, with up to 3mm of dark brownish grey clay fill.			-
												10.5 —
						-24.70	10.70		Medium strong (locally weak, and probably strong in places), indistinctly			
	100	53	23				-		aminated dark grey argillaceous LIMESTONE. Largely unweathered.			11.0
				10			-		10.70-11.60m: 55-75° joints, very closely to closely spaced, planar to slightly			-
							-		<u>undulating, smooth to rough, often with</u> film of dark brownish grey clay.			-
11 70				<u> </u>			Ē		11.60-13.20m: 55-75° joints, closely to medium spaced, planar to slightly			11.5
11.70							-		undulating, smooth to rough, often with film of dark brownish grey clay.			-
							-					12.0
							-		-			-
	100	98	80	5								12.5 —
							-					-
							-					13.0
13.20							-		80.90° joint at 13 2-14 3m undulating smooth to rough patchy dark brown			-
	100						-		staining.			-
									ſ			
		62	47				-					-
		03	17				-					14.0 -
							-		14.30-14.50m; Verv weak fractured limestone with calcite vein. Extremely			-
									closely spaced 50-55° fractures with 10mm calcite vein at 14.4m, and up to 5mm of soft brown clav fill.			14.5 —
14.70							-		80° undulating joint at 14.70-15.25m, smooth to rough.			-
							-		14.50-19.50m: 35-55° joints, medium spaced, planar (often parallel to beddina), smooth, occasionally rough.			15.0
												-
	100	100	73				-					- 15.5
				3			-					-
				1			-		4			-
16 20							-					
							-					-
							-					16.5 —
								- -	-			-
	100	100	93				_					17.0
							-					-
							-					17.5 —
17.70							Ē		4			-
							-		4			18.0
							-					-
	100	97	57	15			-					-
	100	57	57									18.5 —
							-					-
				4			-					19.0 -
19.20							-					-
	100	70	4.2	-			-		19.50-19.55m: Very weak fractured limestone with extremely closely spaced			19.5 —
	100	73	13	20			[45° fractures. 70° undulating joint at 19.70-20.05m (rough) with very closely spaced incinient fractures at 19.55-19.70m			
				10			-			\square		
Remarks	TCR	SCR	RQD	FI					Continued on Next Page Water Added Water S	trike	- Genera	 1
SPT's carried o	ut usir	ng SP	Т На	mme	r SPT CC1				From (m) To (m) Struck at (m) Casing	to (m)	Time (min)	tose to (m)
									Casing Details Chise	lling	Details	e (hburr)
									8.70 250	10 (If	/ 1006	. ()

						Project No.:		Project Name:			Borehole No.					
CALISEWAY				15-664		GDD Overwater SI				В						
		40	-G	E V	TECH	Coordinates:		Client:	Client:							
							328288.30 E		Irish Water							
Method:							242301 90 N		s Representative:	Sca	:50					
Cable Percussion+Geobor S Coring						2.2002.000.11		Tobin A	rup JV	Dri	C+SS					
Plant:							-14 00 mOD		08/08/2015 - 14/08/2016	Logger: MFG						
Depth						Level Depth (m)		Lagand	Description	fe	De elsfil					
(m)		SCR	NQD	-	Field Records	(mOD)	(Thickness)	Legenu	Description	Ň	Dackin					
							-									
							-					20.5 —				
20.70							-									
							-					21.0				
				3			-		50° joint at 21.2m, planar, rough, stained brown.							
	100	93	57				-					21.5 —				
							-		Very weak fractured limestone at 21.85-21.90m (extremely closely spaced 50° fractures with 0-1mm soft brown clay fill). 20mm calcite vein at 21.90m.							
				15			-		21.60-22.20m: Closely spaced 50° fractures (planar, smooth).			22.0				
22.20							-		22.20-22.90m: 80-90° joint at 22.3-22.9m (slightly undulating, rough, stained							
				1			-		dark brown) with 30-50° closely spaced tractures (planar, smooth).			22.5 —				
							-									
	100	98	47				-		22.90-24.85m: 60-70° joints, medium spaced, planar, smooth, stained black with faint slickensides 10-30° joints, medium spaced, planar, rough			23.0				
				10			-					-				
							-					23.5 —				
23.70							-					-				
							-					24.0				
				8			-					-				
	100	83	33				-					24.5 —				
							-					-				
							- (22.90)		24.85-28.00m: 5-25° joints, medium spaced, planar, smooth, rough. 30-50° joints, medium spaced (closely spaced at 26.90-28.0m), planar, smooth.			25.0				
25.20							-					-				
							-					25.5 —				
				6			-					-				
	100	97	53	Ŭ			-					26.0				
							-					-				
							-					26.5 —				
26.70							-									
							-					27.0				
							-									
	100	93	30	8			-					27.5 —				
							-									
							-		28.00-29.40m: 0-20° joints, close to medium spaced, planar, smooth to			28.0 -				
28.20							-		undulating, rough, patchy calcite mineralisation.			-				
				45			-		Limestone highly fractured at 28.50-28.55m, 28.80-28.95m and 29.25-29.40m (extremely closely spaced fractures stained orangey brown			28.5 —				
	100	C 7	22	15			-		and dark brown with up to 2mm dark brown clay film).							
	100	67	23				-		<u>15° joint at 29.15m with 20mm of firm</u> dark brown gravelly clay fill.			29.0				
							-		Ľ							
20.70	L						-					29.5 —				
29.70							-									
	TCR	SCR	RQD	FI					Continued on Next Page	tril.	Ganari	<u> </u>				
Remarks SPT's carried ou	ıt usir	ng SP	Т Наі	mmei	r SPT CC1				From (m) To (m) Struck at (m) Casing	to (m)	Time (min)	ose to (m)				
		-														
									Casing Details Chise To (m) Diam (mm From (m)	lling To (n	Details	e (hh:mm)				
									8.70 250							

						Project	: No.:	Project Name:				No.:			
CAUSEWAY				15-664		GDD Overwater SI				BH08					
		10	-G	FO	TECH	Coordi	nates:	Client:				of 5			
			Ŭ			32828	8.30 E	Irish Water							
Method:							1.90 N	Client'	s Representative:	Scal	e: 1:	50			
Cable Percussion+Geobor S Coring								Tobin A	Arup JV	Drill	C+SS				
Plant:							d Level:	Dates:	logger MEG						
Danido Socori Depth				,,, 		Level Depth (m			08/08/2013 - 14/08/2010	80					
(m)	TCR	SCR	RQD	FI	Field Records	(mOD)	(Thickness)	Legend	Description	Nat Nat	Backfill				
				NI			-		30.10-30.20m: Non-intact. Extremely closely spaced fractures with black clay coating.			-			
							-		30.20-31.20m: 50-70° joints, closely spaced, planar, smooth. Limestone becoming increasingly carbonaceous down to 31.2m.			- 30.5 —			
	100	93	67	5			-								
							-					- 31.0			
31.20							-					-			
							-					31.5 —			
							-					-			
	100	100	87				-		60° joint/vein at 31.85-32.10m, planar to slightly undulating, rough, 1-2mm			32.0			
							-		eanle mineralisation with pateny brown stanning.			-			
				2			-					325			
32.70							-		40° joint at 32.6m, planar to irregular, rough, stained black and dark brown.			-			
							-		JL: 10-33.00m: ~60 Joints at 32.1-32.6m, 32.6-32.9m and 33.45-33.55m, planar to irregular, rough, stained brown.						
							-					-			
	100	97	77				-					-			
						-47.60	33.60		Medium strong to strong thinly to thickly laminated dark grey argillaceous						
							-		LIMESTONE. Unweathered.			-			
3/1 20							_		Discontinuity sets:			34.0 -			
34.20							-		1. 40-50° bedding fractures, medium to widely spaced, planar, smooth.			-			
							-					34.5 —			
	100	100	02				-								
	100	100	93				-					35.0 —			
							-								
							-					35.5 —			
35.70							-								
							-					36.0			
							-					-			
	100	100	100				-					36.5			
				2			(12.00)					-			
							-					37.0			
37.20							-					-			
							-					37.5 —			
							-								
	100	100	77				-					- 38.0 —			
							-		20.00%						
							-		60-90° undulating joint at 38.30-38.60m, smooth, patchy grey staining.			- 38.5 —			
38.70							-					-			
							-								
							-								
	100	100	100				-								
							-								
							-		45-55° joints/veins at 39.85m, 40.00m, 40.30m and 40.60m, planar to						
Pomorko	TCR	SCR	RQD	FI					Continued on Next Page Water Added Water S	trike -	General				
SPT's carried ou	ıt usir	ig SP	Г Наі	mme	r SPT CC1				From (m) To (m) Struck at (m) casing	to (m) Ti	me (min) Ro	se to (m)			
									Casing Details Chise To (m) Diam (mm) From (m)	lling Do To (m)	etails Time	(hh:mm)			
									8.70 250		1				
L															
						Project	: No.:	Project	Borehole No.:						
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CAUSEWAY								GDD O	BH08						
							nates:	Client:		Sheet 5 of					
			G	LO		32828	8.30 E	Irish W	Irish Water						
Method:							1.00 N	Client's	s Representative:	Sca	:50				
Cable Percussion+Geobor S Coring							1.90 N	Tobin A	Dri	C+SS					
Plant:						Ground	d Level:	Dates:							
Dando 3000+Comacchio 405						-14.00 mOD			08/08/2015 - 14/08/2016	LO	ger: N	1FG			
Depth (m)	TCR	SCR	RQD	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill				
40.20							[45-55° joints/veins at 39.85m, 40.00m, 40.30m and 40.60m, planar to undulating, smooth, up to 2mm calcite with patchy brown staining,						
40.20							-								
				6			-					40.5 —			
	95	95	60				-					41.0			
							-					-			
							-					41.5			
41.70							-								
							-					42.0			
							-								
	100	100	100				-					42.5 —			
				2			-					-			
							-					43.0			
43.20				-			-					-			
							-					-			
							-					43.5 —			
	100	0.2	00				-					-			
	100	93	80				-					44.0 -			
							-		60° joint at 44.25-44.40m, planar to irregular, rough, slight grey and black						
							-		44.40-45.60m: bedding fractures become closely spaced (planar, smooth).			44.5 —			
44.70							-		50° calcite vein at 45.35m (open, rough, partly stained orangey brown, and			-			
				10					45.40m.			45.0 —			
	100	90	25				-					-			
							-					45.5 —			
45.60						-59.60	45.60		End of borehole at 45.600m	1					
							-					46.0			
							-					-			
							-					46.5			
							-					-			
							-					47.0			
							-								
							-					-			
												47.5 —			
							-								
							-					48.0 -			
							-					48.5 —			
							-					=			
												49.0			
							-								
							-					- 49.5 —			
												-			
												-			
Remarks	TCR	SCR	RQD	FI					Water Added Water S	trike	- General	<u> </u>			
SPT's carried out	usin	ig SP	Т На	mme	er SPT CC1				From (m) To (m) Struck at (m) Casing	to (m)	Time (min) R	ose to (m)			
									Casing Details Chise	lling	Details	(hh:mm)			
									8.70 250		,e				

Appendix C Core photographs



Borehole BH01 15.00 - 15.80m



Borehole BH01 15.80 - 17.30m



Borehole BH01 17.30 - 18.80m



Borehole BH01 18.80 - 20.30m





Borehole BH01 20.30 - 21.80m



Borehole BH01 21.80 - 23.30m



Borehole BH01 23.30 - 24.80m



Borehole BH01 24.80 - 26.30





Borehole BH01 26.30 - 27.80m



Borehole BH01 27.80 - 29.30m



Borehole BH01 29.30 - 30.80m



Borehole BH01 30.80 - 32.30m





Borehole BH01 32.30 - 33.80m



Borehole BH01 33.80 - 35.40m



Borehole BH01 35.40 - 36.90m



Borehole BH01 36.90 - 38.40m





Borehole BH01 38.40 - 39.90m



Borehole BH01 39.90 - 41.50m



Borehole BH01 41.50 - 43.00m



Borehole BH01 43.00m - 44.50m





Borehole BH01 44.50 - 46.00m



Borehole BH01 46.00 - 47.60m



Borehole BH01 47.60 - 49.10m



Borehole BH01 49.10 - 50.60m





Borehole BH01 50.60 - 52.10m



Borehole BH01 52.10 - 53.60m



Borehole BH01 53.60 - 55.10m



Borehole BH01 55.10 - 56.70m





Borehole BH01 56.70 - 58.30m



Borehole BH01 58.30 - 59.90m





Borehole BH03 8.50 - 10.00m



Borehole BH03 10.00 - 10.80m



Borehole BH03 10.80 - 12.50m





Borehole BH03 12.50 - 13.30m



Borehole BH03 13.30 - 14.80m



Borehole BH03 14.80 - 15.30m





Borehole BH03 15.30 - 16.30m



Borehole BH03 16.30 - 17.80m



Borehole BH03 17.80 - 19.30m



Borehole BH03 19.30 - 20.80m





Borehole BH03 20.80 - 22.30m



Borehole BH03 22.30 - 23.80m



Borehole BH03 23.80 - 25.30m



Borehole BH03 25.30 - 26.80m





Borehole BH03 26.80 - 28.30m



Borehole BH03 28.30 - 29.80m



Borehole BH03 29.80 - 31.30m



Borehole BH03 29.80 - 32.80m





Borehole BH03 32.80 - 34.30m



Borehole BH03 34.30 - 35.80m



Borehole BH03 35.80 - 37.30m



Borehole BH03 37.30 - 38.80m





Borehole BH03 38.80 - 40.30m



Borehole BH03 40.30 - 41.80m



Borehole BH03 41.80 - 43.30m



Borehole BH03 43.30 - 44.80m





Borehole BH03 44.80 - 46.30m



Borehole BH03 46.30 - 47.80m



Borehole BH03 47.80 - 49.30m



Borehole BH03 49.30 - 50.80m





Borehole BH03 50.80 - 52.30m



Borehole BH03 52.30 - 53.80m



Borehole BH03 53.80 - 55.30m



Borehole BH03 55.30 - 56.80m





Borehole BH03 56.80 - 58.30m





Borehole BH05 10.70 - 12.30m



Borehole BH05 12.30 - 13.90m



Borehole BH05 13.90 - 15.60m



Borehole BH05 15.60 - 17.20m





Borehole BH05 17.20 – 18.70m

No Recovery between 18.70m – 20.10m



Borehole BH05 20.10 - 21.70m



Borehole BH05 21.70m - 23.20



Borehole BH05 23.20 - 24.70m





Borehole BH05 24.70 - 26.20m



Borehole BH05 26.20 - 27.70m



Borehole BH05 27.70 - 29.20m



Borehole BH05 29.20 – 30.70m





Borehole BH05 30.70 - 32.20m



Borehole BH05 32.20 - 33.70m



Borehole BH05 33.70 - 35.20m



Borehole BH05 35.20 - 36.70m





Borehole BH05 36.70 - 38.20m



Borehole BH05 38.20 - 39.70m



Borehole BH05 39.70 - 41.20m



Borehole BH05 41.20 - 42.70m





Borehole BH05 42.70 - 44.20m



Borehole BH05 44.20 - 45.70m



Borehole BH05 45.70 - 47.20m



Borehole BH05 47.20 - 48.70m





Borehole BH05 48.70 - 50.20m



Borehole BH05 50.20 - 51.70m



Borehole BH05 51.70 - 53.20m



Borehole BH05 53.20 - 55.00m





Borehole BH08 8.70 - 10.20m



Borehole BH08 10.20 - 11.70m



Borehole BH08 11.70 - 13.20m



Borehole BH08 13.20 - 14.70m





Borehole BH08 14.70 - 16.20m



Borehole BH08 16.20 - 17.70m



Borehole BH08 17.70 - 19.20m



Borehole BH08 19.20 - 20.70m





Borehole BH08 20.70 - 22.20m



Borehole BH08 22.20 - 23.70m



Borehole BH08 23.70 - 25.20m



Borehole BH08 25.20 - 26.70m



Report No.: 15-664





Borehole BH08 26.70 - 28.20m



Borehole BH08 28.20 - 29.70m



Borehole BH08 29.70 - 31.20m



Borehole BH08 31.20 - 32.70m





Borehole BH08 32.70 - 34.20m



Borehole BH08 34.20 – 35.70m (photo taken after sub-sampling)



Borehole BH08 35.70 - 37.20m



Borehole BH08 37.20 - 38.70m





Borehole BH08 38.70 - 40.20m



Borehole BH08 40.20 - 41.70m



Borehole BH08 41.70 - 43.20m



Borehole BH08 44.70 - 45.60m





Borehole BH08 44.70 - 45.60m



APPENDIX D

Vibrocore logs

Cau	seway	Geo	otec	h Ltd	Projec 15-664	t no.	Project GDD Overwater SI						Borehole No. BHVC02			
Method:					ls:	Client:	Irish W	/ater						Sheet 1	of 1	
Pneumatic	Vibrocore			3.60mE	Client's Representative: Tobin Arup JV						Scale: 1:50					
Plant: Vibrocore					Groun	d Level:	Dates: 22/08/2015 22/08/2015						Driller: TA			
	<u> </u>	Casing	Water		-2.79M	OD	Dutton	22/00/2013						Logged By: DC		
Depth (m)	Sample / Test	Depth (m)	Depth (m)	Field Reco	ords	Level & Depth		, ailty fina C	Stra	atum Desc	ription				Water Strikes	Installs
Depth (m) 0.10 - 0.30 0.40 - 0.74 0.80 - 1.00 0.80 - 1.00	Sample / Test	Depth	Depth (m)	Field Reco	ords	Level & Depth (1.30) -4.09 1.30	Dense grey 1.0m Reco	vsilty fine S very due to	Stra	atum Desc with occasic fying of sam	ription pal shells t 1.30 m				Vater Strikes	Backfill
Remarks Deck to bec Deck Level	d 3.53m +0.743 mod							Chisellin From (m)	ng: To (m)	Time (hh:mm)	Water Str Struck (m)	ikes: Rose (m)	to	Time (min)	Last Rev	vised:
								Water A From (m	dded: 1)	To (m)	Casing: To (m)	Di	iamete	er (mm)		S eotech.com
Causeway Geotech Ltd					Projec	t no.	Project Name:	GDD C	Dverv	water SI					Boreho	le No. C03
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Method:					Co-ord	ds:	Client:	Irish W	/ater						Sheet	1 of 1
Pneumatic	√ibrocore				326077	7.10mE	Client's Ba	nroconto	+i.v.o.	Tohin /					Scale: 1	1:50
Plant:					242322 Groun	2.90mN	Chefit S Re	presenta	uve.		Alup JV				Driller: 1	ſA
Vibrocore		<u>.</u>			-5.57M	IOD	Dates:	22/08/2	2015	- 22/08/2	2015				Logged B	y: DC
Depth (m)	Sample / Test	Casing Depth (m)	Water Depth (m)	Field Reco	ords	Level & Depth	n		Stra	atum Desc	ription				Legend 8 Water Strikes	* Backfill Installs
0.10 - 0.30 0.40 - 0.70 0.40 - 0.70 0.80 - 0.90 0.80 - 0.90	D ES D ES	(m)	(m)			(1.30) -6.87 1.30	Dense grey 0.9m recov	Chisellin From	AND 1 3m du - End	vith occasic e to densifu] orborehole e	Water Str Sfruck	ikes: Rom		Time	Last Re	evised:
Deck to bed	l 4.75m							(m)	(m)	(hh:mm)	(m)	(m)		(min)		
Deck Level	-v.818 mod.							Water A From (m	dded:	To (m)	Casing: To (m)		Diamet	ter (mm)		geotech.com

Causeway Geotech Ltd				Projec 15-664	t no.	Project Name:	GDD (Dverv	water SI					Boreho BHV	le No. C04	
Method:					Co-ord	ds:	Client:	Irish W	/ater						Sheet	1 of 1
Pneumatic	Vibrocore				326528	8.70mE		-							Scale: 1	:50
Plant:					242311	1.70mN	Client's Rep	oresenta	tive:	Tobin A	Arup JV				Driller: T	A
Vibrocore					Groun -6.70M	d Level: IOD	Dates:	22/08/	2015	- 22/08/2	2015				Logged By	: DC
Depth (m)	Sample / Test	Casing Depth	Water Depth	Field Rec	ords	Level & Depth			Stra	atum Desc	ription				Legend & Water Strikes	Backfill
Depth (m)	Sample / Test	(m)	Depth (m)	Field Rec	ords	Level & Depth	Dense grey 1.0m recove	silty fine S ery from 1.0 <u>n - Very st</u>	Stra	atum Desc with occasion ayer	at 1.00 m ⁻ -	S.			- Water Strikes	Backfill
Remarks Deck to bec Deck Level	Remarks Deck to bed 5.9m Deck Level 0.798 mod							Chisellin From (m) Water A	ng: To (m) dded:	Time (hh:mm)	Water St Struck (m) Casing:	rikes: Ros (m)	: se to	Time (min)	Last Re	vised:
								From (m	ו) '	To (m)	To (m)		Diame	ter (mm)	www.causeway	P geotech.com

Causeway Geotech Ltd				Projec 15-664	;t no. ↓	Project Name:	GDD C	Over	water SI				Borehol BHVC	e No. :05	
Method:	Vibroooro				Co-orc	ds:	Client:	Irish W	/ater					Sheet 1	of 1
Plient					326979 24230	9.70mE 9.90mN	Client's Re	presenta	tive:	: Tobin A	Arup JV			Scale: 1:	50
Vibrocore					Groun	d Level:	Dates:	22/08/2	2015	5 - 22/08/2	2015			Logged By	: DC
Depth (m)	Sample / Test	Casing Depth	Water Depth	Field Rec		Level & Dept	h		Stra	atum Desc	ription			Legend & Water	Backfill
Vibrocore Depth (m) 0.10 - 0.30 0.40 - 0.70 0.40 - 0.70 0.80 - 1.00 0.80 - 1.00	Sample / Test	Casing Depth (m)	Water Depth (m)	Field Rec	ords	I Level & Depti (1.20) -8.20 1.20	Dates: h Dense grey Densified t	22/08/2	2015 Stra AND very	atum Desc atum Desc with occasio d of borehole a	2015 :ription In 1.20 m	ragments	S	Logged By Strikes	Backfill
Remarks Deck to bec Deck Level	1 6.73m -0.275							Chisellin From (m) Water Ad From (m	ng: To (m) dded:	Time (hh:mm)	Water Stri Struck (m) Casing: To (m)	kes: Rose to (m)	Time (min) eter (mm)		rised:
														www.causewayg	eotech.com

Causeway Geotech Ltd Proje				Projec 15-664	;t no. ↓	Project Name:	GDD (Dverv	vater SI				Borehol BHVC	e No. 206	
Method:					Co-orc	ds:	Client:	Irish W	/ater					Sheet 1	of 1
Vibrocore					327429	9.20mE	Client's Rei	oresenta	tive:	Tobin A	VL au			Scale: 1	:50
Plant: Pneumatic	Vibrocore				Groun	d Level:	Datae:	22/08/	2015	22/08/5	0015			Driller: T	С
	T	Casing	Water	Γ	-8.35M	IOD T	Dates.	22/00/	2010	- 22/00/2	2015			Logged By Legend &	':
Depth (m)	Sample / Test	Depth (m)	Depth (m)	Field Rec	ords	Level & Depth			Stra	atum Desc	ription			Water Strikes	Backfill
Depth (m) 0.10 - 0.30 0.40 - 0.70 0.40 - 0.70 0.80 - 1.00 0.80 - 1.00	Sample / Test	Casing Depth (m)	Water Depth (m)	Field Rec	ords	Level & Depth (1.85) -10.20 1.85	Dense grey 1.0m recove	silty fine S. ery due to c	Stra	itum Desc	rription onal shells ple.			Legend & Water Strikes	Backfill
Remarks Deck to bec Deck Level Bottom den chipboard.	d 10.1m 1.77 mod ıse/hard whilst	dippin	g bed l	evel. First att	empt ab	ported on large	e piece of	Chisellin From (m) Water A From (n	ng: To (m) dded:	To (m)	Water Stri Struck (m) Casing: To (m)	ikes: Rose to (m)	Time (min) eter (mm)		vised:
									,					www.causewayg © Causeway G	jeotech.com

Causeway Geotech Ltd				Projec 15-664	t no.	Project Name:	GDD C	Over	water SI				Borehol BHV(e No. :07	
Method:					Co-orc	ls:	Client:	Irish W	/ater					Sheet 1	of 1
Pneumatic	Vibrocore				327728	3.90mE	Client's Rep	resenta	tive	Tobin A	run .IV			Scale: 1	:50
Plant: Vibrocore					242303 Groun	d Level:	Detect	00/00/	2045					Driller: T	A
		Casing	Water		-9.58M	OD	Dates:	22/08/	2015	6 - 22/08/2	015			Logged By	r: DC
Depth (m)	Sample / Test	Depth (m)	Depth (m)	Field Reco	ords	Level & Depth			Str	atum Desc	ription			Water Strikes	Backfill Installs
0.10 - 0.30 0.10 - 0.30	D ES						Dense grey s 1.4m recover	silty fine S. ry due to c	AND lensif	with occasio ication	nal shells.				
0.70 - 0.90 0.70 - 0.90	D ES					(1.70)									
1.20 - 1.40 1.20 - 1.40	D ES					11 00 1 70									
						-11.28 1.70			Ēn	d of borehole at	t 1.70 m				
Remarks	emarks							Chisellin From	ng: To	Time	Water Strike	es: ose to	Time	Last Rev	vised:
Deck to bec Deck Level	ck to bed 9.92m ck Level 0.337 mod							(m)	(m)	(hh:mm)	(m) (n	n)	(min)		
								Water A From (m	i)	To (m)	Casing: To (m)	Diamet	er (mm)		S
1														© Causeway G	eotech Ltd

Causeway Geotech Ltd					Projec 15-664	ct no. 4	F	Project Name:	GDD C	Verv	vater SI				Borehol BHVC	e No. :08	
Method:	()					Co-or	ds:	0	Client:	Irish W	ater					Sheet 1	of 1
						32841 24230	4.40mE 3.10mN	Ċ	Client's Repr	esenta	tive:	Tobin A	rup JV			Scale: 1:	50
Plant: Vibrocore						Groun	nd Level:		Dates:	22/08/2	2015	- 22/08/2	015			Driller: T/	A • DC
		Casing	Water			-15.53	MOD	-	butto.	LLIOON		22,00,2				Logged By Legend &	: DC
Depth (m)	Sample / Test	Depth (m)	Depth (m)	Field R	leco	ords	Level & Dept	th	Croy silty fina	SAND	Stra	atum Desc	ription			Water Strikes	Installs
0.10 - 0.40 0.10 - 0.40	DES						(0.10) -15.63 0.10 (0.30) -15.93 0.40		Grey silty fine Dense grey sil Gravel is roun	SAND Ity gravel ded fine	ly fine to coa	t lo coarse S irse. I of borehole a	SAND with r t ō.40 m	nigh shel	ll content.		
Remarks	16 28m									From (m)	To (m)	Time (hh:mm)	Struck R (m) (r	ose to n)	Time (min)	Last Rev	/ised:
Deck to bed	10.∠8M).754 mod									Water Ad	ided:	To (m)	Casing: To (m)	Diame	ter (mm)	AG	S eotech.com

Causeway Geotech Ltd	Projec 15-664	;t no. ↓	Project GDD Overwater SI	Borehole BHVC	• No. 09
- Method:	Co-orc	ds:	Client: Irish Water	Sheet 1	of 1
Pneumatic Vibrocore	328722	2.00mE		Scale: 1:5	50
Plant:	342297	7.90mN	Client's Representative: Tobin Arup JV	Driller: TA	
Vibrocore	Groun -17.42	d Levei: MOD	Dates: 22/08/2015 - 22/08/2015	Logged By:	DC
Casing Water Depth (m) Sample / Test Depth Depth Field Reco	ords	Level & Depth	Stratum Description	Legend & Water	Backfill Installs
Remarks (m) (m) <		(0.30) -17.72 0.30	Crey gravely fine to coarse SAND with medium to high shell content. Gravel is fine to medium rounded. O.15m Recovery End of borehole at 0.30 m Chiselling: From To Time Struck Rose to Time From To The Struck Rose to Time Time	Last Rev	ised:
Deck to bed 19.63m Deck Level 2.208 mod			(m) (m) (hh:mm) (m) (m) (min)		
Insufficient sample for PSD					
			Water Added: Casing: From (m) To (m) To (m) Diameter (mm)		otech.com

Caus	seway	Geo	otec	h Ltd	Projec	;t no. 1	Project Name:	GDD C	Overv	water SI				Borehol	e No. :10
Method:					Co-ore	ds:	Client:	Irish W	/ater					Sheet 1	of 1
Pneumatic	√ibrocore	_	_		329170	0.90mE	Oliantia Por			Tabin /	N/			Scale: 1:	50
Plant:					242293	3.30mN	Client's Rep	presenta	tive.	IODIN F	Arup J v			Driller: T/	٩
Vibrocore					-20.40	MOD	Dates:	22/08/2	2015	- 22/08/2	2015			Logged By	: DC
Depth (m)	Sample / Test	Casing Depth	Water Depth	Field Reco	ords	Level & Depth	1		Stra	atum Desc	ription	_		Legend & Water	Backfill Installs
Depth (m)	Sample / Test	Depth (m)	Depth (m)		prds	Level & Depth	No Recover	y Chisellin	Stra Enc	atum Desc	water Stri	kes:		Last Rev	/ised:
Deck to bec	1 22.36m							From (m)	To (m)	Time (hh:mm)	Struck (m)	Rose to (m)	Time (min)		iseu.
Deck Level Two attemp	1.958 mod its at this locat	tion													
								Water A	dded:	To (m)	Casing:	Diamo	ter (mm)	AG	S
									.,		10 (11)	Diame		www.causewayg © Causeway G	eotech.com

Caus	seway (Geo	otec	h Ltd	Projec 15-664	t no.	Project Name:	GDD C	Overv	vater SI				Borehole BHVC	e No. 11
Method:					Co-orc	ds:	Client:	Irish W	/ater					Sheet 1	of 1
Pneumatic	/ibrocore				32962	1.00mE	Client's Rep	presenta	tive:	Tobin A	vrup JV			Scale: 1:	50
Plant: Vibrocore					Groun	d Level:	Datas	22/08/2	2015	22/08/2	2015			Driller: TA	
	<u> </u>	Casing	Water		-26.34	MOD	Dates.	22/00/2	2010	- 2210012	015			Logged By: Legend &	DC
Depth (m)	Sample / Test	Depth (m)	Depth (m)	Field Reco	ords	Level & Depth	_		Stra	atum Desc	ription			Water Strikes	Backfin
Remarks						(0.10) -26.44 0.10	<u>No Recover</u>	Y	ng: To	Time	Water Striks	es: Rose to	Time	Last Rev	ised:
Deck to bed	27.25m							(m)	(m)	(hh:mm)	(m) (i	m)	(min)	_	
Two attemp	0.91 ts at this locat	ion													
								Water A From (m	dded: 1)	To (m)	Casing: To (m)	Diame	ter (mm)	AG	S
									ſ	_				www.causewayge	eotech.com



Vibracore BHVC02



Vibracore BHVC03



Vibracore BHVC04



GDD Overwater SI

Report No.: 15-664



Vibracore BHVC05



Vibracore BHVC06



Vibracore BHVC07





Vibracore BHVC08



Vibracore BHVC09



Appendix E Geotechnical laboratory test results



SOIL AND ROCK SAMPLE ANALYSIS LABORATORY TEST REPORT

То:	ABCO
From:	Stephen Watson
	Laboratory Manager
	Causeway Geotech Ltd
Tel:	+44(0)2827666640
E-mail:	stephen.watson@causewaygeotech.com
Date:	14/09/15
Ref:	15-664/

Greater Dublin Drainage Scheme: Offshore SI

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

The samples were delivered to our laboratory in Ballymoney, Co. Antrim on 24/08/15 and tested in accordance with the electronic schedule received on 28/08/15.

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

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

Approved Signatory

Stephen Watson Laboratory Manager



Project Name Greater Dublin Drainage Scheme: Offshore SI

Report Reference. 15-664/1

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

Material tested	Type of test/Properties measured/Range of measurement	Standard specifications	Number of test results included in the report
SOIL	Moisture content - oven drying method	BS 1377-2:1990	40
SOIL	Liquid limit - cone penetrometer	BS 1377-2:1990	17
SOIL	Liquid limit - cone penetrometer - one point	BS 1377-2:1990	17
SOIL	Plastic limit	BS 1377-2:1990	17
SOIL	Plasticity index and liquidity index	BS 1377-2:1990	17
SOIL	Particle size distribution - wet sieving	BS 1377-2:1990	19
SOIL	Particle size distribution - dry sieving	BS 1377-2:1990	19
SOIL	Particle size distribution -sedimentation hydrometer method	BS 1377-2:1990	7
SOIL	Particle density – gas jar	BS 1377-2:1990	18
SOIL	Laboratory vane	BS 1377- 7:1990	1
SOIL	Undrained shear strength – triaxial compression without measurement of pore pressure (loads from 0.12 to 24 kN)	BS 1377- 7:1990	4
SOIL	Shear strength by direct shear	BS1377 : Part 7 : Clause 4 : 1990	4



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ROCK	Point load index	ISRM Commission on Testing Methods. Suggested Method for Determining Point Load Strength 1985	74
ROCK	UCS	ISRM Suggested Methods - Rock Characterization Testing and Monitoring, Ed. E T Brown - 1981	10
ROCK	Porosity/Density using saturation/buoyancy		9
ROCK	Indirect Tensile Strength (by the Brazilian Test)		10
ROCK	Norwegian Abrasion Cutter Steel Test Swedish Brittleness Test Sievers' J Value Test		4
ROCK	Cerchar Abrasivity		4
ROCK	Porosity		4
ROCK	Total Sulfur Content Acid Soluble Sulfate Content Water Soluble Sulfate		4
ROCK	Thin Section Petrography		4
ROCK	X-ray Diffraction		4

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

CA	USE	WAY			Summar	y of C	Clas	sific	ation	n Test	Re	suli	ts	
Project No. 15-	664		Project	Name			GDD	0 Overw	vater SI					
Hole No.	Pof	Sar	mple	Turne	Soil Description	Dens bulk	ity dry	W	Passing 425µm	LL	PL	ΡI	Particle density	Casagrande
	Rei	тор	Dase	туре		Mg/m	n3	%	%	%	%	%	Mg/m3	
BH01	15	2.00		В	Grey slightly silty SAND			24.0	98	28 -1pt	NP		2.63-gj	
BH01	16	3.00		В	Grey slightly silty SAND			24.0	98	29 -1pt	NP			
BH01	18	5.00		в	Grey slightly silty SAND			24.0	90	30 -1pt	NP		2.64-gj	
BH01	21	8.00		В	Grey very gravelly SAND			9.3	56	25 -1pt	NP			
BH01	24	10.00		В	Grey very gravelly SAND			12.0						
BH01	27	12.00		В	Greyish brown gravelly SAND			6.0						
BH01	13	12.90	13.60	В	Brownish grey slightly sandy gravelly CLAY			14.0	70	26 -1pt	15	11	2.63-gj	CL
BH03	4	0.00	1.00	В	Grey brown silty SAND with shell and shell fragments.			22.0						
BH03	5	1.00	2.00	В	Grey silty SAND with shells and shell fragments.			24.0					2.59-gj	
BH03	9	1.20		D	Grey silty fine SAND with shells			24.0						
BH03	10	2.00		D	Grey silty fine SAND with shells			22.0						
BH03	6	2.00	3.00	В	Grey silty SAND with shells and shell fragments.			24.0					2.62-gj	
BH03	11	3.00		D	Grey silty SAND with shells and shell fragments			22.0						
BH03	7	3.00	4.00	В	Grey silty SAND with shells and shell fragments			27.0	97	29 -1pt	NP		2.65-gj	
BH03	12	4.00		D	Grey slightly gravelly sandy SILT with occasional shells.			26.0						
BH03	8	4.00	5.00	В	Grey slightly gravelly sandy SILT with occasional shells.			28.0	64	37 -1pt	NP			
BH03	13	5.00		D	Grey slightly gravelly sandy silty CLAY with occasional shells.			18.0						
BH03	14	5.00	6.00	В	Grey slightly gravelly sandy silty CLAY with occasional shells.			21.0	98	25 -1pt	16	9	2.61-gj	CL
BH03	15	6.00		D	Grey slightly gravelly sandy silty CLAY with occasional shells.			16.0						
BH03	16	6.00	7.00	В	Grey slightly gravelly sandy silty CLAY with occasional shells.			30.0	57	26 -1pt	16	10	2.64-gj	CL
BH03	18	6.40	7.50	В	Grey slightly gravelly sandy silty CLAY with occasional shells.			25.0	78	25 -1pt	16	9		CL
BH03	17	7.00		D	Brown slightly sandy gravelly silty CLAY with occasional limestone and sandstone cobbles.			20.0						
BH03	19	8.00	8.50	В	Brown slightly sandy gravelly silty CLAY with occasional limestone and sandstone cobbles.			7.3	36	21 -1pt	13	8	2.61-gj	CL
BH03	20	8.50		D	Dark grey sandy silty GRAVEL			7.8						
BH05	1	0.00	1.00	В	Grey silty SAND with shells and shell fragments.			24.0	90	29 -1pt	NP		2.62-gj	
BH05	2	2.00	3.00	В	Grey silty SAND with shells and shell fragments.			25.0	99	31 -1pt	NP		2.65-gj	
All tests perfe	ormed	in acco	rdance v	vith BS	S1377:1990 unless specifie	d otherw	ise							-
Key								Date F	Printed		Appr	oved	Ву	Table
Density Linear m	test neasure	ment unles	s :	Liquid I	Limit Particl	e density nall pyknom	neter		17/11/20)15				1
wd - wat	er displ	acement		cas - C	asagrande method gj - ga	s jar								sheet
wi-imn	nersion	in water		1pt - sii	ngle point test						Step	hen.	Watsor	1

CAUSEWAY

Summary of Classification Test Results

-07	GLO	TECH				-								
Project No.	664		Project	Name		_	GDF) Overw	ater SI	_	_	_		
		Sar	nple			Dens	ity	w	Passing	LL	PL	ΡI	Particle	
Hole No.	Ref	Тор	Base	Туре	Soil Description	bulk Ma/m	dry	%	425µm %	%	%	%	density Ma/m3	Casagrande classification
BH05	3	3.10	3.50	В	Grey sandy silty GRAVEL with shells and shell fragments.	Mg/H		12.0	35	30 -1pt	NP		2.65-gj	
BH05	5	6.00	7.00	В	Grey sandy gravelly silty CLAY.			20.0	60	35 -1pt	16	19	2.66-gj	CL/CI
BH08	1	0.00	1.00	В	Grey fine to medium subrounded GRAVEL with shells and shell fragments			6.5					2.65-gj	
BH08	3	1.00		D	Grey fine to medium subrounded GRAVEL with many shells and occasional cobbles.			26.0						
BH08	4	1.50	2.50	В	Grey sandy silty GRAVEL with shells and shell fragments.			15.0					2.64-gj	
BH08	6	2.00		D	Grey slightly sandy fine to medium subangular to subrounded GRAVEL with many shells			9.0						
BH08	8	3.00	3.50	В	Grey sandy fine to coarse subangular to subrounded GRAVEL with high cobble content.			3.7						
BH08	9	4.00	4.50	В	Grey sandy fine to coarse subangular to subrounded GRAVEL with high cobble content.			3.9						
BH08	10	5.00	5.50	в	Grey sandy silty GRAVEL.			7.0					2.65-gj	
BH08	11	6.00		D	Grey sandy fine to coarse subangular to subrounded GRAVEL with high cobble content.			12.0						
BH08	12	6.20	7.20	В	Grey brown sandy silty CLAY.			21.0	98	35 -1pt	19	16	2.64-gj	CL/CI
BH08	13	7.00		D	Grey brown silty CLAY.			6.1						
BH08	14	7.30	7.80	В	Grey brown sandy gravelly silty CLAY.			15.0	62	26 -1pt	15	11	2.68-gj	CL/CI
BH08	15	8.40	8.70	В	Dark grey silty GRAVEL (Possible weathered bedrock.)			0.6						
All tests perfo	ormed	in acco	rdance v	vith BS	1377:1990 unless specified	d otherw	ise							
Кеу								Date F	Printed		Appr	oved	Ву	Table
Density Linear m	test leasure	ment unles	s :	Liquid L 4pt con	.imit Particle e unless : sp - sm	e density nall pyknom	neter		7/11/20	15				2
wd - wat wi - imm	er displation	acement in water		cas - Ca 1pt - sir	asagrande method gj - gas	sjar								sheet 2
vvi - 11111				10 10										2





•	CA	USFW	YAY		DADT		חוכדי	יםו			Job Ref	:	15-664
		-GEOT	ECH		FANI		וונוס				Borehole/Pit No.		BH01
Site	e Nam	ne		GDD Overwa	iter Sl						Sample No.		13
Soi	l Deso	cription		Brownish grey	slightly sa	ndy gravelly (CLAY				Depth, m		12.90
Spe	ecime	en Refer	ence	4		Specimer Depth	1			m	Sample Type		В
Tes	st Me	thod		BS1377:Part 2	:1990, clau	uses 9.2 and 9).5				KeyLAB ID	Caus2	0151104213
	_	<u></u>		SILT			SA	ND			GRAVEL	00001 50	
	100		Fin	e Medium	Coars	e Fine	Mee	dium	Coarse	e Fine	Medium Coarse		BOULDERS
	90												
	80												
	70												
% Di	60												
Jassir	50												
itage I	50												
Percer	40												
ш.	30												
	20												
	10												
	0 0.0	001		0.01		0.1			1		10	100	1000
								Par	ticle Size	mm			
	—		Sie	ving		Sedim	entation						
	Par	rticle Siz	e mm	% Passing	Part	icle Size mm	% F	Passin	g	Dry N	Aass of sample, g		5012
	⊢	125		100		0.0630		58		Sample Prop	oortions	%	dry mass
		90		100		0.0353		48		Cobbles			0
		75		100		0.0189		37		Gravel			24
	_	63 50		100		0.0107		29		Sand			18
		37.5		95		0.0031		19		Fines < 0.063	mm		58
		28 20		94 91						Grading Ana	lysis		
		14		83						D100	mm		
	⊢	10		82						D60	mm		0.0865
	⊢	6.3		82						D30	mm		0.0115
	⊢	5 2 2 ⊑		81 77						Uniformity C	oefficient mm		
	⊢	3.55 2		76						Curvature Co	pefficient		
	<u> </u>	1.18		75								1	
	⊢	0.6		72	Par	ticle density	(assume	ed)		Remarks			
		0.425	5	71		1.40	Mg/m3	_		Preparation and	testing in accordance with BS137	7 unless noted belo	w
		0.3		68									
		0.212		66									
		0.15		64									
		0.063	3	58									
											Chaot printed		
				Appro	ved					:	Sheet printea		Fig 3
				Stephen.V	Vatson					17,	/11/2015 09:28		Sheet

	CALISEW	AY			וב נו ז ר ה					Job Ref		:	15-664	
	GEOTEG	СН		PARIIC	LE SIZE D	13 I K	IBUI	ION		Borehole,	/Pit No.		BH03	
Sit	e Name		GDD Overwate	er Sl						Sample N	lo.		4	
So	il Description		Grey brown silty	SAND wit	h shell and she	ell fragi	ments.			Depth, m			0.00	
Sp	ecimen Referer	nce	2		Specimen Depth				m	Sample T	уре		В	
Te	st Method		BS1377:Part 2:1	990, clause	e 9.2					KeyLAB II	D	Caus	201508293	
	CLAY	Ein	SILT	Coorso	Fino	SAI	ND	Coarso	Fino	GRAVEL	Coorso	COBBLES	BOULDERS	
	100			Coarse	Fille	Ivieu			Fille					
	90				_									
	00													
	80					ľ –								
%	70	-												
° gn	60													
assi														
ge P	50													
enta	40	_			/									
Perc	20													
	30													
	20													+
	10													1
		Sie	ving		Sediment	ation	Particl	e Size	mm					
	Particle Size	mm	% Passing	Partic	e Size mm	% Pa	assing		Dry N	vlass of sam	nple, g		2059	
	125		100				U		Sample Prov	ortions		%	dry mass	
	90		100						Cobbles			,,,	0	
	75		100						Gravel				12	
	63 50		100	_					Sand				83	
	37.5		100						Fines < 0.063	Smm			5	
	28		100						Creative			·		
	14		100 97						D100	aiysis	mm			
	10		96						D60		mm		0.172	
	6.3		94					4	D30		mm		0.106	
	5 3.35		93 91						Uniformity (Coefficient	mm		2.5	
	2		88						Curvature Co	pefficient			0.93	
	1.18		86						Descard					
	0.6		84 83						Kemarks Preparation and	testing in accord	lance with BS137	7 unless noted belo	w	
	0.3		82					1						
	0.212		80											
	0.15		47 5	-										
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	CALISEN									Job Ref			15-664	
	GEOT	ECH		PARTIC		JJIKI	вопо	'IN		Borehole	/Pit No.		BH03	
Sit	e Name		GDD Overwate	er Sl						Sample N	lo.		5	
So	il Description		Grey silty SAND	with shells	and shell frag	gments.				Depth, m			1.00	
Sp	ecimen Refer	ence	3		Specimen Depth				m	Sample T	уре		В	
Те	st Method		BS1377:Part 2:1	990, clause	9.2					KeyLAB II	D	Caus	5201508294	
	CLAY	Fir	SILT ne Medium	Coarse	Fine	SAN Mediu	D ım Co	oarse	Fine	GRAVEL Medium	Coarse	COBBLES	BOULDERS	
	100					[
	90 -					4								-
	80													-
	70													
%	10													
ssinç	60													1
e Pas	50					_								
ntage	40				1									
ercei	40													
۵.	30													
	20													-
	10													
	0													
		Sie	eving		Sedimen	tation			Dry N	Mass of san	nple, g		7405	
	Particle Siz	e mm	% Passing	Particle	e Size mm	% Pas	ssing							
	125		100						Sample Prop	portions		%	dry mass	
	90 75		100						Cobbles Gravel				0	
	63		100						Sand				89	
	50 27 5		100										11	
	28		100	-					11163 \0.003	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		ļ	11	
	20		100						Grading Ana	alysis				
	14		100						D100 D60		mm		0.114	
	6.3		100						D30		mm		0.0791	
	5		100						D10		mm			
	3.35		100						Uniformity C	oetticient				
	1.18		100						Sal value of			1		
	0.6		100	_					Remarks	tostin - '-	lance with post-	7 unless and 11		
	0.425)	100	_					Preparation and	testing in accord	ance with BS137	v unless noted bel	uw	
	0.212	2	99											
	0.15)	83											
	0.063	5	11	I				l						
			Approve	d					:	Sheet printe	d		Fig	5
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	CALISEWA	Y			יור נוזר ר	лст	וחוח			Job Ref		:	15-664	
-58	GEOTEC	СН		PARII	LE SIZE L	121	RIBU	TION		Borehole	/Pit No.		BH03	
Sit	e Name		GDD Overwate	er SI						Sample N	lo.		6	
So	il Description		Grey silty SAND	with shells	and shell frag	gmen	ts.			Depth, m			2.00	
Sp	ecimen Referen	ice	3		Specimen Depth				m	Sample T	уре		В	
Te	st Method		BS1377:Part 2:1	990, claus	e 9.2					KeyLAB II	D	Caus	201508295	
	CLAY	Fin	SILT e Medium	Coarse	Fine	S	AND	Coarse	Fine	GRAVEL Medium	Coarse	COBBLES	BOULDERS	
	100													
	90					[
	80													
	00													
%	70				////////									
ing	60	_												
Pass	50													
age	30													
rcent	40													
Pel	30	_												-
	20													
	20													
	10	_												-
	0													
		Sie	ving	_	Sedimen	tatio	n		Dry N	Mass of san	nple, g		8652	
	Particle Size	mm	% Passing	Partic	le Size mm	%	Passin	g						
	125		100						Sample Prop	portions		%	dry mass	
	90 75		100						Cobbles Gravel				0	
	63		100						Sand				91	
	50		100						Fines (0.000					
	37.5		100	_					rines <0.063	SINITI		1	Э	
	20		100						Grading Ana	alysis				
	14		100	_					D100		mm	-	0 121	
	6.3		100						D30		mm mm		0.0827	
	5		100						D10		mm		0.0641	
	3.35		100 99	_					Uniformity C	Coefficient			1.9	
	1.18		99							Genicient		1	0.00	
	0.6		98						Remarks					
	0.425		98 98	_					Preparation and	testing in accord	iance with BS137	/ unless noted belo	w	
	0.212		97											
	0.15		77											
	0.063		9											
			Approve	d					:	Sheet printe	d		Fig	6
									17	/11/2015 09	9:28		Shart	
													Sneet	

	CAUS	EWAY			E CI7E	סדפור		τιων		Job Ref			15-664	
	G	EOTECH		PARIIC			100			Borehole	/Pit No.		BH03	
Sit	e Name		GDD Overwat	er SI						Sample N	lo.		7	
Soi	il Descript	ion	Grey silty SAND	with shells	and shell fra	gments				Depth, m			3.00	
Sp	ecimen Re	eference	4		Specimen Depth				m	Sample T	уре		В	
Te	st Method	1	BS1377:Part 2:1	990, clause	s 9.2 and 9.5	5				KeyLAB II	D	Caus	201508296	
	CLA	AY Fir	SILT ne Medium	Coarse	Fine	SAN Medi	ND ium	Coarse	Fine	GRAVEL Medium	Coarse	COBBLES	BOULDERS	
	100						+-+							
	90 -													
	80													
	70				/	_								
% ɓi	60													
assir	00													
ge P.	50													
enta	40	_												
Perc	20													
	30													
	20			/	4									
	10													
	[Sie	eving		Sedimer	Itation	Parti	cle Size	mm	Ass of com	anla a		6002	
	Particle	Size mm	% Passing	Particle	e Size mm	% Pa	assing		Dryn		ipie, g		6083	
	1	25	100	0.	0630		24		Sample Pro	portions		%	dry mass	
		90	100	0.	0358	-	10		Cobbles				0	
		75 63	100	0. 0	0188 0103		5 3		Gravel Sand			<u> </u>	2	
		50	100	0.	0060		2							
	3	7.5	100	0.	0029		0		Fines < 0.063	3mm			24	
		20	100						Grading Ana	alysis				
		14	100						D100		mm		0.463	
		10 5.3	100	_					D60 D30		mm		0.104	
	È	5	100						D10		mm		0.0353	
	3	.35	99						Uniformity (Coefficient			2.9	
	1	2 18	98 98						Curvature Co	oemicient		L	1.3	
		0.6	97	Partic	e density	assume	d)		Remarks					
	0.	425	97	1	1.50	Mg/m3			Preparation and	testing in accord	lance with BS1377	unless noted belo	w	
	0.	.3	97											
	0	.15	87											
	0.	063	24											
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	GE	OTECH						/11		Borehole,	/Pit No.		BH03	
Sit	e Name		GDD Overwat	er Sl						Sample N	0.		14	
So	il Descriptio	on	Grey slightly gra	avelly sandy	silty CLAY w	vith occasio	nal shel	lls.		Depth, m			5.00	
Sp	ecimen Ref	erence	4		Specimen Depth				m	Sample T	уре		В	
Te	st Method		BS1377:Part 2:2	1990, clause	s 9.2 and 9.	5				KeyLAB II)	Caus	2015082913	
	CLA	Y Fir	SILT Medium	Coarse	Fine	SAND		oarse	Fine	GRAVEL	Coarse	COBBLES	BOULDERS	
	100													
	90					_								
	80	_												
	70				/									
g %														
assinį	60													
ge Pa	50													
centa	40	_												
Perc	30													
	20													
	20													
	10													
			0.01							10		400		
		Sie	eving		Sedime	Pa		Jze	mm					
	Particle	Size mm	% Passing	Particle	e Size mm	% Pass	ing	1	Dry N	VIdSS OF Sdff	ipie, g		6770	
	12	25	100	0.	0575	75		1	Sample Prop	oortions		%	dry mass	
	9	0	100	0.	0322	55		-	Cobbles				0	
	6	3	100	0.	0097	31		ł	Sand				23	
	5	0	100	0.	0057	22		ł	Fines <0.062				75	
	2	8	98			13		1	1 1103 \0.003				, ,	
	2	0	98 98					ł	Grading Ana	alysis	mm			
	1	0	98					İ	D60		mm		0.0368	
	6	.3	98					ł	D30		mm		0.00915	
	3.	35	98					ł	Uniformity C	Coefficient	mm			
	1	2	98					ļ	Curvature Co	pefficient				
	0.	.6	98	Partic	e density	(assumed)		ł	Remarks					
	0.4	25	98		1.50	Mg/m3		ļ	Preparation and	testing in accord	ance with BS137	77 unless noted bel	ow	
	0.2	.3	98 97											
	0.	15	96											
	0.0	063	75					l						
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		GEOT	ECH		PARI			IS I KIL	501				Во	orehole	e/Pit N	0.			BH	103	
Sit	e Nan	ne		GDD Over	water SI								Sa	imple I	No.				1	.9	
So	il Deso	cription		Brown sligh sandstone	ntly sandy gra cobbles.	avelly silt	y CLAY v	vith occas	siona	limest	tone ar	nd	De	epth, n	n				8.	00	
Sp	ecime	n Refer	ence		4	Spe Dep	cimen th					m	Sa	mple 1	Гуре					В	
Те	st Me	thod		BS1377:Pai	rt 2:1990, cla	uses 9.2	and 9.5	·					Ke	eyLAB I	D			Ca	aus201	.508291	8
	_	CLAY		SIL	T			SAND)				GR	AVEL			COE	BLES	В	OULDERS	
	100	1	Fin	ie Medi	um Coar	se	Fine	Mediur	n	Coars	e	Fine	Me	edium	Co	arse		1			
	90																				
	80	ļ																			
` 0	70																				
ssing %	60											_	_	-/	r						
ge Pas	50												_								
rcenta	40										_								$\left \right $		
Ре	30																				
	20																				
	10		•																		
	0	L		0.0	1		0.1			<u> </u>			1	0			1 <u> </u> 1(, <u> </u>			<u> </u>
			Sie	ving			ediment	P	articl	e Size	mm	n					–				
	Par	ticle Siz	e mm	% Pass	ing Par	ticle Size	mm	% Pass	sing			Dry	Mass	of sar	mple,	g			91	149	
		125		100		0.0575		24			Sai	mple Pro	oporti	ons					% dr	y mass	
		90 75		74		0.0315		19			Col	bbles							2	26	
	⊢	63		74		0.00170		11			Sar	nd							2	20	
		50		74		0.0057		8											-		
	⊢	37.5 28		67		0.0028		б			FIN	ies <0.06	53MM						2	24	
		20		65							Gra	ading Ar	nalysis								
	\vdash	14		55	∥						D1	00				mm			1	25	
	⊢	6.3		50						-	D3	0				mm			0.1	174	
		5		48							D1	0				mm			0.0	0785	
		3.35		46							Un	iformity	Coeffi	cient					21	L00	
		2		43							Cu	rvature	Coeffic	ient					0.	.23	
	┣	1.18		40		rticlo de	acity (-	ccumod)		_	Po	marke									
	\vdash	0.6	5	3/	Pa	1.50	isity (a M	issumed) lg/m3			Prep	paration an	nd testing	g in accor	dance wi	ith BS13	77 unle	ess noted	below		
	\vdash	0.3		34				J,		-											
		0.212	2	32																	
		0.15		29																	
		0.063	3	24																	
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				App	proved								Jilee	c printe	u					Fig	9
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- 28	GEOTECH	4		PARTI	CLE SIZE L	JIST K	IBUI	ION		Borehole	/Pit No.		BH05	
Sit	e Name	GDD	Overwate	er Sl						Sample N	10.		1	
So	il Description	Grey	silty SAND	with shell	s and shell fra	gments.				Depth, m	1		0.00	
Sp	ecimen Referenc	e	4		Specimen Depth				m	Sample T	уре		В	
Te	st Method	BS13	877:Part 2:1	990, claus	se 9.2					KeyLAB II	D	Caus	\$201509013	
	CLAY	Fine	SILT	Coarse	e Fine	SAI Med	ND	Coarse	Fine	GRAVEL Medium	Coarse	COBBLES	BOULDERS	
	100									••				
	90													
	80													
%	70													
sing	60				/									
e Pas	50													
itage														
ercer	40													
Å	30													
	20													
	10													
	0													Щ
		Sieving		_	Sedimen	tation	Fartic		Dry I	Mass of san	nple, g		1723	
	Particle Size m	im s	% Passing	Partio	cle Size mm	% Pa	assing							
	125		100						Sample Pro	portions		%	dry mass	
	90 75	_	100					_	Cobbles				0	
	63		100						Sand				85	
	50		100										4.6	
	37.5		100	-∦					Fines < 0.063	smm		ļ	10	
	20		99						Grading Ana	alysis				
	14		99					_	D100		mm		0.115	
	6.3	_	98					\dashv	D30		mm mm	+	0.0799	
	5		98						D10		mm			
	3.35		97 05	_⊩				_	Uniformity (Coefficient		+		
	1.18		93							Jenncient		1		
	0.6		91		I				Remarks					
	0.425		91 00	_⊩				_	Preparation and	testing in accord	dance with BS137	7 unless noted belo	ow	
	0.3		88											
	0.15		82											
	0.063		11											
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	GEOTE	СН		PARTI	CLE SIZE	וכוס	RIBU	JIIC	JIN		Borehole	e/Pit No.		BH05	
Site	e Name		GDD Overwate	er Sl							Sample N	No.		2	
Soi	l Description		Grey silty SAND	with shel	ls and shell fra	agmer	nts.				Depth, m	1		2.00	
Spe	ecimen Refere	nce	4		Specimen Depth					m	Sample T	Туре		В	
Tes	st Method		BS1377:Part 2:1	990, clau	se 9.2						KeyLAB I	D	Caus	201509014	
	CLAY	Fin	SILT e Medium	Coarse	e Fine	S M	SAND	C	oarse	Fine	GRAVEL	Coarse	COBBLES	BOULDERS	
	100					- IV									
	90 -									_					
	80 -														
	70														
% bi	60														
assin	60														
age P	50														
rcenta	40														
Ре	30	_													
	20				/					_					
	10														
	0		0.01		0.1				1		10		100		 1000
							Par	ticle S	Size	mm					
		Sie	ving	-11	Sedime	ntatio	n		1						
	Particle Size	mm	% Passing	Parti	cle Size mm	%	6 Passin	g	1	Dry N	Aass of sar	nple, g		2799	
	125		100			-		0	1	Sample Prop	oortions		%	dry mass	
	90		100							Cobbles				0	
	63		100							Gravel Sand				93	
	50		100]	Einer 20.002	mm			7	
	28		100						1					/	
	20		100							Grading Ana	lysis				
	14		100							D60		mm mm		0.109	
	6.3		100]	D30		mm		0.0799	
	5 3 25		100						-	D10	`oefficient	mm		0.065	
	2		100							Curvature Co	pefficient		1	0.9	
	1.18		100						1						
	0.6		99	_						Remarks	testing in accord	dance with PC12	77 unless noted bal	ow	
	0.425		99						1	ricparation and	cesting in accord	aance with D313	, amess noted bei		
	0.212		97												
	0.15		91												
	0.063		7						J						
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										Job Ref		15-664	
-		GEOT	ECH		PARTI	LLE SIZE L	אואנ	JIION		Borehole/Pit No.		BH05	
Sit	e Na	ame		GDD Overwat	er Sl					Sample No.		3	
So	il De	escription		Grey sandy silty	GRAVEL v	vith shells and	shell fragm	ents.		Depth, m		3.10	
Sp	ecin	nen Refere	ence	4		Specimen Depth			m	Sample Type		В	
Те	st N	1ethod		BS1377:Part 2:1	1990, claus	se 9.2	÷			KeyLAB ID	Caus	201509015	
		CLAY	Fir	SILT Ie Medium	Coarse	e Fine	SAND Medium	Coarse	Fine	GRAVEL Medium Coarse	- COBBLES	BOULDERS	
	100)											
	90	D											
	80	л								/			
	70												
% (10												
Issinç	60) 											
je Pa	50	o											
entaç	40	,							/				
Perce	20												
	30												
	20) 											
	10	o											
	(, L											<u> </u>
			Sie	ving		Sedimen	Par		mm Dry N	Aass of sample, g		5432	
	Р	article Siz	e mm	% Passing	Partie	cle Size mm	% Passin	g	,			0.01	
		125		100					Sample Prop	portions	%	dry mass	
	┝	90 75		100					Cobbles Gravel			0 55	
		63		100					Sand			42	
	\vdash	50 37.5		100 89					Fines < 0.063	mm		2	
	E	28		88								-	
	┝	20		83 75					Grading Ana	Ilysis	<u></u>		
	\vdash	14		66					D60		n	6.71	
		6.3		59					D30	mi	n	0.178	
	\vdash	5 3.35		56 51	_∥				D10 Uniformity (mi Coefficient	n	0.0824 81	
	L	2		45					Curvature Co	pefficient		0.057	
	F	1.18		40					Pomarka				
	\vdash	0.6	;	35	$-\parallel$				Preparation and	testing in accordance with BS1	.377 unless noted bel	ow	
		0.3		34									
	\vdash	0.212		33	_								
	L	0.15		27									
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•		-GEOT	ECH		rakii		אופוס	UDU			Borehole/Pit No.		BH05		
Site	e Nam	e		GDD Overwat	er SI						Sample No.		5		
Soi	Soil Description Grey sandy gravelly					CLAY.					Depth, m		6.00		
Spe	Specimen Reference 4					Specimen Depth				m	Sample Type	В			
Tes	Test Method BS1377:P			BS1377:Part 2:1	990, clau	ses 9.2 and 9	.5				KeyLAB ID	Caus	Caus201509017		
	_	CLAY		SILT			SAN	ND			GRAVEL	COBBLES	BOULDERS		
	100 -		Fin	e Medium	Coarse		Med		Coarse	Fine	Medium Coarse				
	90 -										/			-	
	80 -										/				
\ 0	70 -													-	
sing %	60 -													-	
je Pas	50 -													-	
centaç	40 -													-	
Per	30 -													-	
	20 -													-	
	10 -													-	
	0 -			0.01		01			1		10	100	1		
	010							Partic	le Size	mm					
			Sie	ving		Sedime	entation			Day	Asso of completing	2144			
	Part	ticle Size	e mm	% Passing	Parti	cle Size mm	% Pa	assing		Dry N	viass of sample, g				
		125		100		0.0559	4	49		Sample Prop	portions	%			
		90 75		100		0.0303	2	44 38		Gravel			37		
		63		100	_	0.0092		30		Sand			14		
		37.5		84 76	_	0.0054		25 18		Fines < 0.063	mm		49		
		28		73							l				
		20 14		71						D100	niysis mm				
		10		69						D60	mm		0.357		
		6.3		66						D30	mm	().00932		
		2 25		65 64					_	D10	mm				
	\vdash	2		64						Curvature Co	pefficient				
		1.18		63											
		0.6 61		Part	icle density	(assume	d)		Remarks						
		0.425		61	_	1.50	Mg/m3			Preparation and	testing in accordance with BS137	7 unless noted belo	w		
		0.3		59											
	⊢	0.212		55											
		0.063		49											
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	GEC	DTECH		PARTIC	LE SIZE D	US I KIBU	TION		Borehole/P	Pit No.		BH08	
Site	e Name		GDD Overwat	er SI					Sample No.			1	
Soi	I Description	n	Grey fine to me	dium subro	unded GRAVE	EL with shells	s and shell fr	agments.	Depth, m			0.00	
Spe	ecimen Refe	erence	3		Specimen Depth			m	Sample Typ	De		В	
Tes	Test Method BS1377:Part 2:199				9.2				KeyLAB ID		Caus2015082939		
	CLAY		SILT Medium	Coarse	Fine	SAND	Coarse	Fine	GRAVEL	Coarse	COBBLES BOULDERS		
	100								Medium				
	90												
	80									/			
	00												
%	70												
ssing	60												
e Pas	50												_
ntag∈	40												
erce	40												
Δ.	30												
	20												
	10												
						Part	icle Size r	nm					
		Sie	eving		Sediment	tation		Dry N	Mass of sample, g		8535		
	Particle S	ize mm	% Passing	Particl	Particle Size mm		3						
	12	5	100 100					Sample Proj Cobbles	portions		%	dry mass 0	
	75	6	100					Gravel				59	
	63 50)	100 89					Sand				40	
	37.	5	89					Fines < 0.063	3mm			1	
	28	}	84					Grading Area	alveie				
	14	,	78					D100	219515	mm			
	10)	76	_				D60		mm		3.02	
	6.3	3	73 71					D30 D10		mm mm		1.44 0.233	
	3.3	5	65					Uniformity (Coefficient			13	
	2	•	41		[[Curvature Co	oefficient			2.9	
	0.6	0 0	15	-				Remarks					
	0.42	25	14]				Preparation and	testing in accordan	nce with BS1377	unless noted bel	ow	
	0.3	3 L2	12 9										
	0.1	5	4										
	0.06	53	1										
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	GE	ОТЕСН			PARIIC	LE SIZE I		UTION		Borehole/Pit No.		BH08	
Site	e Name		GDD	O Overwate	er Sl					Sample No.		4	
Soi	l Descriptio	on	Grey	y sandy silty	GRAVEL w	ith shells and	I shell fragm	ents.		Depth, m		1.50	
Spe	ecimen Ref	erence		4		Specimen Depth			m	Sample Type		В	
Tes	Test Method BS1377:Part 2:2					9.2				KeyLAB ID	Caus	2015082942	
	CLAY			SILT Medium	Coarse	Fine	SAND Medium	Coarse	Fine	GRAVEL Medium Coarse	COBBLES	BOULDERS	
	100												
	90					_							
	80	_				_				F			
	70												
g %													
ssinę	60												
е Ра	50					_	_						
ntag	40												
erce													
ш	30												
	20					_							
	10 -						/						
	·	Si	eving			Sedimer	Par	rticle Size	mm	·	0500		
	Particle S	Size mm	Ť	% Passing		Particle Size mm		% Passing		Mass of sample, g		8599	
	12	25	-	100	_				Sample Pro	portions	%		
	9	0		100					Cobbles		,	0	
	7	5	-	100	_				Gravel			38	
	5	0	╀	100					Sanu			00	
	37	.5		99					Fines < 0.063	3mm		2	
	2	8 0	╉	99 97				— I	Grading Ana	alysis			
	1	4		91					D100	mn	1		
	1	0	+	88					D60	mn	1	1.81	
	<u>ь</u>	.s	╉	81					D10	mn mn	1	0.332	
	3.3	35		76					Uniformity (Coefficient		12	
	1	2	-	62 50				I	Curvature C	oefficient		0.4	
	0.	.6	+	38					Remarks				
	0.4	25		34					Preparation and	testing in accordance with BS13	77 unless noted belo	w	
	0.	3	+	29									
	0.2	15		9									
	0.0	63		2									
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		-GEOTECH					וכוס	RIDC			Borehole/Pit No.		BH08	
Sit	e Name		GI	DD Overwate	er SI						Sample No.		10	
So	il Descri	ption	Gr	ey sandy silty	GRAVEL.						Depth, m		5.00	
Sp	Specimen Reference			4		Specimen Depth				m	Sample Type		В	
Te	Test Method			1377:Part 2:19	990, claus	se 9.2					KeyLAB ID	Caus	2015082948	
	С		ine	SILT Medium	Coarse	e Fine	S M	SAND edium	Coarse	Fine	GRAVEL Medium Coarse	COBBLES BOULDERS		
	100										/			
	90 -													
	80 -													-
	70										/			-
% bu	60 -													
assil														
age F	50													
rcent	40 -													
Реі	30 -									/				
	20													
	20													
	10 -						1							
	0	1		0.01					1		10	100		
		S	ievin	g		Sedime	entatio	Part		Dry Mass of sample g				
	Partic	cle Size mr	n	% Passing	Partic	Particle Size mm		Passin	g	Diyi	hass of sumple, g		10221	
		125		100						Sample Prop	portions	%	dry mass	
		90 75	_	100	_					Cobbles Gravel			0 67	
		63		100						Sand			33	
		50 37 5	+	98 91						Fines <0 062		<u> </u>	1	
		28		89								I	<u> </u>	
		20		82						Grading Ana	alysis			
		14	+	65 61	_					D100	mm mm	+	9.71	
		6.3		52						D30	mm		1.4	
		5	+	49						D10	mm		0.3	
		2	+	33						Curvature Co	pefficient		0.67	
		1.18		28										
		0.6	+	23						Remarks	testing in accordance with RS127	7 unless noted belo	ow	
		0.3		10										
		0.212		3										
	╞	0.15	╋	1 1	-									
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	GEOTECH		ARTICLE SIZE	וסואוסו			Borehole	/Pit No.		BH08	
Sit	e Name	GDD Overwater	r Sl				Sample N	0.		12	
So	il Description	Grey brown sand	y silty CLAY.				Depth, m			6.20	
Sp	ecimen Reference	4	Specimen Depth			m	Sample Type			В	
Те	st Method	BS1377:Part 2:19	90, clauses 9.2 and 9.	5			KeyLAB II)	Caus	2015082950	
	CLAY	SILT ne Medium	Coarse Fine	SAND Medium	Coarse	Fine	GRAVEL Medium	Coarse	COBBLES BOULDERS		
	100		,								
	90										
	80			_							
	70										
%	10										
ssing	60										+
Pas	50			_							
itage											
srcen	40										
Å	30			_							
	20										
	20										
	10										
	0										Ц
	Sie	ving	Sedime	Par	rticle Size	mm			4412		
	Particle Size mm	% Passing	Particle Size mm	% Passir	ng	5171		1610) 8			
	125	100	0.0567	94		Sample Prop	ortions		%	dry mass	
	90	100	0.0309	81		Cobbles				0	
	63	100	0.0166	65 52		Gravel Sand			}	5	
	50	100	0.0055	42						-	
	37.5	100	0.0027	31		Fines < 0.063	mm			94	
	28	100	╢───┤			Grading Ana	lysis				
	14	100				D100	-	mm			
	10	100	┨─────┤			D60		mm		0.0131	
	6.3 5	100	╢───┤			D30 D10		mm			
	3.35	100				Uniformity C	Coefficient				
	2	100	┨─────┤			Curvature Co	pefficient				
	0.6	99	Particle densitv	(assumed)		Remarks					
	0.425	98	1.50	Mg/m3		Preparation and	testing in accord	ance with BS1377	unless noted belo	w	
	0.3	97									
	0.212	97 97	╢								
	0.063	94	1								
		Approved	1				Sheet printe	d		Fig	17
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	CA	USEW	AY .				ידאח	פופי	ידו	1		Job Ref			15-664		
	/	-GEOTEC	СН		FANIN		DIST		5110			Borehol	e/Pit No.		BH08		
Sit	e Nam	e		GDD Overwate	er Sl							Sample	Sample No.		14		
So	Soil Description Grey brown sandy					y silty CLAY.						Depth, i	Depth, m		7.30		
Sp	Specimen Reference								m	Sample	Туре		В				
Те	st Met	hod		BS1377:Part 2:1	990, claus	es 9.2 and 9.	.5					KeyLAB	ID	Caus	Caus2015082952		
	CLAY			SILT	1		S/	AND				GRAVEL		COBBLES			
	100 -		Fin	e Medium	Coarse	Fine	Me	dium	C	oarse	Fine	Medium	Coarse				
	00																
	90 -																
	80 -																
%	70 -		-														
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Pass	50																
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	0.0	001		0.01		0.1		Par	ticle S	1 Size	mm	10		100	1	1000	
				_						1							
			Sie	ving		Sedime	ntation	on			Dry Mass of sample, g						
	Part	ticle Size	mm	% Passing	Partic	le Size mm	%	Passir	ıg								
		125 90		100 100	(0.0575		49 39			Sample Pro	oportions		% dry mass 0			
		75		100	(0.0170		30			Gravel	Gravel			34		
		63 50		100 97	().0095).0056		24 20			Sand				17		
		37.5		95).0028		14			Fines < 0.06	i3mm			49		
		28		90 85							Grading Ar	alveic					
		14		63 77						ł	D100	1017313	mm				
		10		72							D60		mm		0.148		
		6.3 5		69 68	-∦					ł	D30 D10		mm mm	-	0.0168		
		3.35		67						1	Uniformity	Coefficient					
		2		66						ł	Curvature (Coefficient					
		0.6		65 63	Parti	cle density	(assum	ed)		ł	Remarks						
	U.6 63 0.425 63				1.50	Mg/m3	}			Preparation an	d testing in acco	rdance with BS137	7 unless noted belo	DW			
		0.3		62													
		0.212		61 60													
		0.063		49]							
												Shoot	od		1		
				Approve	d							sneet print	.eu		Fig	18	
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1															Sneet		
PARTICLE SIZE UIS INBUILTON Recorded/PR No. BH08 Stre Hame 600 Overwater SI Sample No. 15 Sail Docurighton Dut grey ally GRAVEL (Possible weathered bedrack.) Depth, n 8.40 Specimen Reference 4 Specimen Bedramic m Sample No. 15 Sail Docurighton Dut grey ally GRAVEL (Possible weathered bedrack.) Depth, n 8.40 Guillowing Specimen Reference 4 Specimen Reference 8 Specimen Reference 8 Feature Specimen Reference Reference 8 CLAV Trie SMED Cases Trin Maduum <		CALISEN			DADTI					Job Ref	:	15-664					
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Site Name GDD Overwrater SI Sample No. 15 Sold Description Dark grey ally GRAVEL (Possible weathered bedrock.) Depth, m 8.40 Specimen Reference 4 Specimen Depth m Sample Noc B Text Method \$1377.9Hr12.1990, daux 8.2 KeyrA& ID Counce Distance Counce Distance B 10 10 10 10 Counce Distance ID		GEOT	ECH		PARTI		DISTRI	BUTION		Borehole/Pit No.		BH08					
Sol Description Lark grey sity GRUPTL (Possible weathered betrick.) Deptit, n S.40 Spectrum Reference A Spectrum Reference N Sample Type B Test Method SS33771Priz 21990, daus 9.2 Key AB ID Caus2015082953 Caus2015082953 Variation Reference SS33771Priz 21990, daus 9.2 Key AB ID Caus2015082953 Caus2015082953 Variation Reference SS3371Priz 21990, daus 9.2 Key AB ID Caus2015082953 Caus2015082953 Variation Reference SS3371Priz 21990, daus 9.2 Key AB ID Caus2015082953 Caus2015082953 Variation Reference SS3371Priz 21990, daus 9.2 Key AB ID Caus2015082953 Caus2015082953 Variation Reference Caus2015082953 Reference Caus2015082953 Reference Caus2015082953 Variation Reference SS3771Priz 21990, daus 9.2 Key AB ID Caus2015082953 Reference R	Site	e Name		GDD Overwat	er SI					Sample No.		15					
Spectmen Reference 4 Spectmen pupp m Sumple Type B Test Method B1377-Part 2-1290, daues 9.2 KoyLAB ID Caus2015082953 CLAV Find Modum Cause Find Modum Cause Count is Counces 100 Find Modum Cause Find Modum Cause Counces Counces 20 Find Modum Cause Find Modum Cause Counces Counces 20 Find Modum Cause Find Modum Cause Counces Counces 20 Find Modum Find Modum Cause Find Modum Cause Find Find <td< td=""><td>Soi</td><td>l Description</td><td></td><td>Dark grey silty G</td><td>GRAVEL (P</td><td>ossible weath</td><td>ered bedro</td><td>ock.)</td><td></td><td>Depth, m</td><td></td><td>8.40</td><td></td></td<>	Soi	l Description		Dark grey silty G	GRAVEL (P	ossible weath	ered bedro	ock.)		Depth, m		8.40					
Test Method IS1377.94rt 2:1390, clause 9.2 ReyLAB ID Cau2015082853 0 Image: Method SAND Come is an operation of the second of the secon	Spe	ecimen Refere	ence	4		Specimen Depth			m	Sample Type		В					
CLAN SILT Castre Fine Medium Fine Medium Castre Fine Medium Fine	Tes	st Method		BS1377:Part 2:1	.990, claus	se 9.2				KeyLAB ID	Caus	Caus2015082953					
Steving <		CLAY	Fin	SILT Medium	Coarse	Fine	SANE) m Coarse	Fine	GRAVEL Medium Coarse	COBBLES	BOULDERS					
Second Second<		100															
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Induce size min Arrassing For dee size min Arrassing 125 100		Particle Size	9 mm	% Passing	Parti	cle Size mm	% Pag	sing	Dry N	Mass of sample, g		9343					
125 100 50 69 0 63 100 0 0 63 100 0 0 50 69 0 0 28 14 0 0 10 0 0 0 6.3 0 0 0 14 1 0 0 10 0 0 0 5 0 0 0 3.35 0 0 0 0.6 0 0 1 0.6 0 0 1 0.15 0 0 1 0.15 0 0 1				70 Passing	Partie		70 P d S	Sing	Course Day								
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3.35 0 1.8 2 0 1 1.18 0 1 0.6 0 1 0.425 0 1 0.3 0 1 0.15 0 1 0.063 0 1		5		0					D10	mm		25					
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	USEW GEOT	AY		Particle Density by Gas Jar Tests - Summary of Results					
Project No.			Project	i Nam	e				
15-	·664				GDI	O Ove	rwater SI		
Hole No.	Ref	Top	npie Base	Туре	Soil Description at test horizon	Parti I	cle Density Mg/m3		Remarks
BH01	15	2.00		в	Grey slightly silty SAND		2.63		
BH01	18	5.00		В	Grey slightly silty SAND		2.64		
BH01	13	12.90	13.60	В	Brownish grey slightly sandy gravelly CLAY		2.63		
BH03	5	1.00	2.00	В	Grey silty SAND with shells and shell fragments.		2.59		
BH03	6	2.00	3.00	В	Grey silty SAND with shells and shell fragments.		2.62		
BH03	7	3.00	4.00	В	Grey silty SAND with shells and shell fragments		2.65		
BH03	14	5.00	6.00	В	Grey slightly gravelly sandy silty CLAY with occasional shells.		2.61		
BH03	16	6.00	7.00	В	Grey slightly gravelly sandy silty CLAY with occasional shells.		2.64	_	
BH03	19	8.00	8.50	В	Brown slightly sandy gravelly silty CLAY with occasional limestone and sandstone cobbles.		2.61		
BH05	1	0.00	1.00	В	Grey silty SAND with shells and shell fragments.		2.62		
BH05	2	2.00	3.00	В	Grey silty SAND with shells and shell fragments.		2.65		
BH05	3	3.10	3.50	В	Grey sandy silty GRAVEL with shells and shell fragments.		2.65		
BH05	5	6.00	7.00	В	Grey sandy gravelly silty CLAY.		2.66		
BH08	1	0.00	1.00	В	Grey fine to medium subrounded GRAVEL with shells and shell fragments.		2.65		
BH08	4	1.50	2.50	В	Grey sandy silty GRAVEL with shells and shell fragments.		2.64		
BH08	10	5.00	5.50	В	Grey sandy silty GRAVEL.		2.65		
BH08	12	6.20	7.20	В	Grey brown sandy silty CLAY.		2.64		
BH08	14	7.30	7.80	В	Grey brown sandy gravelly silty CLAY.		2.68		
		_							
Notes							Date Printe	d	Table
Tests perform Gas Jar tests	ed in a to BS1	ccordan 377: Par	ce with E rt 2 : 199	3S 137 /0, clau	7 unless annotated otherwise Ise 8.2		17/11/2015		sheet

Geotechnical Testing Laboratory

Shear B	ox Test	GDD Ov	erwater				
Ref:	15-664		Size mm		100	Initial wet mass g	554
BH	BH03		Thickness	mm	31.7	Bulk Density mg/m3	1748
Depth m	0m						
Our Ref	4			σ' _v kPa			
Soil type	Grey Gravelly	y SAND cont	shells				
Rate of sh	earing mm/m	in	0.5	30			
-				60			
				120			
Peak		Ultimate					
σ' _n kPa	τ kPa	σ' _n kPa	τ kPa				
30)	30	24				
60)	60	50				
120)	120	98				

Peak angle of internal friction Ultimate angle of internal friction

> y = 0.819x Shear Stress (kPa) Normal Stress (kPa)

Figure 1 Failure Envelope

QUB

Shear Box Test



Figure 2 Stress-strain behaviour

Shear B	ox Test G	DD Overwater				
					Loading 50 kPa	
Ref:	15-664	Size mm		100	Initial wet mass g	610
BH	BH03	Thickness	s mm	31.7	Bulk Density mg/m3	1924
Depth m	5m				Final wet mass g	612
Our Ref	14		σ' _v kPa		Dry mass g	500
Soil type	Grey Silty CLAY				Initial water content %	22.0
Rate of sh	earing mm/min	0.01	5 50		Final water content %	22.4
			100		Loading 100 kPa	
			200		Initial wet mass g	560
Peak	UI	timate			Bulk Density mg/m3	1924
σ' _n kPa	τ kPa σ'	_n kPa τ kPa			Final wet mass g	561
50)	50 38	8		Dry mass g	460
100)	100 60	0		Initial water content %	21.7
200)	200 11	1		Final water content %	22.0
					Loading 200 kPa	
					Initial wet mass g	606
					Bulk Density mg/m3	1924
					Final wet mass g	599
Peak angl	e of internal frict	ion			Dry mass g	495
Ultimate a	ngle of internal f	riction	29		Initial water content %	22.4
					Final water content %	21.0



Figure 1 Failure Envelope

Shear Box Test



Figure 2 Stress-strain behaviour

Geotechnical Testing Laboratory

Shear B	ox Test	GDD Ov	erwater				
Ref:	15-664		Size mm		100	Initial wet mass g	645
BH	BH05		Thickness	mm	33.7	Bulk Density mg/m3	1914
Depth m	0m						
Our Ref	1			σ' _v kPa			
Soil type	Grey SAND						
Rate of sh	earing mm/m	nin	0.5	40			
				80			
		R		160			
Peak		Ultimate					
σ' _n kPa	τ kPa	σ' _n kPa	τkPa				
40)	40	34	·			
80)	80	57				
160)	160	103				

Peak angle of internal friction Ultimate angle of internal friction

33



Figure 1 Failure Envelope

QUB

Shear Box Test



Figure 2 Stress-strain behaviour

Geotechnical Testing Laboratory

Shear B	ox Test	GDD Ov	erwater				
	1		o:		100		
Ref:	15-664		Size mm		100	Initial wet mass g	749
BH	BH05		Thickness	mm	34.2	Bulk Density mg/m3	2190
Depth m	3.1m						
Our Ref	3			σ' _v kPa			
Soil type	Grey Gravelly	SAND cont	shells				
Rate of sh	earing mm/m	in	0.5	40			
				80			
		-		160			
Peak		Ultimate					
σ' _n kPa	τkPa	σ' _n kPa	τkPa				
40) 38	40	33				
80) 73	80	64				
160) 131	160	122				

Peak angle of internal friction Ultimate angle of internal friction 39 **37**



Figure 1 Failure Envelope

Shear Box Test



Figure 2 Stress-strain behaviour

	SEW GEOT	ECH			Summary	of Labo	oratory V	ane Test	t Result	S
Project No.	664		Project N	lame		GP		\$1		
	004	0								
Hole No.	Ref	Top	Base	Туре	Soil Description at test horizon	Moisture Content %	Vane shea Undisturbed kPa	ar strength Remoulded kPa	Sensitivity	Remarks
BH05	5	6.00	7.00	В	Very soft grey sandy gravelly CLAY	20		17		
Notes Tests performed Tests carried out Shear strengths	in acco in nom are ave	ordance wi ninally 100 erage of at	th BS 1377 mm diame least 3 tes	7:Part 7 ter tube ts unle:	Clause 3 using 19mm x 30mm va e unless noted otherwise ss noted otherwise	ne	Date Printed 14/09/20	Appro	oved By	I able 1 sheet 1











LABORATORY RESTRICTION REPORT

Project Reference	15-664			То	Darren O'Mahony
Project Name	Greater Dublin Drainage Sch	Creater Dublin Drainage Schemer, Offebore SI			Project Manager
	Greater Dublin Drainage Sch	enie. Olisii		From	Stephen Watson
TR reference	15-664	1	1		
		,	·	Position	Laboratory Manager

The following sample(s) and test(s) are restricted as detailed below.

Hole	S	Sample		Test		
Number	Number	Depth	Туре	Туре	Reason for Restriction	Required Action
		(m)				
BH03		0	В	Lab vane	SAND - Testing not suitable	Testing cancelled
BH03		5	в	Quick triaxial	Not suitable on a disturbed sample. Insufficient material to allow remoulded specimen. Shearbox testing took priority	Testing cancelled
BH08		0	В	Lab vane	GRAVEL - Testing not suitable	Testing cancelled
BH08		1.5	в	Atterberg Limit	GRAVELLY SAND - Testing not suitable	Testing cancelled
BH08		5	В	Atterberg Limit	SANDY GRAVEL - Testing not suitable	Testing cancelled
BH08		8.4	В	Atterberg Limit Particle density	GRAVEL - Testing not suitable	Testing cancelled
				1		Desired Manager 21
For electrelectrelectronic	onic repor signature	ting a forn or printed	n of I name	e is	Laboratory Signature Stephen Watson	Project Manager Signature Darren O'Mahony
acceptab	le				Date	Date
					16 November 2015	16 November 2015



LABORATORY RESTRICTION REPORT

Project Reference	15-664	То	Darren O'Mahony	
Project Name	Greater Dublin Drainage Scheme: Offshore SI	Position	Position Project Manager	
,		From	Stephen Watson	
TR reference	15-664 / 1	Position	Laboratory Manager	

The following sample(s) and test(s) are restricted as detailed below.

Hole	5	Sample		Test		
Number	Number	Depth (m)	Туре	Туре	Reason for Restriction	Required Action
BH05		20.10- 23.20		Quick triaxial	No suitable sample to allow QUT	Testing cancelled
BH05		32.30- 33.70		Quick triaxial	No suitable sample to allow QUT	Testing cancelled
BH05		33.70- 35.20		Quick triaxial	No suitable sample to allow QUT	Testing cancelled
BH05		39.70- 41.20		Quick triaxial	No suitable sample to allow QUT	Testing cancelled
BH05		47.20- 52.80		Quick triaxial	No suitable sample to allow QUT	Testing cancelled
BH01		1		Moisture content Atterberg	Lab did not receive sample	Testing cancelled
BH01		7		Moisture content PSD	Lab did not receive sample	Testing cancelled
BH01		9		Moisture content PSD	Lab did not receive sample	Testing cancelled
BH01		11		Moisture content PSD Particle density	Lab did not receive sample	Testing cancelled

For electronic reporting a form of electronic signature or printed name is	Laboratory Signature Stephen Watson	Project Manager Signature Darren O'Mahony
acceptable	Date	Date
	16 November 2015	16 November 2015



•	WAY OTECH					Ро	int l	₋oao Sum	d Sti nmai	reng ry of	th In Res	dex ults	Test	ts				
Project No.	15-664			Projec	ct Name	;				GDD	Overwa	ater SI						
Borehole	Ş	Sample		Spe	cimen	Rock Type	Test see	Type ISRM	alid (Y/N)		Dime	nsions		Force P	ent diameter, De	Point Strengt	Load h Index	Remarks (including
No.	Depth	Ref.	Туре	Ref.	Depth		Type (D, A, I, B)	Direction (L, P or U)	Failure Va	Lne	W	Dps mm	Dps' mm	kN	B Equivale	Is MPa	Is(50) MPa	water content if measured)
BH01	18.90		с	2		LIMESTONE	I	U	YES	55.0	100.0	65.0	58.0	28.7	85.9	3.9	5.0	
BH01	20.20		с	2		LIMESTONE	D U YES 79.0					73.0	68.0	29.6	83.3	4.3	5.4	
BH01	22.50		с	2		MESTONE A U YES					102.0	88.0	79.0	22.6	101.3	2.2	3.0	
BH01	23.20		с	2		LIMESTONE	D	U	NO	60.0	102.0	102.0	96.0	28.9	99.0	3.0	4.0	
BH01	29.00		с	2		LIMESTONE	D	U	NO	75.0	102.0	102.0	94.0	32.3	97.9	3.4	4.6	
BH01	29.10		с	2		LIMESTONE	A	U	YES		102.0	69.0	72.0	30.6	96.7	3.3	4.4	
BH01	32.50		С	2		LIMESTONE	88.0	102.0	102.0	96.0	21.0	99.0	2.1	2.9				
BH01	33.50		с	2		LIMESTONE	A	U	YES		102.0	60.0	56.0	16.9	85.3	2.3	3.0	
BH01	41.70		С	2		LIMESTONE	A	U	NO		102.0	86.0	80.0	20.6	101.9	2.0	2.7	
BH01	42.80		с	2		LIMESTONE	D	U	YES	73.0	102.0	102.0	95.0	22.9	98.4	2.4	3.2	
BH01	44.60		С	2		LIMESTONE	D	U	YES	59.0	102.0	102.0	96.0	22.6	99.0	2.3	3.1	
BH01	44.70		с	2		LIMESTONE	A	U	YES		102.0	63.0	57.0	19.6	86.0	2.6	3.4	
BH01	48.00		с	2		LIMESTONE	А	U	YES	50.0	102.0	64.0	60.0	1.4	88.3	0.2	0.2	
BH01	48.80		с	2		LIMESTONE	D	U	YES	53.0	102.0	101.0	97.0	7.6	99.5	0.8	1.0	
BH01	52.80		с	2		LIMESTONE	D	U	YES	51.0	102.0	102.0	100.0	7.9	101.0	0.8	1.1	
BH01	53.40		с	2		LIMESTONE	А	U	NO		102.0	52.0	47.0	17.6	78.1	2.9	3.5	
BH01	55.30		с	2		LIMESTONE	D	U	YES	56.0	102.0	101.0	96.0	20.3	99.0	2.1	2.8	
BH01	55.50		с	2		LIMESTONE	А	U	NO		102.0	76.0	70.0	26.2	95.3	2.9	3.9	
BH01	56.90		с	2		LIMESTONE	D	U	YES	50.0	102.0	102.0	98.0	25.9	100.0	2.6	3.5	
BH01	57.40		с	2		LIMESTONE	А	U	YES	34.0	102.0	85.0	58.0	22.0	86.8	2.9	3.7	
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								D _{ps} ↓	Axial	P	Lne	Blo	ck/irreg	ular lum	P D _{ps}			
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.								16	6/11/20	15	Stept	nen.W	/ atson	sheet	1			

GEOTECH							Ро	int l	Loao Sum	d Sti Imai	reng ry of	th In Res	dex ults	Test	ts			
Project No.	15-664			Projec	ct Name	9				GDD	Overwa	ater SI						
Borehole	ξ	Sample		Spe	cimen	Rock Type	Test see	Type ISRM	alid (Y/N)		Dime	nsions		Force P	ent diameter, De	Point Strengt	Load h Index	Remarks (including
No.	Depth	Ref.	Туре	Ref.	Depth		Type (D, A, I, B)	Direction (L, P or U)	Failure Va	Lne	W	Dps	Dps'	kN	B Equivale	Is MPa	Is(50) MPa	water content if measured)
BH01	59.70		с	2		LIMESTONE	D	U	NO	59.0	102.0	102.0	95.0	27.5	98.4	2.8	3.8	
BH01	59.90		с	1		IMESTONE A U NO					65.0	65.0	59.0	20.5	69.9	4.2	4.9	
BH03	17.90		с	1		LIMESTONE A U YES 55.0					103.0	79.0	73.0	21.6	97.8	2.3	3.1	
BH03	18.40		с	1		LIMESTONE	D	U	YES	56.0	103.0	103.0	94.0	27.6	98.4	2.9	3.9	
BH03	22.40		с	1		LIMESTONE	D	U	YES	55.0	103.0	103.0	93.0	30.6	97.9	3.2	4.3	
BH03	22.70		с	1	LIMESTONE A U YES						103.0	37.0	32.0	11.6	64.8	2.8	3.1	
BH03	25.30		с	1		56.0	103.0	103.0	90.0	23.6	96.3	2.5	3.4					
BH03	25.60		с	1		LIMESTONE	D	U	YES	55.2	103.0	103.0	91.0	32.1	96.8	3.4	4.6	
BH03	27.10		с	1		LIMESTONE	A	U	YES	55.9	103.0	88.0	80.0	20.9	102.4	2.0	2.8	
BH03	27.40		с	1		LIMESTONE	D	U	YES	55.1	103.0	103.0	93.0	30.4	97.9	3.2	4.3	
BH03	31.20		с	1		LIMESTONE	A	U	YES	55.5	103.0	68.0	60.0	24.7	88.7	3.1	4.1	
BH03	31.45		с	1		LIMESTONE	D	U	YES	55.4	103.0	103.0	92.0	31.8	97.3	3.4	4.5	
BH03	34.80		с	1		LIMESTONE	A	U	YES	55.0	103.0	64.0	59.0	11.6	88.0	1.5	1.9	
BH03	35.60		с	1		LIMESTONE	A	U	YES	45.0	103.0	55.0	47.0	18.6	78.5	3.0	3.7	
BH03	39.70		С	1		LIMESTONE	D	U	YES	53.2	103.0	102.0	94.0	19.4	98.4	2.0	2.7	
BH03	39.80		С	1			D	U	YES	55.4	103.0	103.0	95.0	23.2	98.9	2.4	3.2	
BH03	44.60		С	1			D	U	NO	55.2	103.0	102.0	95.0	29.6	98.9	3.0	4.1	
BH03	46.80		С	1			A	U	NO	33.0	103.0	68.0	61.0	26.0	89.4	3.3	4.2	
BH03	47.10		С	1			A	U	NO	29.0	103.0	58.0	50.0	23.0	81.0	3.5	4.4	
BH03	48.20		С	1		LIMESTONE	A	U	NO	56.0	103.0	102.0	94.0	23.6	111.0	1.9	2.7	
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									D _{ps}	Axial	P	Lne	Blo	ck/irreg		P ↓ D _{ps}		
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.								16/11/2015 Approved By Table 2 Stephen Watson 2				2 2						

							Ро	int I	_oao Sum	d Sti nma	reng ry of	th In Res	dex ults	Test	ts			
Project No.	15-664			Projec	ct Name	9				GDD	Overwa	ater SI						
Borehole	Ş	Sample		Spe	cimen	Rock Type	Test see	Type ISRM	alid (Y/N)		Dime	nsions		Force P	ent diameter, De	Point Strengt	t Load th Index	Remarks (including
No.	Depth	Ref.	Туре	Ref.	Depth		Type (D, A, I, B)	Direction (L, P or U)	Failure Va	Lne	W	Dps	Dps'	kN	Equivale	Is MPa	Is(50) MPa	water content if measured)
BH03	48.70		с	1		LIMESTONE	А	U	YES	57.0	103.0	102.0	95.0	20.5	111.6	1.6	2.4	
BH03	49.50		с	1		LIMESTONE	D	U	YES	56.0	103.0	102.0	97.0	22.9	100.0	2.3	3.1	
BH03	50.60		с	1		IMESTONE D U NO 58.0				58.0	103.0	101.0	95.0	10.6	98.9	1.1	1.5	
BH03	54.70		с	1		LIMESTONE	D	U	NO	55.0	103.0	102.0	99.0	16.4	101.0	1.6	2.2	
BH03	54.80		с	1		LIMESTONE	A	U	YES	55.0	103.0	90.0	82.0	19.2	103.7	1.8	2.5	
BH03	58.00		с	1	LIMESTONE D U YES						103.0	103.0	93.0	20.6	97.9	2.2	2.9	
BH03	58.30		с	1		LIMESTONE	A	U	YES	45.0	103.0	57.0	46.0	19.3	77.7	3.2	3.9	
BH08	10.80		с	1		LIMESTONE	A	U	NO	55.0	103.0	70.0	62.0	16.9	90.2	2.1	2.7	
BH08	11.50		с	1		LIMESTONE	I	U	YES	39.0	65.0	49.0	41.0	19.8	58.3	5.8	6.3	
BH08	11.70		с	1		LIMESTONE	D	U	NO	59.0	103.0	103.0	98.0	18.4	100.5	1.8	2.5	
BH08	12.50		с	1		LIMESTONE	I	U	NO	55.0	103.0	73.0	66.0	14.9	93.0	1.7	2.3	
BH08	15.70		с	1		LIMESTONE	Α	U	YES	17.0	103.0	39.0	33.0	29.6	65.8	6.8	7.7	
BH08	15.90		с	1		LIMESTONE	I	U	YES	51.0	97.0	65.0	60.0	22.3	86.1	3.0	3.8	
BH08	19.20		с	1		LIMESTONE	D	U	YES	52.0	103.0	103.0	98.0	16.0	100.5	1.6	2.2	
BH08	19.40		С	1		LIMESTONE	A	U	NO	16.0	103.0	31.0	27.0	3.6	59.5	1.0	1.1	
BH08	22.40		с	1		LIMESTONE	I	U	NO	30.2	76.0	67.0	57.0	22.6	74.3	4.1	4.9	
BH08	22.60		с	1		LIMESTONE	A	U	YES	31.0	103.0	65.0	58.0	23.5	87.2	3.1	4.0	
BH08	27.00		с	1		LIMESTONE	A	U	NO	32.5	103.0	66.0	61.0	8.9	89.4	1.1	1.4	
BH08	27.40		С	1		LIMESTONE	D	U	NO	55.0	103.0	103.0	95.0	23.3	98.9	2.4	3.2	
BH08	31.50		С	1		LIMESTONE	D	U	YES	55.2	103.0	103.0	96.0	26.3	99.4	2.7	3.6	
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								D _{ps}	Axial	P	L _{ne}	Blo	ck/irreg		p D _{ps}			
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.								Date F	Printed	15	Appro	ved By	/	Table sheet	3 3			

CAUSEWAY GEOTECH Sun								d Sti mai	Strength Index Tests nary of Results									
Project No.	15-664			Projec	ct Name	9				GDD	Overwa	ater SI						
Borehole	ç	Sample		Spe	cimen	Rock Type	Test see	Type ISRM	alid (Y/N)		Dime	nsions		Force P	ent diameter, De	Point Strengt	Load h Index	Remarks (including
No.	Depth	Ref.	Туре	Ref.	Depth		Type (D, A, I, B)	Direction (L, P or U)	Failure Va	Lne	W	Dps mm	Dps' mm	kN	B Equival	Is MPa	Is(50) MPa	water content if measured)
BH08	32.45		с	1		LIMESTONE	A	U	YES	27.3	103.0	44.0	37.0	17.3	69.7	3.6	4.1	
BH08	32.65		с	1		LIMESTONE D U YES 55.				55.0	103.0	103.0	94.0	27.5	98.4	2.8	3.9	
BH08	32.90		с	1		LIMESTONE	А	U	YES	54.0	103.0	103.0	95.0	21.6	111.6	1.7	2.5	
BH08	33.30		с	1		LIMESTONE	A	U	NO	26.0	103.0	55.0	50.0	11.5	81.0	1.8	2.2	
BH08	35.35		с	1		LIMESTONE	A	U	YES	44.0	103.0	84.0	77.0	23.9	100.5	2.4	3.2	
BH08	35.60		с	1	LIMESTONE D U YES						103.0	103.0	96.0	22.7	99.4	2.3	3.1	
BH08	37.00		с	1	LIMESTONE D U NO 4						103.0	103.0	95.0	38.6	98.9	3.9	5.4	
BH08	37.10		с	1		LIMESTONE	A	U	YES	37.0	103.0	65.0	60.0	22.0	88.7	2.8	3.6	
BH08	40.00		с	1		LIMESTONE	D	U	YES	55.0	103.0	103.0	97.0	25.2	100.0	2.5	3.4	
BH08	40.15		с	1		LIMESTONE	D	U	NO	54.0	103.0	103.0	96.0	29.3	99.4	3.0	4.0	
BH08	42.50		с	1		LIMESTONE	А	U	YES	26.0	103.0	50.0	40.0	26.6	72.4	5.1	6.0	
BH08	43.00		с	1		LIMESTONE	D	U	YES	54.9	103.0	103.0	90.0	32.3	96.3	3.5	4.7	
BH08	44.90		с	1		LIMESTONE	A	U	NO	26.0	103.0	47.0	42.0	18.6	74.2	3.4	4.0	
BH08	50.00		с	1		LIMESTONE	D	U	YES	53.0	103.0	103.0	92.0	27.9	97.3	2.9	4.0	
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									D _{ps} ▼	Axial	P	L _{ne}	Blo	ck/irreg	ular lum	P ↓ D _{ps}		
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.								Date Printed Approved By Table 16/11/2015 4 sheet 4				4						

Project No. 15-6	664		Project	+ Nlows	UNIAXIAL COMPRESSION TEST ON ROCK - SUMMARY OF RESULTS										
15-0	004			t name	e					e munete m C					
						s	pecime	n	GDD OV	erwaler 5					
		San	nple		5 I T	Dir	nensior	ns2	Bulk	Water Content	Uniaxi	al Compre	ession3		
Hole No.	Ref	Тор	Base	Туре	Коск Туре	Dia.	Length	H/D	Densityz	1	Condition	Mode of failure	UCS	Remarks	
						mm	mm		Mg/m3	%			MPa		
BH01		50.10		С	LIMESTONE	103.0	252.0	2.4	2.67	0.2	as received	AC	69.4		
BH01		52.90		с	LIMESTONE	103.0	230.0	2.2	2.68	0.2	as received	S	38.3		
BH01		57.00		С	LIMESTONE	103.0	243.0	2.4	2.67	0.1	as received	AC	51.4		
BH03		25.40		с	LIMESTONE					0.2	as received			Sample broke during preparation	
BH03		36.00		С	LIMESTONE	103.0	250.0	2.4	2.66	0.4	as received	MS	14.3		
BH03		46.30		с	LIMESTONE	103.0	205.0	2.0	2.64	0.1	as received	MS	16.7		
BH03		48.30		с	LIMESTONE	103.0	259.0	2.5	2.66	0.1	as received	AC	29.9		
BH08		16.00		с	LIMESTONE	IESTONE 103.0 205.0 2.0 2.63 0.1 as received AC 43.6									
BH08		31.20		с	LIMESTONE	103.0	220.0	2.1	2.65	0.1	as received	AC	46.6		
BH08		33.00		с	LIMESTONE	103.0	213.0	2.1	2.64	0.2	as received	S	17.9		
BH08		35.40		с	LIMESTONE	103.0	182.0	1.8	2.65	0.1	as received	AC	36.5		
Notes 1 { 2 { 3 { a	ISRM p ISRM p ISRM p ISRM p above r	87 test 1, 86 clause 153 part 1 notes appl	water cor e (vii), Cali 1, determi ly unless a	ntent at 1 iper meth nation of annotate	05 ± 3 oC, specimen a nod used for determina Uniaxial Compressive d otherwise in the rem	as tested f ation of bul e Strength arks	or UCS lk volume (UCS) of	and deriv f Rock Ma	ation of bulk o	density	Mode of failu S - Single sh AC - Axial cle	re : ear eavage	MS - multiple F - Fragmen	e shear ted	
Test Specific	cation) ational	Society	v for P	ock Mechanics	The con	nolete I	SRM ๑י	Indested	Date Prin	ted	Approved	Ву	Table	
r	metho	ods for	r Rock Characterization Testing and Monitoring, 2007						-9900100	16/11	/2015	Stephen	.Watson	1 sheet 1	



Unit 4 Heol Aur Dafen Ind Estate Dafen Carmarthenshire SA14 8QN Tel: 01554 784040 01554 750752 Fax: 01554 770529 01554 784041 Web: www.geo.uk.com

Certificate of Analysis

Date:	24/11/2015
Client:	Causeway Geotech LTD
Our Reference:	29018-121115
Client Reference:	15.664
Contract Title:	Greater Dublin Drainage
Description: (Total Samples)	1
Date Received:	12/11/2015
Date Started:	17/11/2015
Date Completed:	24/11/2015
Test Procedures:	(B.S. 1377 : PART 3 : 1990)

Notes:

Solid samples will be disposed 1 month and liquids 2 weeks

Approved By:

Authorised Signatories:

Emma Williams Laboratory Office Manager Ben Sharp Contracts Manager



Paul Evans Quality Manager Contract No:29018-121115Client Ref:15.664Location:Greater Dublin DrainageDate:24/11/2015

SUMMARY OF CHEMICAL ANALYSIS

(B.S. 1377 : PART 3 : 1990)

			Sulphate	Content SO3 (as	s SO ₄)	Chloride C	ontent				
			Acid	Aqueous	Ground-	Soluble	Ground-	рН	Total	Loss	
Hole	Sample	Depth	Soluble	Extract	water	Chloride as	water	Value	Sulphur	on	Remarks
Number	Number	m	Sulphate	Sulphate		% equiv.		@ 25°C		Ignition	
			as % SO ₄	as g/l SO ₄	g/l	NaCl	g/I		%	%	
			Clause 5.5.	Clause 5.5.	Clause 5.4.	Clause 7.3	Clause 7.2	Clause 9.		Clause 4.	
BH01		52.10-53.20	0.12 (0.14)	0.02 (0.02)					0.07		
											1
											I

NCP - No Chloride present

Test Report:

Determination of Indirect Tensile Strength by the Brazil Test ISRM : Document No. 8 : Part 2 : pp. 117-121 (1977).

Date: Contract Number: Location: Sample Type: Sample Preparation: Operator: 19-Nov-15 29018-121115 Greater Dublin Drainage Core Capping and Grinding Wayne Honey

Borehole Number	Sample Number	Depth (m)	Diameter mm (mm)	Length mm (mm)	Initial mass g (g)	Initial (cm3): Volume	Bulk Density Mg/m ³	Moisture Content %	Dry Density Mg/m ³	Load Failure kN	Maximum Tensile Strength (mpa)	Mode OF FAILURE	Date Tested
										1			
BH01		49.10-50.10	102.40	100.30	2218.4	826.13	2.69	0.10	2.68	90.3	5.592	Satisfactory	19-Nov-15
BH01		53.20-53.60	102.00	105.40	2357	861.36	2.74	0.12	2.73	128.2	7.584	Satisfactory	19-Nov-15
BH01		57.00-58.30	102.00	104.30	2335.6	852.38	2.74	0.14	2.74	117.4	7.018	Satisfactory	19-Nov-15

Remarks:

For and behalf of GEO Site & Testing Services Lir

Paul Evans - Technical/Quality Manager

Emma Sharp - Office Manager

Ben Sharp- Contracts Manager

and

Date Approved:

8.12.15

Unit 4 Heol Aur, Dafen, Llanelli SA14 8QN



GEO/031

September-04 Issue No.1

Cerchar Apparatus (1986) GAI-JTr/JS No. 86-538 - ASTM D7625-10

Client ref:	15-664
Location:	Greater Dublin Drainage
Contract Number:	29018-121115
Date tested:	19/11/2015
BH Number:	BH01
Sample Number:	
Depth (m) :	52.10-53.20

Tested By	Wayne Honey	
Mean Test Result (5 pi	2.1	
CA Index	2.1	



Sample Tested with a pin of hardened steel with a Rockwell hardness HRC of 54-56



For and behalf of GEO Site & Testing Services Ltd

Authorised By: Vaughan Edwards (Managing Director)

Date: 8.12.15

Test Report: SUGGESTED METHOD FOR POROSITY/DENSITY DETERMINATION USING SATURATION AND CALIPER TECHNIQUES

(Rock Characterization Testing and Monitoring ISRM Suggested Methods Part 1 : 2 : Page 83)

Contract Number:	29018-1211	15	
Location	Greater Dub	lin Drainage	
Client Ref	15-664		
Borehole Number	BH01	BH01	BH01
Depth (m)	49.10-50.10	52.10-53.20	57.00-58.30
Bulk Density - p (Mg/m3):	2.69	2.73	2.76
Dry Density - pd (Mg/m3):	2.68	2.73	2.75
	00.27	44 50	44 10
Buik volume - v (g):	98.27	44.59	44.18
Moisture Content - w (%)	0.04	0.16	0.16
Porosity - n (%):	0.3	1.6	1.4



For and behalf of GEO Site & Testing Services Limited

Paul Evans - Technical/Quality Manager



Date Approved:

08/12/15

GEO/020

Issue No.1

Unit 4 Heol Aur, Dafen, Llanelli SA14 8QN

Cerchar Apparatus (1986) GAI-JTr/JS No. 86-538 - ASTM D7625-10

Client ref:	15-664
Location:	Greater Dublin Drainage
Contract Number:	28551-061015
Date tested:	18/10/2015
BH Number:	BH03
Sample Number:	
Depth (m) :	46.30 - 47.80

Tested By	Wayne Honey	
Mean Test Result (5 pins)	1.0667	
CA Index	1.0667	



Sample Tested with a pin of hardened steel with a Rockwell hardness HRC of 54-56



For and behalf of GEO Site & Testing Services Ltd

Authorised By: Vaughan Edwards (Managing Director)

Date: 21.10.15

Cerchar Apparatus (1986) GAI-JTr/JS No. 86-538 - ASTM D7625-10

Client ref:	15-664
Location:	Greater Dublin Drainage
Contract Number:	28551-061015
Date tested:	18/10/2015
BH Number:	BH05
Sample Number:	
Depth (m) :	48.70 - 50.20

Tested By	Wayne Honey	
Mean Test Result (5 pins)	1.3333	
CA Index	1.3333	



Sample Tested with a pin of hardened steel with a Rockwell hardness HRC of 54-56



For and behalf of GEO Site & Testing Services Ltd

Authorised By: Vaughan Edwards (Managing Director)

Date: 21.10.15

Cerchar Apparatus (1986) GAI-JTr/JS No. 86-538 - ASTM D7625-10

Client ref:	15-664
Location:	Greater Dublin Drainage
Contract Number:	28551-061015
Date tested:	18/10/2015
BH Number:	BH08
Sample Number:	
Depth (m) :	35.70 - 36.20

Tested By	Wayne Honey	
Mean Test Result (5 pins)	1.2333	
CA Index	1.2333	



Sample Tested with a pin of hardened steel with a Rockwell hardness HRC of 54-56



For and behalf of GEO Site & Testing Services Ltd

Authorised By: Vaughan Edwards (Managing Director)

Date: 21.10.15

Test Report:

Determination of Indirect Tensile Strength by the Brazil Test ISRM : Document No. 8 : Part 2 : pp. 117-121 (1977).

Date: Contract Number: Location: Sample Type: Sample Preparation: Operator: 18-Oct-15 28551-061015 Greater Dublin Drainage Core Capping and Grinding Wayne Honey

Borehole Number	Sample Number	Depth (m)	Diameter mm (mm)	Length mm (mm)	Initial mass g (g)	Initial (cm3): Volume	Bulk Density Mg/m ³	Moisture Content %	Dry Density Mg/m ³	Load Failure kN	Maximum Tensile Mode Strength OF FAILURE (mpa)		Date Tested
BH03		25.60 - 26.80	101.70	110.60	2413.8	898.55	2.69	0.10	2.68	67.5	3.817	Satisfactory	18-Oct-15
BH03		35.80 - 37.30	102.00	110.00	2434.5	898.96	2.71	0.10	2.71	88.0	4.988	Satisfactory	18-Oct-15
BH03		46.30 - 47.80	102.10	104.90	2299.3	858.96	2.68	0.20	2.67	98.2	5.831	Satisfactory	18-Oct-15
BH08		35.70 - 36.20	102.00	106.90	2309.4	873.62	2.64	0.10	2.64	94.3	5.500	Satisfactory	18-Oct-15

Remarks:

For and behalf of GEO Site & Testing Services Lir

Paul Evans - Technical/Quality Manager

Emma Sharp - Office Manager

Ben Sharp- Contracts Manager

Date Approved:

21.10.15

Unit 4 Heol Aur, Dafen, Llanelli SA14 8QN

GSTL GEO Site & Testing Services Limited

GEO/031

September-04 Issue No.1

 Contract No:
 28551-061015

 Client Ref:
 15-664

 Location:
 Greater Dublin Drainage

 Date:
 20/10/2015

Summary of Chemical Analysis

(B.S. 1377 : PART 3 : 1990 AND BRE CP2/79)

			Sulphate	e Content SO3 (as	SO ₄)	Chloride Content						
			Acid	Aqueous	Ground-	Soluble	Ground-	рН	Total	Magnesium	Nitrate	Organic
Hole	Sample	Depth	Soluble	Extract	water	Chloride as	water	Value	Sulphur			%
Number	Туре	m	Sulphate	Sulphate		% equiv.		@ 25°C	%	g/l	mg/l	
			as % SO₄	as g/l SO ₄	g/I	NaCI	g/l					
			Clause 5.5.	Clause 5.5.	Clause 5.4.	Clause 7.3	Clause 7.2	Clause 9.				
BH03	С	46.30 - 47.80	0.22 (0.27)	0.05 (0.07)					0.16			
BH05	С	48.70 - 50.20	0.22 (0.27)	0.08 (0.09)					0.14			
BH08	С	35.70 - 36.20	0.24 (0.29)	0.04 (0.05)					0.19			
							L		ļ			
					-							

NCP - No Chloride present



15074IG - Restricted

Test report

Rock testing for 15-664 Greater Dublin

Determination of Drilling Rate Index $^{\rm m}$ and Cutter Life Index $^{\rm m}$ of 4 rock samples

Author

Niklas Haugen



SINTEF Building and Infrastructure Infrastructure 2015-11-13



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KEYWORDS Rock drillability

Test report

Rock testing for 15-664 Greater Dublin

Determination of Drilling Rate Index[™] and Cutter Life Index[™] of 4 rock samples

DATE
2015-11-13
CLIENT'S REF.
Ciaran Doherty
NUMBER OF
PAGES/APPENDICES 23
TEST OBJECT RECEIVED
2015-10-12
N DATE OF TEST
Engineering From 2015-10-13
То 2015-11-12

ABSTRACT

The samples are analysed in order to determine Drilling Rate Index[™] (DRI[™]) and Cutter Life Index[™] (CLI[™]).

Drilling Rate Index[™] (DRI[™]) and Cutter Life Index[™] (CLI[™]) are determined in accordance with: *http://www.drillability.com*, *SINTEF/NTNU* (2003), Suggested Methods for determining DRI[™], BWI[™] and CLI[™].

The trademarked acronyms and terms Drilling Rate Index[™], Cutter Life Index[™], DRI[™] and CLI[™] are unique for test results and calculated indices originating from the NTNU/SINTEF laboratory and can only be obtained by testing samples at our reference laboratory.

The test results relate only to the items tested

PREPARED BY Niklas Haugen

APPROVED BY Filip Dahl

REPORT NO. 15074IG

SIGNATURE SIGNATUR

CLASSIFICATION Restricted

The report is the client's property and cannot be given to a third party without the client's written consent. The report shall not be reproduced except in full without the written approval of SINTEF

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() SINTEF

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1 Executive summary

Test results, calculated indices and classifications are given in the following table.

Sample No. (given by SINTEF)	1	2	3	4	
Sample ID	BH03,	BH05,	BH08,	BH01,	
(given by the Client)	46.30 - 47.80	48.70 - 50.20	34.20 - 35.70	52.10 - 53.00	
Brittleness Value	50.8	75.0	46.8	48.0	
(\$20)	Medium	Extremely high	Medium	Medium	
Sievers' J-Value	79.7	101.7	108.9	79.0	
(SJ)	Very low surface hardness	Extremely low surface hardness	Extremely low surface hardness	Very low surface hardness	
Abrasion Value Cutter Steel	0.5	1.5	0.5	2.0	
(AVS)	Extremely low	Very low	Extremely low	Very low	
Drilling Rate Index [™]	61	87	61	58	
(DRI™)	High	Extremely high	High	High	
Cutter Life Index [™]	97	70	110	57	
(CLI™)	Extremely high	Very high	Extremely high	Very high	

Classification of S_{20} , SJ, and AVS according to Dahl. F., et al. 2012. Classifications of properties influencing the drillability of rocks, based on the NTNU/SINTEF test method. Tunnelling and Underground Space Technology 28 (2012). 150-158.

Classification of DRITM and CLITM according to Project Report "13A-98 Drillability Test Methods", published by the Department of Civil and Transport Engineering at the Norwegian University of Science and Technology.

1.1 Remark on sample No. 2, BH05, 48.70 – 50.20

The received *Sample No. 2, BH05, 48.70 - 50.20* consisted of highly weathered/altered rock core sections/fragments and soil particles (*see photo on page 22*). The sample was hence not well suited for rock drillability testing and it was in accordance with the Client decided to separate the intact rock core fragments and perform the testing on a reconstituted sample.


2 Table of rock samples received for testing

(given by the Client)

Sample No. ¹⁾	Exploratory hole number	Sample type: B, J/D, U, P, W, SPT	Sample depth at (m)	Sample depth to (m)
1	BH03	С	46.30	47.80
2	BH05	С	48.70	50.20
3	BH08	С	34.20	35.70
4	BH01	С	52.10	53.00

¹⁾ Given by SINTEF



3 Results DRI[™] and CLI[™]

TEST RESULTS

Sample No. (given by SINTEF)	1	2	3	4
Sample ID (given by the Client)	BH03, 46.30 - 47.80	BH05, 48.70 - 50.20	BH08, 34.20 - 35.70	BH01, C, 52.10 - 53.00
Brittleness Value (S ₂₀ , 11.2 - 16.0 mm)	50.8	75.0	46.8	48.0
Flakiness	1.34	1.30	1.35	1.34
Compaction index	1	3	1	1
Density (g/cm ³)	2.70	2.52	2.69	2.73
Sievers' J-Value (SJ)	79.7	101.7	108.9	79.0
Abrasion Value Cutter Steel (AVS)	0.5	1.5	0.5	2.0

CALCULATED INDICES

Drilling Rate Index [™] (DRI)	61	87	61	58
Cutter Life Index [™] (CLI)	97	70	110	57

CLASSIFICIATION

Category	DRI	CLI
Extremely Low	≤ 25	< 5
Very Low	26 - 32	5.0 - 5.9
Low	33 - 42	6.0 - 7.9
Medium	43 - 57	8.0 - 14.9
High	58 - 69	15 - 34
Very High	70 - 82	35 - 74
Extremely High	≥ 83	≥ 75



4 Comments and remarks on NTNU/SINTEF Drillability tests and test methods

4.1 Brittleness Value (S₂₀)

Rock brittleness or the ability to be crushed by repeated impacts is determined by the Brittleness Value. The Brittleness Value test is normally performed on three extractions from one representative and homogenized sample of crushed and sieved rock material and should hence be regarded as representative for the tested rock sample.



Table 1.	Classification of	rock brittleness	or the	ability to	be crushed	by repeated	impacts	according t	o Dahl.
<i>F., et al.</i>	TUST 28 (2012)	150 -158.							

Category – brittleness	Brittleness Value	Cumulative percentage
	[%]	
Extremely low	≤ 29.0	0-5%
Very low	29.1 - 34.9	5-15 %
Low	35.0-40.9	15 – 35 %
Medium	41.0 - 50.9	35-65 %
High	51.0 - 59.9	65 – 85 %
Very high	60.0 - 65.9	85 – 95 %
Extremely high	≥ 66.0	95 - 100 %



4.2 Sievers' J-Value (SJ)

Rock surface hardness or the resistance to indentation is determined by the Sievers' J-Value. The standard number of Sievers' J drillings performed on each sample is 4 to 8, depending on the variation in the texture of the sample. We try to place the holes in soft and hard layers according to a visual interpretation of the composition of the rock. E.g. 60% light and 40% dark layers in a sample would result in 3 holes in the light layer(s) and 2 holes in the dark layer(s). We also try to avoid the soft/hard combination, but we do not always succeed in that matter due to e.g. thin layers of alternating mineral composition.

The Sievers' J charts on pages 14 - 17 show elapsed time in seconds. The Sievers' J-Value is defined as the penetration depth after 200 revolutions and the rotation of the drill bit is hence stopped when this is achieved. As may be seen in some of the graphs, 200 revolutions occur after approximately 67 seconds of drilling.



Table 2. Classification of rock surface hardness or the resistance to indentation according to Dahl. F., et al. TUST 28 (2012) 150 - 158.

Category –	SJ-Value	Cumulative percentage
surface hardness	[mm/10]	
Extremely high	≤ 2	0 –5 %
Very high	2.0-3.9	5 – 15 %
High	4.0 - 6.9	15 – 35 %
Medium	7.0 - 18.9	35 - 65 %
Low	19.0 - 55.9	65 - 85 %
Very low	56.0 - 85.9	85 – 95 %
Extremely low	≥ 86.0	95 - 100 %

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4.3 Abrasion Value Cutter Steel (AVS)

Rock abrasivity or the ability to induce wear on cutter ring steel is determined by the Abrasion Value Cutter Steel. Abrasion test material is taken from the extractions used for the Brittleness test. The AVS tests use test pieces of cutter ring steel. Quartz and other hard minerals will cause abrasion on the test pieces. Grain size, shape and binding are other factors that are believed to have substantial influence on the abrasiveness of the rock.



Table 3.	Classification of roc	k abrasivity o	r the ability t	o induce w	ear on cutter	ring steel	according to
Dahl.F.,	et al. TUST 28 (201	2) 150 -158.					

Category – cutter steel abrasion	AVS [weight loss mg]	Cumulative percentage
Extremely low	≤ 1.0	0-5%
Very low	1.1 – 3.9	5 - 15 %
Low	4.0 - 12.9	15 – 35 %
Medium	13.0 - 25.9	35 - 65 %
High	26.0 - 35.9	65 - 85 %
Very high	36.0 - 43.9	85 - 95 %
Extremely high	\geq 44.0	95 - 100 %

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4.4 Drilling Rate Index[™]

The Drilling Rate IndexTM is assessed on the basis of the Brittleness Value (S₂₀) and the Sievers' J-Value (SJ). The DRITM may be described as the Brittleness Value corrected for the rock surface hardness (SJ).

Sample No. 2, BH05, 48.70 - 50.20 showed an extremely high DRITM. The cause of the extreme value is the combination of extremely high brittleness (S₂₀) and extremely low surface hardness (SJ), as shown in Table 4.

*Table 4. Sample showing extremely high DRI*TM *and the associated S*₂₀ *and SJ values.*

Sample	Drilling Rate Index™	Brittleness Value	Sievers' J-Value
	(DRI TM)	(S_{20})	(SJ)
No. 2, BH05,	87	75.0	101.7
48.70 - 50.20	Extremely high	Extremely high	Extremely low surface hardness





Category – Drilling rate	Drilling Rate Index TM	Cumulative percentage
Extremely low	≤ 25	0-5%
Very low	26 - 32	5-15 %
Low	33 - 42	15 – 35 %
Medium	43 – 57	35 - 65 %
High	58 - 69	65 - 85 %
Very high	70-82	85 - 95 %
Extremely high	≥ 83	95-100 %

Table 5. Classification of Drilling Rate Index™ according to Project Report "13A-98 Drillability Test Methods", published by the Department of Civil and Transport Engineering, NTNU.

4.5 Cutter Life Index™

The Cutter Life IndexTM is assessed on the basis of Sievers' J-Value (SJ) and the Abrasion Value Cutter Steel (AVS). The CLITM expresses lifetime of TBM disc cutter steel.

Sample No. 1, BH03, C, 46.30 - 47.80 and Sample No. 3, BH08, C, 34.20 - 35.70 showed an extremely high CLI[™]. The cause of the extreme values are combinations of very low/extremely low hardness and extremely low abrasion on cutter steel, as shown in Table 6.

Sample	Cutter Life Index™	Sievers' J-Value	Abrasion Value Cutter
	(CLI™)	(SJ)	Steel
			(AVS)
No. 1, BH03,	97	79.7	0.5
46.30 - 47.80	Extremely high	Very low surface hardness	Extremely low
No. 3, BH08,	110	108.9	0.5
34.20 - 35.70	Extremely high	Extremely low surface hardness	Extremely low

*Table 6. Sample showing extremely high CLI*TM *and the associated SJ and AVS values.*





Table 7. Classification of Cutter Life Index[™] according to Project Report "13A-98 Drillability Test Methods", published by the Department of Civil and Transport Engineering, NTNU.

Category – Cutter life	Cutter Life Index TM	Cumulative percentage
Extremely low	< 5	0-5%
Very low	5.0 - 5.9	5-15 %
Low	6.0 - 7.9	15-35 %
Medium	8.0 - 14.9	35-65 %
High	15 - 34	65 - 85 %
Very high	35 - 74	85-95 %
Extremely high	≥75	95-100 %



5 Individual values from tests used to determine DRI[™] and CLI[™]

Test No.	Brittleness Value S ₂₀ [%]	Sievers' J-Value SJ [1/10 mm]	Abrasion Value Cutter Steel AVS [mg]
1	48.2	69.5	1
2	53.5	70.4	0
3	50.9	90.7	
4		88.1	
Mean	50.8	79.7	0.5
Stdev	2.65	11.28	0.71

Sample No.: 1 Sample ID: BH03, 46.30 - 47.80

Sample No.: 2 Sample ID: BH05, 48.70 - 50.20

Test No.	Brittleness Value	Sievers' J-Value	Abrasion Value Cutter Steel
	\mathbf{S}_{20}	SJ	AVS
	[%]	[1/10 mm]	[mg]
1	76.4	84.1	1
2	74.3	61.2	2
3	74.3	124.9	
4		106.3	
5		65.3	
6		75.2	
7		178.8	
8		118.0	
Mean	75.0	101.7	1.5
Stdev	1.22	39.19	0.71

Sample No.: 3 Sample ID: BH08, 34.20 - 35.70

Test No.	Brittleness Value	Sievers' J-Value	Abrasion Value Cutter Steel
	\mathbf{S}_{20}	SJ	AVS
	[%]	[1/10 mm]	[mg]
1	46.0	136.0	0
2	47.8	87.9	1
3	46.6	97.6	
4		85.4	
		97.4	
		149.2	
Mean	46.8	108.9	0.5
Stdev	0.90	26.85	0.71



Test No.	Brittleness Value	Sievers' J-Value	Abrasion Value Cutter Steel
	\mathbf{S}_{20}	SJ	AVS
	[%]	[1/10 mm]	[mg]
1	48.7	68.9	2
2	43.9	69.7	2
3	51.4	84.5	
4		92.8	
Mean	48.0	79.0	2.0
Stdev	3.84	11.66	0.00

Sample No.: 4 Sample ID: BH01, 52.10 - 53.00





6 Sievers' J-Value drillings presented as charts

Photo of the Sievers' J(SJ) specimen subsequent to completed testing. The numbered white arrows indicate the position of the drillings.

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Photo of the Sievers' J (SJ) specimens subsequent to completed testing. The received sample consisted of weathered/altered rock core sections/fragments and soil particles (see photo on page 22). It was in accordance with the Client hence decided to separate the intact rock core fragments and perform the testing on a reconstituted sample. The selected two core fragments for determination of SJ were, due to the visually observed weak texture, moulded in epoxy prior to testing in order to avoid breakage. The numbered white arrows indicate the position of the drillings.

5.

14 15 cm

6 in

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Photo of the Sievers' J (SJ) specimen subsequent to completed testing. The numbered white arrows indicate the position of the drillings. Red X indicates an unsuccessful drilling which not has been used for calculation of the SJ-Value.

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Photo of the Sievers' J (SJ) specimen subsequent to completed testing. The numbered white arrows indicate the position of the drillings.

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7 Photographs of the test methods, equipment and methodology

Pre-cutting of a piece from a rock core for determination of Sievers' J-Value.



A section of a rock core sample showing the orientation of the pre-cut Sievers' J piece in relation to the core axis and foliation.





Jaw crusher.



Brittleness test equipment.



A sample prior to impacts.

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Sieving machine.



Brittleness test. Mortar with sample.



A sample subsequent to 20 impacts.

VERSION 1





Sievers' J-Value test equipment.



Close up of drill and Sievers' J piece.



Miniature drills used to determine Sievers' J-Value.





Test equipment used to determine Abrasion Value (AV) and Abrasion Value Cutter Steel (AVS).



Part of a cutter ring, a 10 mm slice taken from the same ring, and two prepared AVS test pieces which are cut out of the centre of the slice.



AV (left) and AVS (right) test pieces subsequent to testing. For scale, the right-hand test piece is 30 mm long.

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8 Photographs of the received rock samples



Sample No. 1, " BH03, 46.30 - 47.80".



Sample No. 2, " BH05, 48.70 - 50.20".



Sample No. 3, "BH08, 34.20 - 35.70".

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102009979-2	

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Sample No. 4, "BH01, 52.10 - 53.00".



Technology for a better society www.sintef.no Appendix F Environmental laboratory test results



Certificate of Analysis

Report No.:	15-46959
Issue No.: Date of Issue	1 06/10/2015
Customer Details:	Darren O'Mahony Causeway Geotech Ltd 8 Drumahiskey Road Ballymoney Co. Antrim BT53 7QL
Order No.:	Not given
Customer Reference:	15-664
Quotation Reference:	150827/10
Description:	13 sediment samples in plastic containers
Date Received:	8/9/2015
Test Methods:	Details available on request (refer to SOP code against relevant result/s)
Notes:	None

(d

Approved By: Marco Lattughi, Operational Director

This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. Observations and interpretations are outside of the scope of UKAS accreditation. Results reported herein relate only to the items supplied to the laboratory for testing.

The Environmental Consultancy Ltd, trading as RPS Mountainheath. Registered in England No. 01470149 20 Western Avenue, Milton Park, Abingdon, Oxfordshire OX14 4SH A member of the RPS Group plc. RPS Laboratories and RPS Mountainheath terms and conditions apply - copy on request



Results Summary - Dry Weights, Moisture, Total Organic Carbon, TPH, Organotins & Density

Report No.:	15-46959
Customer Reference:	15-664
Order No:	Not given

Customer Sample M					C	1.0.0			BHVC02 0.1	BHVC02 0.8	BHVC03 0.1	BHVC03 0.8	BHVC04 0.1	BHVC04 0.8	BHVC05 0.1	BHVC05 0.8	BHVC06 0.1	BHVC06 0.8	BHVC07 0.1	BHVC07 1.2	BHVC08 0.1
			Custome	r Sample ID	Certifie	a Reference aterial	AQC spike													1	1
			RPS	Sample No					276955	276956	276957	276958	276959	276960	276961	276962	276963	276964	276965	276966	276967
			Sa	mple Type	SE	DIMENT	SEDI	MENT	SEDIMENT												
			Sam	ple Location																1	1
			Sampl	e Depth (m)			Spike on clean sediment		0.1	0.8	0.1	0.8	0.1	0.8	0.5	0.8	0.1	0.8	0.1	1.2	0.1
	Samplin Samplin			mpling Date	CR	M-646	(20µg/kg)		11	//	11	11	11	11	11	11	11	11	11	//	//
	mpling Time			(20µg/kg)													ļ	1			
																	L	L			
Determinand	CAS No	Codes	SOP	Units	Result	Recovery %														1	1
dry solids (at 105°C)			In house	%	n/a	n/a	n/a	n/a	81.2	81.7	82.5	79.5	81.8	78.8	81	80.7	80.8	82.2	79.4	81.8	81.3
dry solids (assisted air-drying at <30°C)			208	% w/w	n/a	n/a	n/a	n/a	Completed												
carbonate % dry matter			In house	%	n/a	n/a	n/a	n/a	14.7	34	10.1	9.37	10.1	9.38	10.8	18.7	9.8	10.3	10.5	10.6	39.1
total organic carbon*		S		%	n/a	n/a	n/a	n/a	0.09	0.14	0.17	0.16	0.16	0.27	0.11	0.13	0.17	0.16	0.35	0.21	0.29
total petroleum hydrocarbons by GCFID (C10 - C40)			In house	mg/kg	n/a	n/a	n/a	n/a	< 10.00	< 10.00	< 10.00	< 10.00	< 10.00	< 10.00	< 10.00	< 10.00	< 10.00	< 10.00	14.1	< 10.00	15.8
dibutyltin (DBT)	1002-53-5		In house	ug/kg DW	626	81.3	20.02	100.1	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
tributyltin (TBT)	56573-85-4		In house	ug/kg DW	472	98.3	20.16	100.8	< 2.00	< 2.00	< 2.00	< 2.00	< 2.00	< 2.00	< 2.00	< 2.00	< 2.00	< 2.00	< 2.00	< 2.00	< 2.00
density (on dry solid)	_		In house	g/cm3	n/a	n/a	n/a	n/a	1.6	1.7	1.5	1.6	1.5	1.5	1.6	1.4	1.5	1.6	1.5	1.7	1.6

Dibutyltin and tributyltin results have been dry weight corrected



Results Summary - Metals

Report No.:	15-46959
Customer Reference:	15-664
Order No:	Not given

	Standar	d Reference	BHVC02 0.1	BHVC02 0.8	BHVC03 0.1	BHVC03 0.8	BHVC04 0.1	BHVC04 0.8	BHVC05 0.1	BHVC05 0.8	BHVC06 0.1	BHVC06 0.8	BHVC07 0.1	BHVC07 1.2	BHVC08 0.1					
				Custome	r Sample ID	Ma	aterial													
				RPS	Sample No			276955	276956	276957	276958	276959	276960	276961	276962	276963	276964	276965	276966	276967
				Sa	mple Type	SED	DIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT							
				Sam	ple Location															
				Sample	e Depth (m)			0.1	0.8	0.1	0.8	0.1	0.8	0.5	0.8	0.1	0.8	0.1	1.2	0.1
				Sa	mpling Date	SRI	SRM-2702		11	11	11	11	11	11	11	11	11	11	11	11
				Sa	mpling Time															
Determinend	646 N.	C			11	D It	D													
Determinand	CAS NO	Codes	SOP	Mass	Units	Result	Recovery %	15000	1.4000	16100	1.4200	10200	10200	17200	10000	17000	15400	17000	15000	17700
aiuminium*	7429-90-5	SI	ICP-MS	2/	mg/kg DW	8570	101.9	15000	14000	16100	14200	18200	18300	17200	16600	1/200	15400	1/600	15900	1//00
arsenic*	7440-38-2	SI	ICP-MS	75	mg/kg DW	46.6	102.9	3.67	5.12	6.87	4.73	5.33	6.57	5.63	5.95	11.4	6.66	5.08	6.32	7.82
cadmium*	7440-43-9	SI	ICP-MS	111	mg/kg DW	0.97	118.7	0.21	0.16	0.13	0.14	0.2	0.17	0.13	0.14	0.14	0.12	0.15	0.11	0.12
chromium*	7440-47-3	SI	ICP-MS	52	mg/kg DW	338.3	96.1	35.1	35.1	33.1	27.8	35.5	44.2	27.5	33.6	53.8	31.8	30.3	27.2	27.9
copper*	7440-50-8	SI	ICP-MS	65	mg/kg DW	Not certified	n/a	3.22	3.76	3.87	3.8	4.65	5.79	4.68	4.42	6.7	4.17	5.66	3.8	4.39
lead*	7439-92-1	SI	ICP-MS	208	mg/kg DW	138.8	104.5	7.8	8.69	8.11	10.7	8.83	14.2	8.38	9.19	8.71	8.33	14.5	7.95	7.82
lithium*	7439-93-2	SI	ICP-MS	7	mg/kg DW	Not certified	n/a	14.5	9.67	9.06	4.24	7.97	18.3	8.71	9.11	9.89	7.13	10.1	5.32	8.04
mercury*	7439-97-6	SI	AFS	202	mg/kg DW	0.4	0.4 89.4		< 0.01	< 0.01	0.02	0.02	0.02	< 0.01	0.01	0.02	< 0.01	0.02	< 0.01	0.01
nickel*	7440-02-0	SI	ICP-MS	60	mg/kg DW	66.3	66.3 87.9		8.62	9.21	7.4	11	11.1	9.67	10.2	16.1	9.58	9.85	9.44	10.9
zinc*	7440-66-6	SI	ICP-MS 65 mg/kg DW 592.4 122.				122.1	24.9	33.9	32.6	36.2	34.1	51.6	32.1	35.4	54.8	34.4	50.9	33.1	37.2



Results Summary - Polycyclic Aromatic Hydrocarbons (EPA 16 PAHs)

Report No.:	15-46959
Customer Reference:	15-664
Order No:	Not given

	Sample No					BHVC02 0.1	BHVC02 0.8	BHVC03 0.1	BHVC03 0.8	BHVC04 0.1	BHVC04 0.8	BHVC05 0.1	BHVC05 0.8	BHVC06 0.1	BHVC06 0.8	BHVC07 0.1	BHVC07 1.2	BHVC08 0.1				
				Custome	er Sample ID	Certified	Reference	AQC	spike													
				RP	S Sample No					276955	276956	276957	276958	276959	276960	276961	276962	276963	276964	276965	276966	276967
				Sa	mple Type	SED	DIMENT	SEDIMENT		SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT								
				Sam	ple Location																	
				Samp	le Depth (m)			Snike on cle	an codimont	0.1	0.8	0.1	0.8	0.1	0.8	0.5	0.8	0.1	0.8	0.1	1.2	0.1
				Sa	impling Date	NIS	T-1944	(1000	an seument	11	11	11	11	11	11	11	11	11	11	11	11	11
				Sa	mpling Time			(1000	iig/kg/													
Determinand CAS No Codes SOD Mass Units					-																	
Determinand	CAS No	Codes	SOP	Mass	Units	Result	Recovery %	Result	Recovery %													
haphthalene	91-20-3		304	128	ug/kg DW	Not certified	n/a	1017.7	101.77	7.02	5.26	6.91	7.05	5.99	7.61	7.04	7.56	6.44	7.06	10.60	6.48	9.85
icenaphthylene	208-96-8		304	152	ug/kg DW	Not certified	n/a	1020.9	102.09	7.14	7.10	7.03	7.43	7.09	7.61	7.41	7.56	7.18	7.06	9.94	5.50	9.11
cenaphthene	83-32-9		304	154	ug/kg DW	Not certified	n/a	1044.9	104.49	5.67	5.51	5.58	5.79	5.63	6.09	5.80	5.95	5.70	5.60	23.30	5.50	6.03
luorene	86-73-7		304	166	uq/kq DW	Not certified	n/a	1059	105.9	6.40	5.99	6.31	6.80	6.36	7.87	6.55	6.69	6.44	6.33	21.00	6.24	7.88
henanthrene	85-01-8		304	178	ug/kg DW	5086.3	96.5142315	985.8	98.58	5.17	4.40	5.21	7.05	5.38	9.64	5.43	5.33	5.20	5.23	110.00	5.14	11.90
Inthracene	120-12-7		304	178	ug/kg DW	Not certified	n/a	996.5	99.65	6.90	6.73	6.67	8.06	6.73	7.49	8.03	6.94	6.81	6.69	30.20	6.73	10.60
luoranthene	206-44-0		304	202	ug/kg DW	8152.98	91.40112108	1089.4	108.94	6.77	6.12	6.31	14.30	6.36	10.30	6.30	6.45	6.31	6.33	188.00	6.36	6.40
byrene	129-00-0		304	202	ug/kg DW	8227.51	84.81969072	1097.5	109.75	6.16	5.63	5.70	12.50	5.87	9.64	5.80	5.83	5.82	5.84	169.00	5.87	21.80
enzo(a)anthracene	56-55-3		304	228	ug/kg DW	3772.66	79.92923729	1104.2	110.42	7.39	6.97	7.64	13.10	7.09	9.51	7.04	7.06	7.06	7.06	115.00	7.09	17.40
hrysene	218-01-9		304	228	ug/kg DW	4844.79	99.68703704	1000.8	100.08	4.68	< 0.100	4.49	8.43	4.65	6.34	4.57	4.21	4.58	4.50	82.90	4.65	11.80
penzo(b)fluoranthene	205-99-2		304	252	ug/kg DW	5467.14	91.42374582	966.1	96.61	7.51	6.36	6.67	14.30	6.85	12.30	6.67	6.69	6.56	6.81	130.00	6.73	27.70
enzo(k)fluoranthene	207-08-9		304	252	ug/kg DW	1905.15	82.8326087	861	86.1	6.65	6.24	6.18	9.57	6.24	8.50	6.30	6.32	6.31	6.21	48.50	6.24	13.20
enzo(a)pyrene	50-32-8		304	252	ug/kg DW	3515.21	81.74906977	953.1	95.31	8.13	7.71	7.03	13.20	7.71	10.50	7.78	7.81	7.68	7.67	112.00	7.71	22.50
ndeno(1,2,3-c,d)pyrene	193-39-5		304	276	ug/kg DW	772.1	101.7259552	841.3	84.13	7.39	6.85	6.79	9.94	6.85	9.90	6.92	6.94	6.93	6.81	53.40	6.85	15.90
libenzo(a,h)anthracene	53-70-3		304	278	ug/kg DW	2255.18	81.12158273	886.2	88.62	7.14	6.97	6.91	8.18	6.97	7.99	7.04	7.06	7.06	6.94	24.30	6.97	9.85
penzo(g,h,i)perylene	191-24-2		304	276	ug/kg DW	2650.99	93.34471831	895.9	89.59	7.27	6.48	6.67	9.94	6.73	9.77	6.67	6.69	6.56	6.69	65.80	6.73	17.10

PAH results have been dry weight corrected



Results Summary - Organochlorine Pesticides & Polychlorinated Biphenyls (ICES 7)

Report No.:	15-46959
Customer Reference:	15-664
Order No:	Not given

List List <th< th=""><th></th><th>r Sample No</th><th></th><th></th><th></th><th></th><th>BHVC02 0.1</th><th>BHVC02 0.8</th><th>BHVC03 0.1</th><th>BHVC03 0.8</th><th>BHVC04 0.1</th><th>BHVC04 0.8</th><th>BHVC05 0.1</th><th>BHVC05 0.8</th><th>BHVC06 0.1</th><th>BHVC06 0.8</th><th>BHVC07 0.1</th><th>BHVC07 1.2</th><th>BHVC08 0.1</th></th<>		r Sample No					BHVC02 0.1	BHVC02 0.8	BHVC03 0.1	BHVC03 0.8	BHVC04 0.1	BHVC04 0.8	BHVC05 0.1	BHVC05 0.8	BHVC06 0.1	BHVC06 0.8	BHVC07 0.1	BHVC07 1.2	BHVC08 0.1		
Personal product Personal product Semilar			Custon	ner Sample IC	D Certified Reference Material		AQC spike													ſ Į	
Semple Data in the semple D			D	DC Comple No					276055	276056	276057	276059	276050	276060	276061	276062	276062	276064	276065	276066	276067
Sample Locating Sample Locating Sample Dept (n) Sampling Date Sampling Tra NIST-1944 Distance and the sampling Date Sampling Tra Distance and the sampling Tra <thdistance and="" andetance="" sampling="" th="" the="" tra<=""> Distance</thdistance>				Sample Type	SED	IMENT	SED	IMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT
Sample Depth (m) Sampling Data Smpling Data NIST-1944 Spike on class sediment (25µg/kg) 0.1 0.8 0.1 0.8 0.1 0.8 0.1 0.8 0.1 0.8 0.1 0.8 0.1 0.8 0.1 0.8 0.1 0.8 0.1 0.8 0.1 0.8 0.1 0.8 0.1 0.8 0.1 0.8 0.1 1.1 1.2 0.1 1/1			Sa	mple Location	025		010		DEDITIEN	0101112111	02011211	JED I I I I	ULD I I LITI	ULD I I LI	DEDINIEN	U LD111LIII	ULD	ULDINEN	ULD I I LITI	ULDI	ULD I I LITT
Sampling bark Sampling Tark Splike in clean sediment (25g/kg) -			Sam	nle Depth (m)					0.1	0.8	0.1	0.8	0.1	0.8	0.5	0.8	0.1	0.8	0.1	1.2	0.1
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$				Sampling Date	NIS	-1944	Spike on cl	ean sediment	11	11	11	11	11	11	11	11	11	11	11		11
Determinand CAS No Cas SOP Units Rescure γ_0 Rescure γ_0			S	ampling Time			(25)	µg/kg)													
DeterminandCAS orCodeSOPUnitsRecovery %Recovery %Recovery % in																					
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Determinand	CAS No	Codes SOP	Units	Result	Recovery %	Result	Recovery %													
$ \begin{array}{llllllllllllllllllllllllllllllllllll$	ldrin	309-00-2	In house	e ug/kg DW	n/a	n/a	n/a	n/a	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
eta-heachtorocyclohexane (beta-HC), updat-HC) 319-85-7 In house ug/kg DW n/a	lpha-hexachlorocyclohexane (alpha-HCH)	319-84-6	In house	e ug/kg DW	n/a	n/a	n/a	n/a	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
etch-heat/norcyclohexane (deta+HC); 319-86-8 In house ug/kg DW n/a n/a <td>eta-hexachlorocyclohexane (beta-HCH, beta-BHC)</td> <td>319-85-7</td> <td>In house</td> <td>e ug/kg DW</td> <td>n/a</td> <td>n/a</td> <td>n/a</td> <td>n/a</td> <td>< 1.00</td>	eta-hexachlorocyclohexane (beta-HCH, beta-BHC)	319-85-7	In house	e ug/kg DW	n/a	n/a	n/a	n/a	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	elta-hexachlorocyclohexane (delta-HCH)	319-86-8	In house	e ug/kg DW	n/a	n/a	n/a	n/a	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
exactionscience (HS) 118-/+1 In house log/kg DW n/a n/a n/a n/a n/a < < < <th< td=""><td>amma-hexachlorocyclohexane (lindane)</td><td>58-89-9</td><td>In house</td><td>e ug/kg DW</td><td>n/a</td><td>n/a</td><td>n/a</td><td>n/a</td><td>< 1.00</td><td>< 1.00</td></th<>	amma-hexachlorocyclohexane (lindane)	58-89-9	In house	e ug/kg DW	n/a	n/a	n/a	n/a	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
$ \frac{5(1)}{2} + $	exachlorobenzene (HCB)	118-/4-1	In house	e ug/kg DW	n/a	n/a	n/a	n/a	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
and-chrostrate $5103-742$ In house $0g/kg$ DW n/a <	is-chlordane	5103-71-9	In house	e ug/kg DW	n/a	n/a	n/a	n/a	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	ans-chlordane	5103-74-2	In house	e ug/kg DW	n/a	n/a	n/a	n/a	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	ieldrin	60-57-1	In house	e ug/kg DW	n/a	n/a	n/a	n/a	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	ndrin	72-20-8	In house	e ug/kg DW	n/a	n/a	n/a	n/a	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	ndosulran A	959-98-8	In house	e ug/kg DW	n/a	n/a	n/a	n/a	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
epidemic /b-++-s In house ug/kg DW n/a n/a n/a n/a <th<< td=""><td>ndosulfan B</td><td>33213-65-9</td><td>In house</td><td>e ug/kg DW</td><td>n/a</td><td>n/a</td><td>n/a</td><td>n/a</td><td>< 1.00</td><td>< 1.00</td></th<<>	ndosulfan B	33213-65-9	In house	e ug/kg DW	n/a	n/a	n/a	n/a	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	eptachior	76-44-8	In house	e ug/kg DW	n/a	n/a	n/a	n/a	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	eptachior epoxide	1024-57-3	In house	e ug/kg DW	n/a	n/a	n/a	n/a	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
p-DDD 53-19-0 In house Ug/kg DW n/a n/a n/a		72-43-5	In house	e ug/kg DW	n/a	n/a	n/a	n/a	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
yP-DDD 942+02*0 IIII002E Ug/Ng DW 1 a 1 a 1 a 1 a 1 a < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.0	,p-DDD	2424.92.6	In house	e ug/kg DW	n/a	n/a	n/a	n/a	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
	,p-000 n' DDT	790.02.6	In house	e ug/kg DW	II/d	li/d	II/d	li/d	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
y-vui rosuzzo jiintouze vyikaj vi ita ita ita ita ita ita ita ita ita it	,p-DDT	789-02-6	In house	e ug/kg DW	n/a	n/a	n/a	n/a	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
JP-DDT 72570 IIII002E Ug/Kg DW 1 d 1 d 1 d 1 d 1 d < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00	n' DDE	72-34-0	In house	ug/kg DW	II/d	II/d	II/d	II/d	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
yPDDE //23379 III1002E Ug/Kg DW 1 d 1 d 1 d 1 d 1 d < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.00 < 1.0	,p-DDE	72-33-9	In house	e ug/kg DW	II/d	li/d	II/d	li/d	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
_p=but = 52,00,8 lb house loging but ing	ifuralio	1582-00-8	In house		n/a	n/a	n/a	n/a	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
maramine 1922 20 1111022 (1978) 20 1111022 (1978) 20 11102 (1978) 20 110 1102 (1978) 20 1102 (197	4.4 trichlorohinhonyl (PCR congonar 28)	7012-27-5	210	ug/kg DW	72.2	90.5	27.6	110.2	< 0.30	< 0.20	< 0.20	< 0.20	< 0.20	< 0.30	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
	2' 5 5'-tetrachlorobinhenvl (PCB congener 52)	35603-00-3	319	ug/kg DW	84.4	106.3	27.0	110.2	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
2/2/ 55-portal/prohoben/URR ponpener101 37/580-73-2 319 Un/Ro DW 7/7 976 281 1125 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.	2' 4 5 5'-nentachlorobiphenyl (PCB congener 101)	5,5'-tetrachlorobiphenyl (PCB congener 52) 35693-99-3 319 ug/kg D		ug/kg DW	71.7	97.6	28.1	112.5	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
	2' 4 4' 5-pentachlorobiphenyl (PCB congener 118)	31508-00-6	319	ug/kg DW	60.1	103.6	30.1	120.4	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
274 4 5-by-straineroopping (PCR138) 2506578-2 310 Un/kn DW 655 1047 301 103 < 202 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.	2' 3 4 4' 5-beyachlorobinbenvi (PCB 138)	35065-28-2	319	ug/kg DW	65.0	104.7	30.1	120.4	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
	(7,3,4,4,5-nexachiorobiphenyi (PCB 138) 35065-28-2 319 ug/kg DW			ug/kg DW	75.4	101.9	29.2	116.8	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
7.3 4 / 5 (Schentzchlonobiner) (PCB 180) 35065-29-3 319 Un/kn DW 45 104 30 6 1224 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.20 < 0.	2' 3 4 4' 5 5'-bentachlorobinbenyl (PCB 180)	2 /4 / 5 5 -hexachioropiphenyl (PCB 153) 35065-27-1 319 Ug/kg DW				104.9	30.6	122.4	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20

OCL and PCB results have been dry weight corrected

2



Results Summary - PSA Results

Report No.:	15-46959
Customer Reference:	15-664
Order No:	Not given

	ample No	BHVC02 0.1	BHVC02 0.8	BHVC03 0.1	BHVC03 0.8	BHVC04 0.1	BHVC04 0.8	BHVC05 0.1	BHVC05 0.8	BHVC06 0.1	BHVC06 0.8	BHVC07 0.1	BHVC07 1.2	BHVC08 0.1			
			Customer	Comple No.	076055	276256	276257	276250	276250	276060	276264	276262	276262	276264	276265	276266	276267
			KPS	Sample No	276955	276956	2/695/	276958	276959	276960	276961	276962	276963	276964	276965	276966	2/696/
			Sar	npie i ype	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT								
	0.1	0.0	0.1	0.0	0.1	0.0	0.5	0.0	0.1	0.0	0.1	1.2	0.1				
			Sample	Depui (III)	0.1	0.8	0.1	0.8	0.1	0.0	0.5	0.8	0.1	0.0	0.1	1.2	0.1
			San	ipling Date	//	//	//		//	//	//	//	//	//	//		//
			Jan	iping nine												<u> </u>	1
Determinand	CAS No	Codes	SOP	Units													
							Unimodal,	Unimodal,	Unimodal,	Unimodal,	Bimodal,						
					Unimodal,	Unimodal,	Moderately	Moderately	Poorly	Moderately	Moderately	Moderately	Poorly	Moderately	Poorly	Moderately	Poorly
sample type*		S			Well Sorted	Well Sorted	Sorted	Well Sorted	Sorted	Sorted	Well Sorted	Sorted	Sorted	Sorted	Sorted	Well Sorted	Sorted
																	Gravelly
textural group (GRADISTAT)*		S			Sand	Muddy Sand	Sand	Muddy Sand	Sand	Sand							
							Moderately	Moderately	Poorly	Moderately	Moderately	Moderately		Moderately		Moderately	Very Fine
					Well Sorted	Well Sorted	Sorted Fine	Well Sorted	Sorted Fine	Sorted Fine	Well Sorted	Sorted Fine	Coarse Silty	Sorted Fine	Medium Silty	Well Sorted	Gravelly
sediment name*		S			Fine Sand	Fine Sand	Sand	Fine Sand	Sand	Sand	Fine Sand	Sand	Fine Sand	Sand	Fine Sand	Fine Sand	Coarse Sand
arithmetic mean (method of moments)*		S		um	229	221	211	237	176	177	193	199	156	214	195	250	1700
arithmetic sorting (method of moments)*		S		um	66.4	65.3	88.7	81.3	80.7	75.7	78.9	84.1	81.5	94.9	104	100	2270
arithmetic skewness (method of moments)*		S		um	0.759	0.77	0.231	0.903	0.003	0.131	0.245	0.248	0.316	0.015	0.013	0.213	2.86
arithmetic kurtosis (method of moments)*		S		um	3.62	3.67	3.62	3.95	3.34	3.55	3.67	3.66	3.05	3.33	2.87	3.46	14.4
geometic mean (method of moments)*		S		um	216	209	175	221	135	144	163	165	118	168	136	211	742
geometic sorting (method of moments)*		S		um	1.33	1.34	2.24	1.4	2.74	2.39	2.16	2.24	2.67	2.63	3.16	2.18	4.54
geometic skewness (method of moments)*		S		um	-0.014	-0.015	-3.46	0.026	-2.86	-3.35	-3.68	-3.44	-2.47	-3.09	-2.12	-3.97	-1.12
geometic kurtosis (method of moments)*		S		um	2.74	2.73	17.6	2.66	11.4	15.9	19.9	17.4	9.94	13.3	6.96	22.4	5.64
logarithmic mean (method of moments)*		S		phi	2.21	2.26	2.52	2.18	2.89	2.8	2.62	2.6	3.09	2.58	2.88	2.24	0.43
logarithmic sorting (method of moments)*		S		phi	0.414	0.421	1.17	0.484	1.45	1.26	1.11	1.17	1.41	1.39	1.66	1.12	2.18
logarithmic skewness (method of moments)*		5		phi	0.014	0.015	3.46	-0.026	2.86	3.35	3.68	3.44	2.4/	3.09	2.12	3.97	1.12
ioganumic kurtosis (method of moments)**		5		pni	2.74	2.73	17.0	2.00	11.4	15.9	19.9	17.4	9.94	13.3	6.96	22.4	5.04
mean (Folk and Ward method - um)*		5		um	216	209	199	220	164	165	183	189	139	203	1/8	233	838
sorung (Folk and Ward method - UM)*		5		um	1.30	1.3/	1./3	1.43	2.1	1.82	1.51	1./1	2.14	1.99	2.35	1.52	3.93
kurtosis (Folk and Ward method - um)*	1	5 C		um	1.03	-0.012	-0.2/3	0.025	-0.390	-0.316	-0.120	-0.202	1.93	-0.331	-0.437	-0.005	1.07
mean (Folk and Ward method - nhi)*	+	5		phi	2.03	2.26	2.72	2 18	2.55	2.95	2.45	2.41	2.03	2.2/	2.40	2 11	0.255
corting (Folk and Ward method - phi)*		5 C		phi	0.446	0.453	0.790	0.516	1.07	0.963	0.505	0.776	1.1	2.5	1.24	0.500	1.07
skewness (Folk and Ward method - phi)*		5	<u> </u>	phi	0.000	0.13	0.705	-0.023	0.308	0.003	0.353	0.770	0.330	0.351	0.457	0.335	0.022
kurtosis (Folk and Ward method - phi)*		S		nhi	1.03	1.01	1 72	0.025	2 53	1.95	1 1	1.7	1.83	2.27	2.46	1 12	1.07
		5		Pui	1.05	1.01	1.72	0.505	2.33	1.55	1.1	1.7	1.05	2.21	2.70	1.12	1.07
mean description (Folk and Ward method)*		S			Fine Sand	Fine Sand	Fine Sand	Fine Sand	Coarse Sand								
							Moderately	Moderately	Poorly	Moderately	Moderately	Moderately	Poorly	Moderately	Poorly	Moderately	Poorly
sorting description (Folk and Ward method)*		S	I	1	Well Sorted	Well Sorted	Sorted	Well Sorted	Sorted	Sorted	Well Sorted	Sorted	Sorted	Sorted	Sorted	Well Sorted	Sorted

							Very Fine	Very Fine			Very Fine	Very Fine	Very Fine		
skewness description (Folk and Ward method)*	S		Symmetrical	Symmetrical	Fine Skewed	Symmetrical	Skewed	Skewed	Fine Skewed	Fine Skewed	Skewed	Skewed	Skewed	Symmetrical	Symmetrical
					Very		Very	Very		Very	Very	Very	Very		
kurtosis description (Folk and Ward method)*	S		Mesokurtic	Mesokurtic	Leptokurtic	Mesokurtic	Leptokurtic	Leptokurtic	Mesokurtic	Leptokurtic	Leptokurtic	Leptokurtic	Leptokurtic	Leptokurtic	Mesokurtic
MODE 1 - um*	S	um	215	215	215	215	215	215	215	215	153	215	215	215	428
MODE 2 - um*	S	um													1700
MODE 3 - um*	S	um													
MODE 1 - phi*	S	phi	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.74	2.24	2.24	2.24	1.25
MODE 2 - phi*	S	phi													-0.743
MODE 3 - phi*	S	phi													
D10 - um*	S	um	142	138	112	138	87.4	94.4	103	104	48.6	105	19.1	136	181
D50 - um*	S	um	216	210	202	220	171	170	186	191	147	207	194	236	782
D90 - um*	S	um	324	317	327	344	281	276	302	313	262	334	327	387	4350
(D90/D10) - um*	S	um	2.28	2.31	2.93	2.49	3.21	2.93	2.93	3	5.38	3.18	17.2	2.85	24
(D90 - D10) - um*	S	um	182	180	216	206	193	182	199	209	213	229	308	251	4170
(D75/D25) - um*	S	um	1.47	1.49	1.72	1.61	1.76	1.73	1.71	1.72	2.06	1.76	1.9	1.69	6.24
(D75 - D25) - um*	S	um	85.2	83.3	108	108	96.5	93.5	98.2	101	106	116	120	126	1770
D10 - phi*	S	phi	1.62	1.66	1.61	1.54	1.83	1.86	1.73	1.68	1.93	1.58	1.61	1.37	-2.12
D50 - phi*	S	phi	2.21	2.25	2.31	2.18	2.55	2.56	2.43	2.39	2.77	2.27	2.37	2.09	0.355
D90 - phi*	S	phi	2.82	2.86	3.16	2.86	3.52	3.41	3.28	3.27	4.36	3.25	5.71	2.88	2.47
(D90/D10) - phi*	S	phi	1.73	1.73	1.96	1.85	1.92	1.83	1.9	1.95	2.26	2.06	3.54	2.1	-1.16
(D90 - D10) - phi*	S	phi	1.19	1.21	1.55	1.32	1.68	1.55	1.55	1.59	2.43	1.67	4.1	1.51	4.59
(D75/D25) - phi*	S	phi	1.29	1.29	1.4	1.38	1.38	1.36	1.37	1.38	1.46	1.43	1.47	1.45	-1.46
(D75 - D25) - phi*	S	phi	0.558	0.575	0.781	0.687	0.814	0.79	0.773	0.779	1.05	0.816	0.924	0.753	2.64
% gravel*	S	%	0	0	0	0	0	0	0	0	0	0	0	0	26.2
% sand*	S	%	100	100	94.8	100	91.5	94.2	95.7	94.9	88.9	92.6	86.3	96.3	68.6
% mud*	S	%	0	0	5.22	0	8.5	5.85	4.35	5.15	11.1	7.42	13.7	3.68	5.16
% very coarse gravel (>32<64mm or <-5>-6phi)*	S	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% coarse gravel (>16<32mm or <-4>-5phi)*	S	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20
% medium gravel (>8<16mm or <-3>-4phi)*	S	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.77
% fine gravel (>4<8mm or <-2>-3phi)*	S	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.31
% very fine gravel (>2<4mm or <-1>-2phi)*	S	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.90
% very coarse sand (>1<2mm or <0>-1phi)*	S	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.70
% coarse sand (>0.5<1mm or <1>0phi)*	S	%	0.00	0.00	0.04	0.28	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.47	20.40
% medium sand (>0.25<0.5mm or <2>1phi)*	S	%	29.60	25.90	26.80	34.70	14.50	13.60	19.20	22.00	11.40	30.00	25.90	43.60	19.90
% fine sand (>0.125<0.25mm or <3>2phi)*	S	%	68.30	70.90	60.70	61.20	62.10	63.70	64.10	62.70	50.50	57.20	53.20	49.60	10.50
% very fine sand (>0.0625<0.125mm or <4>3phi)*	S	%	2.07	3.21	7.21	3.84	15.00	16.90	12.30	10.20	27.00	5.37	7.16	2.63	1.26
% very coarse silt (>0.03125<0.0625mm or <5>4phi*	S	%	0.00	0.00	0.42	0.00	0.25	0.13	0.17	0.28	2.46	0.74	1.10	0.48	0.81
% coarse silt (>0.015625<0.03125mm or <6>5phi)*	S	%	0.00	0.00	1.69	0.00	2.21	1.70	1.45	1.63	2.96	1.74	3.67	0.55	0.96
% medium silt (>0.007813<0.015625mm or <7>6phi)*	S	%	0.00	0.00	0.92	0.00	1.54	0.89	0.57	0.90	1.75	1.37	3.85	0.58	1.19
% fine silt (>0.003906<0.007813mm or <8>7phi)*	S	%	0.00	0.00	0.98	0.00	1.83	1.18	0.83	1.04	1.64	1.57	2.93	0.85	1.09
% very fine silt (>0.001953<0.003906mm or <9>8phi*	 S	%	0.00	0.00	0.62	0.00	1.49	1.04	0.70	0.69	1.30	1.08	1.33	0.63	0.70
% clay (<0.001953mm or >9phi)*	S	%	0.00	0.00	0.60	0.00	1.18	0.92	0.64	0.60	1.01	0.91	0.83	0.58	0.42



Results Summary - PSA Size Class & Statistics

 Report No.:
 15-46959

 Customer Reference:
 15-664

 Order No:
 Not given

	Custo	mer Sam	ple No	BHVC02 0.1	BHVC02 0.8	BHVC03 0.1	BHVC03 0.8	BHVC04 0.1	BHVC04 0.8	BHVC05 0.1	BHVC05 0.8	BHVC06 0.1	BHVC06 0.8	BHVC07 0.1	BHVC07 1.2	BHVC08 0.1
	Customer Sample ID		mple ID													
	RPS Sample No			276955	276956	276957	276958	276959	276960	276961	276962	276963	276964	276965	276966	276967
	Sample Type			SEDIMENT												
	Sample Location														1	
	S	ample De	pth (m)	0.1	0.8	0.1	0.8	0.1	0.8	0.5	0.8	0.1	0.8	0.1	1.2	0.1
		Samplir	ng Date	//	//	11	11	//	11	//	11	//	11	//	//	//
		Samplin	ng Time													
Sediment	mm	phi ø	Units													
Very coarse gravel	>32<64	<-5>-6	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coarse gravel	>16<32	<-4>-5	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20
Medium gravel	>8<16	<-3>-4	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.77
Fine gravel	>4<8	<-2>-3	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.31
Very fine gravel	>2<4	<-1>-2	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.90
Very coarse sand	>1<2	<0>-1	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.70
Coarse sand	>0.5<1	<1>0	%	0.00	0.00	0.04	0.28	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.47	20.40
Medium sand	>0.25<0.5	<2>1	%	29.60	25.90	26.80	34.70	14.50	13.60	19.20	22.00	11.40	30.00	25.90	43.60	19.90
Fine sand	>0.125<0.25	<3>2	%	68.30	70.90	60.70	61.20	62.10	63.70	64.10	62.70	50.50	57.20	53.20	49.60	10.50
Very fine sand	>0.0625<0.125	<4>3	%	2.07	3.21	7.21	3.84	15.00	16.90	12.30	10.20	27.00	5.37	7.16	2.63	1.26
Very coarse silt	>0.03125<0.0625	<5>4	%	0.00	0.00	0.42	0.00	0.25	0.13	0.17	0.28	2.46	0.74	1.10	0.48	0.81
Coarse silt	>0.015625<0.03125	<6>5	%	0.00	0.00	1.69	0.00	2.21	1.70	1.45	1.63	2.96	1.74	3.67	0.55	0.96
Medium silt	>0.007813<0.015625	<7>6	%	0.00	0.00	0.92	0.00	1.54	0.89	0.57	0.90	1.75	1.37	3.85	0.58	1.19
Fine silt	>0.003906<0.007813	<8>7	%	0.00	0.00	0.98	0.00	1.83	1.18	0.83	1.04	1.64	1.57	2.93	0.85	1.09
Very fine silt	>0.001953<0.003906	<9>8	%	0.00	0.00	0.62	0.00	1.49	1.04	0.70	0.69	1.30	1.08	1.33	0.63	0.70
Clay	<0.001953	>9	%	0.00	0.00	0.60	0.00	1.18	0.92	0.64	0.60	1.01	0.91	0.83	0.58	0.42
Statistics*	Mean (phi)			2.21	2.26	2.33	2.18	2.61	2.6	2.45	2.41	2.84	2.3	2.49	2.11	0.255
	Sorting			0.446	0.453	0.789	0.516	1.07	0.863	0.595	0.776	1.1	0.99	1.24	0.599	1.97
	Skewness			0.009	0.012	0.275	-0.023	0.398	0.318	0.128	0.262	0.339	0.351	0.457	0.085	0.022
	Kurtosis			1.03	1.01	1.72	0.985	2.53	1.95	1.1	1.7	1.83	2.27	2.46	1.12	1.07
	% Silt/Clay		%	0.00	0.00	5.23	0.00	8.50	5.86	4.36	5.14	11.12	7.41	13.71	3.67	5.17
	Textural Group**	ĸ		Sand	Muddy Sand	Sand	Muddy Sand	Sand	Gravelly Sand							

* Folk & Ward

** GRADISTAT classification system (Blott, S. J. & Pye, K., 2001)



Results Summary - PSA Wentworth Scale

 Report No.:
 15-46959

 Customer Reference:
 15-664

 Order No:
 Not given

Customer Sam	ple No	BHVC02 0.1	BHVC02 0.8	BHVC03 0.1	BHVC03 0.8	BHVC04 0.1	BHVC04 0.8	BHVC05 0.1	BHVC05 0.8	BHVC06 0.1	BHVC06 0.8	BHVC07 0.1	BHVC07 1.2	BHVC08 0.1
Customer Sam	nple ID													
RPS Sam	ple No	276955	276956	276957	276958	276959	276960	276961	276962	276963	276964	276965	276966	276967
Sample	e Type	SEDIMENT												
Sample Lo	ocation													
Sample Dep	oth (m)	0.1	0.8	0.1	0.8	0.1	0.8	0.5	0.8	0.1	0.8	0.1	1.2	0.1
Samplin	ig Date							11						
Samplin	g Time													
Parameter	Units													
Pebble	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.28
Granule	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.90
Very coarse sand	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.70
Coarse sand	%	0.00	0.00	0.04	0.28	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.47	20.40
Medium sand	%	29.60	25.90	26.80	34.70	14.50	13.60	19.20	22.00	11.40	30.00	25.90	43.60	19.90
Fine sand	%	68.30	70.90	60.70	61.20	62.10	63.70	64.10	62.70	50.50	57.20	53.20	49.60	10.50
Very fine sand	%	2.07	3.21	7.21	3.84	15.00	16.90	12.30	10.20	27.00	5.37	7.16	2.63	1.26
Silt Clay	%	0.00	0.00	5.23	0.00	8.50	5.86	4.36	5.14	11.12	7.41	13.71	3.67	5.17
Total	%	100.0	100.0	100.0	100.0	100.1	100.1	100.0	100.1	100.0	100.0	100.0	100.0	100.1



Report No.:	15-46959				
Customer Reference:	15-664				
Order No:	Not given				

Comments

Description	Job Comments
13 sediment samples in plastic	n/a
containers	
	13 sediment samples in plastic containers



Report Information

Key to Report Codes

U	UKAS Accredited
Μ	MCERTS Accredited
S	Subcontracted to approved laboratory
US	Subcontracted to approved laboratory UKAS Accredited for the test
MS	Subcontracted to approved laboratory MCERTS/UKAS Accredited for the test
SI	Subcontracted to internal RPS Group Laboratory
USI	Subcontracted to internal RPS Group Laboratory UKAS Accredited for the test
MSI	Subcontracted to internal RPS Group Laboratory MCERTS/UKAS Accredited for the test
I/S (in results)	Insufficient Sample
U/S (in results)	Unsuitable sample
S/C (in results)	See Comments
ND (in results)	Not Detected
DW (in units)	Results are expressed on a dry weight basis

Sample Retention and Disposal

Samples will generally* be retained for	or the following times prior to disposal:
Perishables, e.g. foodstuffs	1 month (if frozen) from the issue date of this report
Waters	2 weeks from the issue date of this report
Other Liquids	1 months from the issue date of this report
Solids (including Soils)	1 months from the issue date of this report

*Sample retention may be subject to agreement with the customer for particular projects

Analytical Methods

Please note:	All testing carried out using the <2mm fraction
TBT and DBT	GCMS analysis following the extraction of the wet sediment and subsequent derivatisation.
Dry solids at 105°C	A portion of the wet sediment is dried at 105°C to constant weight.
Density	Determination of density from the dry sediment by gravimetric analysis of a known volume of sediment.
PSA	Wet and dry sieving follewed by laser diffraction analysis.
TOC	Combustion and infrared analysis following carbonate removal with hydrochloric acid.
Metals	ICP-MS analysis following microwave assisted digestion in hydrofluoric acid of the dried (<30°C) and ground sediment.
PAH's and PCB's	GCMS analysis following extraction of the wet sediment with hexane:acetone by ultrasonic and equilibrium extraction. Extract cleaned-up with alumina and activated copper.

Laboratories

RPS Letchworth	UKAS Test House 1663
RPS Manchester (Metals only)	UKAS Test House 0605
ESG Scientifics (TOC only)	UKAS Test House 0001
Thompson PSA only	

Profiency Testing (PT)

RPS Letchworth and Manchester Laboratories participate in the QUASIMEME Proficiency Testing Scheme

Appendix G SPT hammer energy measurement report

Equipe Group

