

PHOTOGRAPHS

Project Number : PCI14596

Project : Coed Darcy Urban Village, North Site Reservoir Dam



View looking north west along the crest of the dam



View from TP06 looking north east

APPENDIX 4

Borehole Records

Sample Types		Groundwater		Strata, Continued	
B	Bulk disturbed sample	Water Strike		Mudstone	
BLK	Block sample	Depth Water Rose To		Siltstone	
C	Core sample	Instrumentation			
D	Small disturbed sample (tub/jar)				
E	Environmental test sample	Seal			
ES	Environmental soil sample				
EW	Environmental water sample	Filter			
G	Gas sample				
L	Liner sample				
P	Piston sample (PF - failed P sample)			Metamorphic Rock	
TW	Thin walled push in sample			Fine Grained	
U	Open Tube - 102mm diameter with blows to take sample. (UF - failed U sample)	Seal		Medium Grained	
UT	Thin wall open drive tube sampler - 102mm diameter with blows to take sample. (UTF - failed UT sample)			Coarse Grained	
V	Vial sample			Igneous Rock	
W	Water sample			Fine Grained	
#	Sample Not Recovered			Medium Grained	
Insitu Testing / Properties		Strata		Coarse Grained	
S	Standard Penetration Test (SPT)	Made Ground Type 1			
C	SPT with cone	Type 2			
VN	Strength from Insitu Vane	Topsoil			
HV	Strength from Hand Vane				
PP	Strength from Pocket Penetrometer	Cobbles and Boulders			
(All other strengths from undrained triaxial testing)		Gravel			
w%	Water content	Sand			
N	SPT Result	Silt			
-/-	Blows/penetration (mm) after seating drive	Clay			
.*/- (mm)	Total blows/penetration	Peat			
()	Extrapolated value				
Rotary Core		Note: Composite soil types shown by combined symbols			
RQD	Rock Quality Designation (% of intact core >100mm)	Chalk			
FRACTURE INDEX Fractures/metre		Limestone			
FRACTURE SPACING (mm)	Maximum Minimum	Sandstone			
NI	Non-intact core	Coal			
NR	No core recovery (where core recovery is unknown it is assumed to be at the base of the run)				
				Backfill Materials	
				Arisings	
				Bentonite Seal	
				Concrete	
				Fine Gravel Filter	
				General Fill	
				Gravel Filter	
				Grout	
				Sand Filter	
				Tarmacadam	

BOREHOLE RECORD - Cable Percussion

Project COED DARCY N SITE RESERVOIR				Engineer ATKINS LIMITED				Borehole Project No BHNSR01				PC114596			
Client ST. MODWEN DEVELOPMENTS LIMITED				National Grid Coordinates 271227.242E 196446.620N				Ground Level 31.51 m OD							

Sampling			Properties			Strata			Scale 1:50		
Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT N	Description	Depth	Legend	Level m OD		
0.30	D					Turf over topsoil** [MADE GROUND]	G.L.		31.51		
1.00	D			18		Soft dark orangish brown slightly sandy slightly gravelly silty clay with a low to medium angular to subrounded cobble content of grey sandstone. Gravel is fine to coarse angular to subrounded sandstone. [MADE GROUND]	0.20		31.31		
1.20- 1.65	D	1.20 (DRY)			S2						
1.50- 2.00	B			38		Between 1.50-2.50m, 5.45-6.00m and at 8.5m and 10.50m, hydrocarbon odour.					
2.00- 2.50	B										
2.00- 2.45	D	2.00 (DRY)			S4	Soft reddish brown and light bluish grey, occasionally greyish brown, slightly sandy silty clay, slightly gravelly in parts with occasional medium gravel sized pockets/lenses of brown silty sand. Gravel is fine to medium angular to subrounded grey sandstone. [MADE GROUND]	1.90		29.61		
3.00- 3.45	U21	3.00 (DRY)	27	33		At 3.00m, low strength					
3.45- 3.50	D					Between 3.45-4.50m, predominantly light bluish grey, occasionally gravelly and with occasional plant remains.					
3.80	D										
4.00- 4.45	D	4.00 (DRY)			S15						
4.50	D										
5.00- 5.45	U18	5.00 (DRY)	22	19		At 5.00m, low strength					
5.45- 5.50	D										
6.00- 6.45	D	6.00 (DRY)			S10						
6.50	D										
7.00- 7.45	U19	7.00 (DRY)	25	34		At 7.00m, low strength					
7.45- 7.50	D					Between 7.45-7.50m, pocket/ lense of grey speckled black organic clay					
8.00- 8.45	D	8.00 (DRY)			S11						
8.50	D										
9.00- 9.45	U19	9.00 (7.60)	13	34		Firm and stiff reddish brown slightly sandy slightly gravelly clay with some medium gravel sized pockets of dark brown and black silty sand and rare medium gravel sized black slag. [MADE GROUND] At 9.00m, very low strength	9.00		22.51		
9.45- 9.50	D										
10.00-10.45	D	10.00 (DRY)			S11		10.00		21.51		

Boring				Progress					Groundwater					
Depth	Hole Dia	Technique	Crew	Depth of Hole	Depth Cased	Depth to Water	Date	Time	Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater
1.20	0.15	Inspection Pit	PO/SW	G.I.	8.00	DRY	09/05/11	08:00						None encountered during excavation.
15.50		Cable Percussion	PO/SW	9.00	8.00	7.60	09/05/11	18:00						
				9.00	8.00	7.60	10/05/11	08:00						
				15.00	15.00	DRY	10/05/11	18:00						

Remarks Inspection pit hand excavated to 1.20m depth.
 Borehole backfilled with cement-bentonite grout on completion.

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres. Logged in accordance with BS5930:1999 + A2:2010

Logged by CL

Figure 1 of 2
28/07/2011

BOREHOLE RECORD - Cable Percussion

Project COED DARCY N SITE RESERVOIR **Engineer** ATKINS LIMITED **Borehole Project No** BHNSR01
Client ST. MODWEN DEVELOPMENTS LIMITED **National Grid Coordinates** 271227.242E 196446.620N **Ground Level** 31.51 m OD

Sampling			Properties			Strata		Scale 1:50		
Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT N	Description	Depth	Legend	Level m OD	
10.50	D					Firm, occasionally soft, light bluish grey, occasionally greenish brown slightly sandy slightly organic clay with occasional plant remains. [MADE GROUND] At 10.50m, slightly gravelly. Gravel is coarse angular grey sandstone.	10.00		21.51	
11.00-11.45	U23	11.00 (DRY)	27	30		At 11.00m, low strength				
11.45-11.50	D						11.45		20.06	
12.00-12.45	D	12.00 (DRY)			S18	Firm dark brown, occasionally black slightly sandy organic silt with some to much plant remains, occasional pockets of silty sand and rare fine and medium gravel sized slag. [MADE GROUND]	12.00		19.51	
12.50	D					Medium dense dark brown and dark greenish brown silty to very silty slightly gravelly sand with a low angular to subrounded cobble content of sandstone and rare quartzite and occasional thin lenses (2mm thick) of soft grey clay. Gravel is fine angular grey sandstone. [POSSIBLE MADE GROUND]	13.00		18.51	
13.00-13.45	D	13.00 (DRY)			S19					
13.50	D					Soft greenish brown and black slightly sandy organic SILT with rare plant remains. Between 13.50-14.00m, slightly gravelly. Gravel is coarse subangular to subrounded grey sandstone				
14.00-14.45	D	14.00 (DRY)			S20					
14.50	D									
15.00-15.45	U25	15.00 (DRY)	39	24		At 15.00m, low strength				
15.45-15.50	D						15.50		16.01	
15.45-15.50	D					End of Borehole				

Boring				Progress					Groundwater					
Depth	Hole Dia	Technique	Crew	Depth of Hole	Depth Cased	Depth to Water	Date	Time	Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks 

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:1999 + A2:2010

Logged by CL

Figure 2 of 2
28/07/2011



Fieldwork Results - SPT Results Summary

Project COED DARCY N SITE RESERVOIR

Project No PC114596

Client PROSURV CONSULT LIMITED

Hole	Depth m bgl	Level m OD	Type	SWP (mm)	Seating Drive		Test Drive				SPT 'N' Value	Uncorrected SPT 'N'					
					0-75 (mm)	75-150 (mm)	0-75 (mm)	75-150 (mm)	150-225 (mm)	225-300 (mm)		10	20	30	40	50	
BHNSR01	1.20	30.31	S	-	1	-	1	-	1	-	2	*					
BHNSR01	2.00	29.51	S	-	1	1	1	1	1	1	4	*					
BHNSR01	4.00	27.51	S	-	1	2	4	3	4	4	15		*				
BHNSR01	6.00	25.51	S	-	1	2	2	3	2	3	10		*				
BHNSR01	8.00	23.51	S	-	1	2	2	3	3	3	11		*				
BHNSR01	10.00	21.51	S	-	1	2	2	3	3	3	11		*				
BHNSR01	12.00	19.51	S	-	2	3	4	4	5	5	18			*			
BHNSR01	13.00	18.51	S	-	4	3	4	5	5	5	19			*			
BHNSR01	14.00	17.51	S	-	4	4	5	5	5	5	20			*			
Driller			Paul Osborn				Remarks Equipment checked and calibration carried out in accordance with BS EN ISO 22476-3: 2005										
Hammer No.			SD1														
Energy Ratio, Er (%)			69.04														
Calibration Date			11/11/2010														

-/- Blows/penetration (mm) after seating

-*/- Total blows/penetration (mm)

SWP Penetration under own weight (mm)

S - Standard Penetration Test (SPT)

C - SPT with cone

L - Split Spoon with liner used



APPENDIX 5

Trial Pit Records

TRIAL PIT RECORD

Trial Pit

Project COED DARCY N SITE RESERVOIR

Engineer

ATKINS LIMITED

Trial Pit

TP01

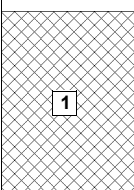
Project No

PC114596

Client ST. MODWEN DEVELOPMENTS LIMITED

National Grid Coordinates 271222.738E
196453.001N

Ground Level 31.53 m OD

Samples and Tests				Strata	Scale 1:50		
Depth	Type	Stratum No	Results	Description	Depth	Legend	Level m OD
0.00- 0.80	B			Dark brown silty sandy gravel grading to slightly sandy slightly gravelly silty clay in parts with a low to medium angular to subrounded cobble content of grey sandstone, occasional roots, rare bricks and medium gravel sized pockets of yellowish brown and orangish brown mottled silty sand. Gravel is fine to coarse angular to subrounded sandstone, coal and brick fragments. [MADE GROUND] Below 0.80m in the eastern half of the pit, firm, occasionally soft, light bluish grey and orangish brown slightly sandy clay with occasional plant remains. [MADE GROUND] End of Excavation	G.L.		31.53
0.80	D		mc=25%		1.20		30.33

Excavation				Groundwater		
Plant	Hand excavated	Width (B)	0.30	Depth Observed	Depth of Pit	Details
Date	10/05/2011	Length (C)	3.00			
Shoring	None.	Date Backfilled	10/05/2011			None encountered during excavation.
Stability	Stable during excavation.					

Remarks		Logged by
Orientation of long axis of pit, approximately northeast to southwest Symbols and abbreviations are explained on the accompanying key sheet. All dimensions are in metres.		CPL Figure 1 of 1 28/07/2011 

Logged in accordance with BS5930:1999 + A2:2010

TRIAL PIT RECORD

Trial Pit

Project COED DARCY N SITE RESERVOIR

Engineer

ATKINS LIMITED

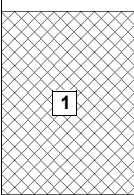
Trial Pit
Project No

TP02
PC114596

Client ST. MODWEN DEVELOPMENTS LIMITED

National Grid
Coordinates 271218.426E
196450.750N

Ground Level 30.13 m OD

Samples and Tests				Strata	Scale 1:50		
Depth	Type	Stratum No	Results	Description	Depth	Legend	Level m OD
0.20	D			Dark orangish brown silty very sandy gravel grading to a slightly sandy slightly gravelly silty clay in parts with a low to medium angular to subrounded cobble content of grey sandstone and occasional roots. Gravel is fine to coarse angular to subrounded sandstone. [MADE GROUND]	G.L.		30.13
0.80- 1.20	B						
0.80	D		mc=13%		1.20		28.93
				End of Excavation			

Excavation				Groundwater		
Plant	Hand excavated	Width (B)	0.40	Depth Observed	Depth of Pit	Details
Date	09/05/2011	Length (C)	0.40			
Shoring	None.	Date Backfilled	09/05/2011			None encountered during excavation.
Stability	Stable during excavation.					

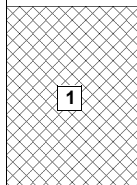
Remarks	AGS	Logged by	CPL
Symbols and abbreviations are explained on the accompanying key sheet.		Figure	1 of 1
All dimensions are in metres.			28/07/2011
Logged in accordance with BS5930:1999 + A2:2010			

geotechnics

Trial Pit

TP03
PC114596

Ground Level 28.32 m OD

Samples and Tests				Strata	Scale 1:50		
Depth	Type	Stratum No	Results	Description	Depth	Legend	Level m OD
0.30	D		mc=9.2%	Dark orangish brown silty sandy gravel grading to a slightly sandy slightly gravelly silty clay in parts with a low to medium angular to subrounded cobble content of grey sandstone and occasional roots. Gravel is fine to coarse angular to subrounded sandstone. [MADE GROUND]	G.I.		28.32
0.70- 1.20 0.70	B D			Below 0.70m, very silty	1.20		27.12
				End of Excavation			

TRIAL PIT RECORD

Trial Pit

Project COED DARCY N SITE RESERVOIR

Engineer

ATKINS LIMITED

Trial Pit

TP04

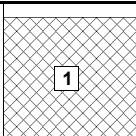
Project No

PC114596

Client ST. MODWEN DEVELOPMENTS LIMITED

National Grid Coordinates 271211.322E
196446.443N

Ground Level 26.64 m OD

Samples and Tests				Strata	Scale 1:50		
Depth	Type	Stratum No	Results	Description	Depth	Legend	Level m OD
				Dark orangish brown slightly silty very sandy gravel with a low to medium cobble content of grey sandstone and occasional roots. Gravel is fine to coarse angular to subrounded sandstone. [MADE GROUND]	G.L.		26.64
0.30	D						
0.40- 1.00	B						
0.60- 1.20	B						
0.80- 1.20	B				0.80		25.84
0.80	D	mc=11%		Dark orangish brown slightly gravelly slightly sandy silty clay grading to a silty sandy gravel in parts with a low angular to subrounded cobble content of grey sandstone and occasional roots. Gravel is fine to coarse angular to subrounded sandstone. [MADE GROUND]	1.20		25.44
				End of Excavation			

Excavation				Groundwater		
Plant	Hand excavated	Width (B)	0.40	Depth Observed	Depth of Pit	Details
Date	10/05/2011	Length (C)	0.40			
Shoring	None.	Date Backfilled	10/05/2011			None encountered during excavation.
Stability	Stable during excavation.					

Remarks 	Logged by CPL
Symbols and abbreviations are explained on the accompanying key sheet.	Figure 1 of 1 28/07/2011
All dimensions are in metres.	
Logged in accordance with BS5930:1999 + A2:2010	

TRIAL PIT RECORD

Trial Pit

Project COED DARCY N SITE RESERVOIR

Engineer

ATKINS LIMITED

Trial Pit

TP05

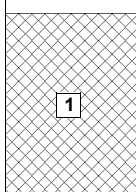
Project No

PC114596

Client ST. MODWEN DEVELOPMENTS LIMITED

National Grid Coordinates 271209.005E
196444.444N

Ground Level 25.15 m OD

Samples and Tests				Strata		Scale 1:50	
Depth	Type	Stratum No	Results	Description	Depth	Legend	Level m OD
				Dark orangish brown silty sandy gravel grading to a slightly sandy slightly gravelly silty clay in parts with a low to medium angular to subrounded cobble content of grey sandstone, occasional roots and rare medium gravel sized coal fragments. Gravel is fine to coarse angular to subrounded sandstone. [MADE GROUND]	G.L.		25.15
0.50	D						
0.80- 1.20	B						
0.80	D		mc=18%				
1.00	D			End of Excavation	1.20		23.95

Excavation				Groundwater		
Plant	Hand excavated	Width (B)	0.40	Depth Observed	Depth of Pit	Details
Date	10/05/2011	Length (C)	0.40			
Shoring	None.	Date Backfilled	10/05/2011			None encountered during excavation.
Stability	Stable during excavation.					

Remarks	AGS	Logged by	CPL
Symbols and abbreviations are explained on the accompanying key sheet.		Figure	1 of 1
All dimensions are in metres.			28/07/2011
Logged in accordance with BS5930:1999 + A2:2010			

TRIAL PIT RECORD

Trial Pit

Project COED DARCY N SITE RESERVOIR

Engineer

ATKINS LIMITED

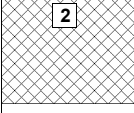
Trial Pit
Project No

TP06
PC114596

Client ST. MODWEN DEVELOPMENTS LIMITED

National Grid
Coordinates 271206.331E
196443.024N

Ground Level 23.72 m OD

Samples and Tests				Strata	Scale 1:50		
Depth	Type	Stratum No	Results	Description	Depth	Legend	Level m OD
0.05	D			Black slightly sandy slightly gravelly organic silt with many rootlets. [MADE GROUND]	G.L. 0.05		23.72 23.67
0.60- 1.20	B			Dark orangish brown silty sandy gravel grading to a slightly sandy slightly gravelly silty clay in parts with a low to medium angular to subrounded cobble content of grey sandstone and occasional roots. Gravel is fine to coarse angular to subrounded sandstone. [MADE GROUND]			
1.10	D			Below 0.60m, with a medium to high sandstone angular to subrounded cobble content.	1.20		22.52
				End of Excavation			

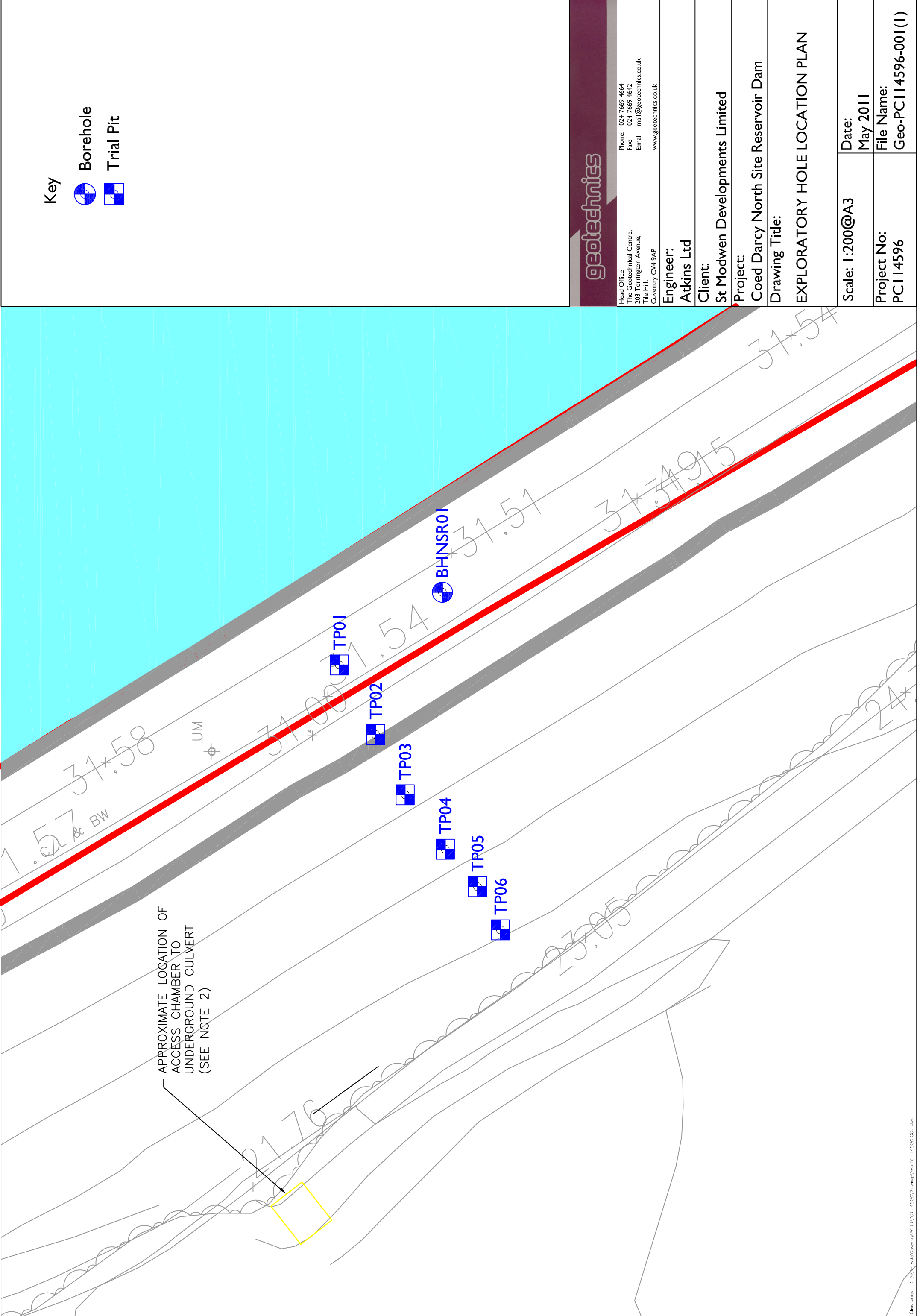
Excavation				Groundwater		
Plant	Hand excavated	Width (B)	0.40	Depth Observed	Depth of Pit	Details
Date	10/05/2011	Length (C)	0.40			
Shoring	None.	Date Backfilled	10/05/2011			None encountered during excavation.
Stability	Stable during excavation.					

Remarks	AGS	Logged by	CPL
Symbols and abbreviations are explained on the accompanying key sheet.		Figure	1 of 1
All dimensions are in metres.			28/07/2011
Logged in accordance with BS5930:1999 + A2:2010			

geotechnics

APPENDIX 6

Exploratory Hole Location Plan



APPENDIX 7

Laboratory Test Results - Geotechnical

Classification and Strength

Symbol	C - Clay (0 - containing organic matter) Plasticity	M - Silt L - Low I - Intermediate H - High V - Very High E - Extremely High
I _p	Plasticity Index	
%	% Retained on 425 µm sieve, shown under I _p value	
w _L	Liquid Limit	
w _p	Plastic Limit	
NP	Non-Plastic	
NAT	Sample tested in natural state	
w	Moisture Content	
p _d	Particle Density	
Test	Quick undrained triaxial tests	
SS	Single stage - 102mm diameter.	
S3	Single stage - set of 3 38mm diameter.	
MS	Multistage - 102mm diameter.	
D	Drained Test	
HV	Hand Vane	
PP	Pocket Penetrometer (kg/cm ²)	
NST	Not suitable for test	
γ _b	Bulk Density	
σ ₃	Triaxial Cell Pressure	
σ ₁ - σ ₃	Deviator Stress	
##	Excessive Strain	
c _u	Undrained Cohesion	
c	Cohesion Intercept	
φ	Angle of Shearing Resistance	
Linear Shrink	Linear Shrinkage	

Consolidation

m _v	Coefficient of Volume Compressibility
c _{v50}	Coefficient of Consolidation - Log t
c _{v90}	Coefficient of Consolidation - √t

Rock

UF	Unacceptable Failure
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Chemical Analysis

Acid Soluble	Total sulphate in specimen, expressed as SO ₃ %, value in brackets expressed as SO ₄ %
Water Soluble	Soluble sulphate in 2:1 water : soil extract, expressed as SO ₃ g/l, value in brackets expressed as SO ₄ g/l
In Water	Sulphate content of groundwater, expressed as SO ₃ g/l, value in brackets expressed as SO ₄ g/l
pH	pH value
Organic content	Organic content expressed as a percentage of dry weight
Chloride	Chloride Ion content expressed as a percentage of dry weight

MCV, Compaction, CBR

MCV	Moisture Condition Value at natural moisture content
MCC	Moisture Condition Calibration
CCV	Chalk Crushing Value

Compaction

Type	2.5 = BS 2.5 kg Rammer
	4.5 = BS 4.5 kg Rammer
	V = BS Vibrating Hammer

γ _b	Bulk Density
γ _d	Dry Density

CBR California Bearing Ratio

Type	2.5 = Test on Specimen Recompacted using BS 2.5 kg Rammer
	4.5 = As above but using BS 4.5 kg Rammer
	V = As above but using BS Vibrating Hammer
	M = Test on open drive mould specimen cut in field
	S = Soaked Specimen
Top	CBR at top of mould
Bottom	CBR at bottom of mould
ND	None Detected

All tests performed in accordance with BS 1377 : Parts 1-9 : 1990 incorporating amendments where appropriate.

LABORATORY RESULTS - Classification and Strength

Project COED DARCY N SITE RESERVOIR

Project No: PC114596

Sample					Classification					Strength					
Hole	Depth (Specimen Depth) m	Type	Sample Ref	Description	Symbol	I_p (>425) %	w_L %	w_p %	w (p_d) %	Test	γ_b (γ_d) Mg/m ³	σ_3 kN/m ²	$\sigma_1 - \sigma_3$ kN/m ²	C_u kN/m ²	C_{Avg} kN/m ²
BHNSR01	1.00 (1.00)	D	C53776	Orangish brown slightly sandy slightly gravelly silty clay. [MADE GROUND]	CL	10 (48%)	27	17	18						
BHNSR01	1.50- 2.00 (1.50)	B	C52795	Orangish brown slightly sandy slightly gravelly silty clay. [MADE GROUND]	CI	25 (11%)	43	18	38						
BHNSR01	3.00- 3.45 (3.00)	U	C52807	Reddish brown and bluish grey slightly sandy silty clay. [MADE GROUND]	CI	21 (NAT)	44	23	33 33 33	MS	1.91 1.91 1.91	30 60 120	53 55 55	27 27 27	27
BHNSR01	5.00- 5.45 (5.00)	U	C52804	Reddish brown and bluish grey slightly sandy slightly gravelly silty clay. [MADE GROUND]	CL	12 (48%)	26	14	19 19 19	MS	2.26 2.26 2.26	50 100 200	41 44 ##	21 22 ##	22
BHNSR01	7.00- 7.45 (7.00)	U	C52806	Reddish brown and bluish grey slightly sandy slightly gravelly silty clay. [MADE GROUND]					34 34 34	MS	1.94 1.94 1.94	70 140 280	48 50 50	24 25 25	25
BHNSR01	9.00- 9.45 (9.00)	U	C52808	Reddish brown mottled grey slightly sandy slightly gravelly clay. [MADE GROUND]					34 34 34	MS	1.96 1.96 1.96	90 180 360	23 25 29	12 13 14 ##	13
BHNSR01	11.00- 11.45 (11.00)	U	C52805	Grey mottled brown slightly sandy clay. [MADE GROUND]	CI	26 (NAT)	49	23	30 30 30	MS	1.81 1.81 1.81	110 220 440	54 54 54	27 27 27	27
BHNSR01	15.00- 15.45 (15.00)	U	C52803	Greenish brown and black slightly sandy slightly gravelly organic SILT.					24 24 24	MS	2.10 2.10 2.10	150 300 600	78	39 ##	39
TP01	0.80 (0.80)	D	C53780	Brown slightly sandy slightly gravelly silty clay. [MADE GROUND]	CI	25 (3%)	45	20	25						
TP02	0.80 (0.80)	D	C53778	Orangish brown silty sandy gravel. [MADE GROUND]		(67%)	22	NP	13						
TP03	0.30 (0.30)	D	C53781	Brown silty very sandy gravel. [MADE GROUND]		(51%)	23	NP	9.2						
TP04	0.80 (0.80)	D	C53784	Brown slightly sandy slightly gravelly clay. [MADE GROUND]	CL	9 (59%)	24	15	11						
TP05	1.00 (1.00)	D	C53785	Brown slightly sandy slightly gravelly clay. [MADE GROUND]	CL	7 (41%)	23	16	18						

Remarks  Tests performed in accordance with BS 1377: 1990



LABORATORY RESULTS - Particle Size Distribution

Project: COED DARCY N SITE RESERVOIR

Hole BHNSR01

Sample Depth 2.00-2.50m

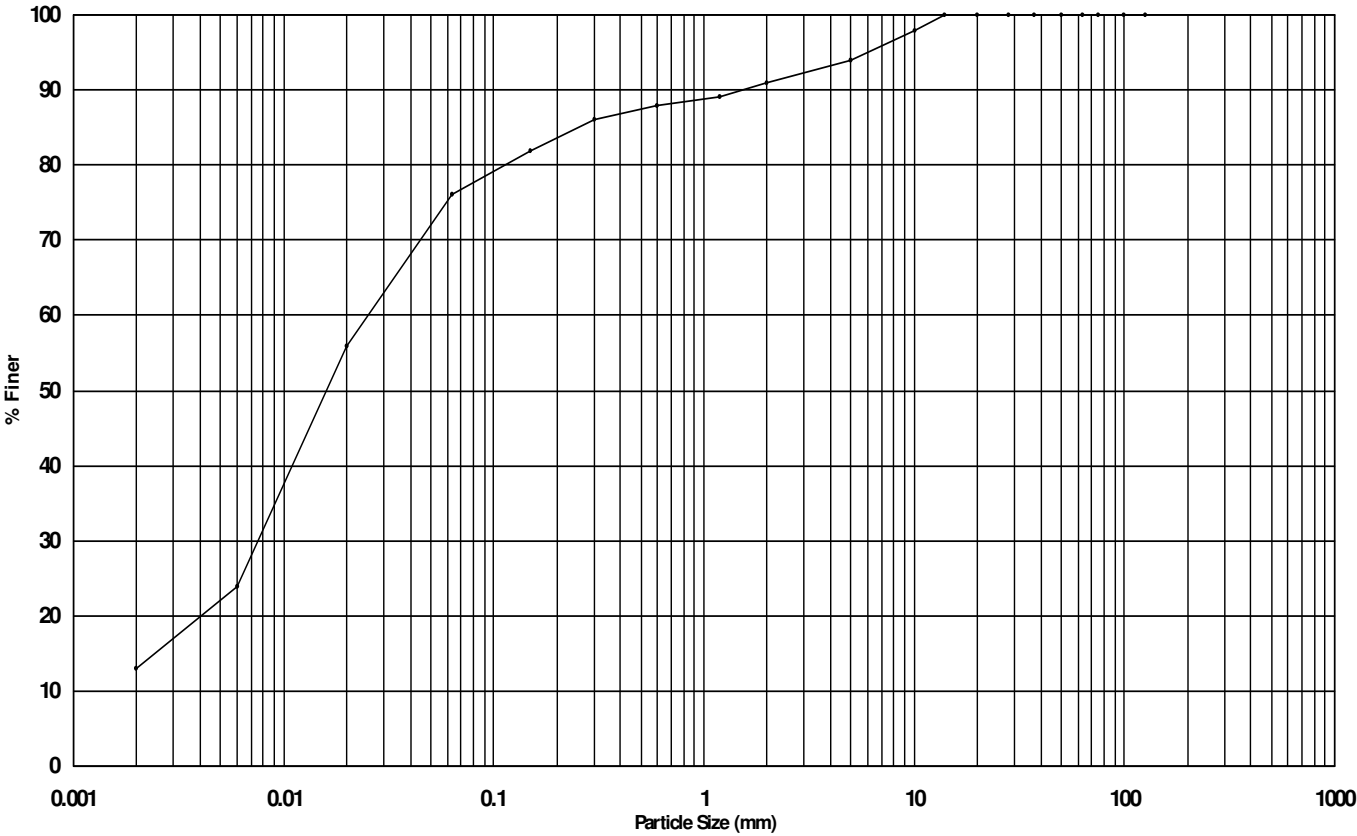
Project No: PC114596

Sample Type B

Sample Ref C52796

Sample Description

Reddish brown and bluish grey slightly sandy slightly gravelly silty clay. [MADE GROUND]



Classification	CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	Cobbles	Boulders
		SILT			SAND			Gravel				

Classification	% of each
CLAY	13
SILT	63
SAND	15
GRAVEL	9
COBBLES	0
BOULDERS	0

Size	Percentage Finer
125mm	100
100mm	100
75mm	100
63mm	100
50mm	100
37.5mm	100
28mm	100
20mm	100
14mm	100
10mm	98
6.3mm	-
5mm	94
3.35mm	-

Size	Percentage Finer
2mm	91
1.18mm	89
600µ m	88
425µ m	-
300µ m	86
212µ m	-
150µ m	82
75µ m	-
63µ m	76
20µ m	56
6µ m	24
2µ m	13

Uniformity Coefficient	
Not Available	
Sieving Method	
Wet sieve	
Fine Particle Analysis	
Method	Pipette
Pre-treated with	Hydrogen Peroxide
% loss on Pre-treatment	0.47
Particle Density	2.65 (Assumed)

Remarks  Test performed in accordance with BS 1377: Part 2: 1990

15/06/2011



LABORATORY RESULTS - Particle Size Distribution

Project: COED DARCY N SITE RESERVOIR

Hole BHNSR01

Sample Depth 3.00-3.45m

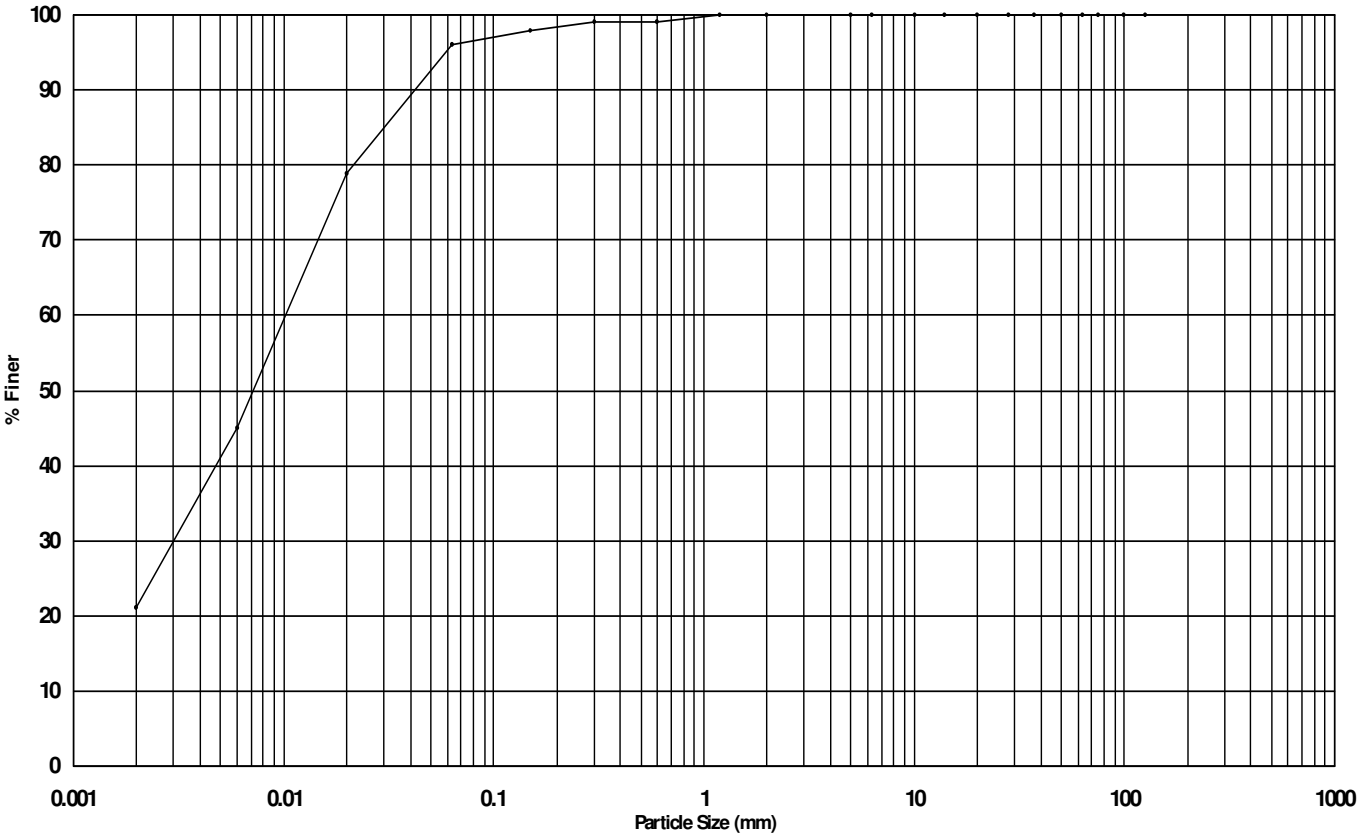
Sample Type U

Sample Ref C52807

Project No: PC114596

Sample Description

Reddish brown and bluish grey slightly sandy silty clay. [MADE GROUND]



Classification	CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	Cobbles	Boulders
		SILT			SAND			Gravel				

Classification	% of each
CLAY	21
SILT	75
SAND	4
GRAVEL	0
COBBLES	0
BOULDERS	0

Size	Percentage Finer
125mm	100
100mm	100
75mm	100
63mm	100
50mm	100
37.5mm	100
28mm	100
20mm	100
14mm	100
10mm	100
6.3mm	100
5mm	100
3.35mm	100

Size	Percentage Finer
2mm	100
1.18mm	100
600µ m	99
425µ m	-
300µ m	99
212µ m	-
150µ m	98
75µ m	-
63µ m	96
20µ m	79
6µ m	45
2µ m	21

Uniformity Coefficient	
Not Available	
Sieving Method	
Wet sieve	
Fine Particle Analysis	
Method	Pipette
Pre-treated with	Hydrogen Peroxide
% loss on Pre-treatment	2.04
Particle Density	2.65 (Assumed)

Remarks Test performed in accordance with BS 1377: Part 2: 1990

15/06/2011



LABORATORY RESULTS - Particle Size Distribution

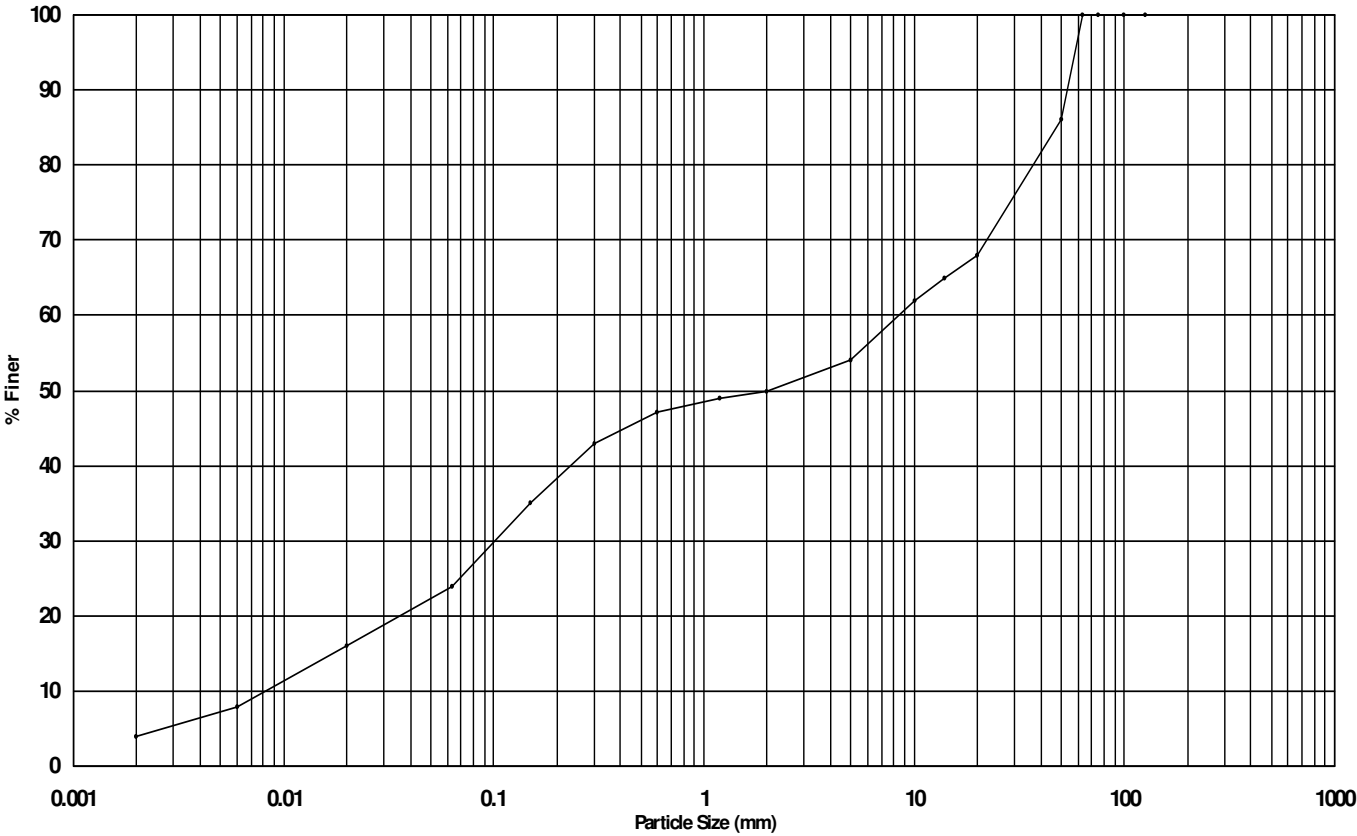
Project: COED DARCY N SITE RESERVOIR

Project No: PC114596

Hole TP01
Sample Depth 0.00-0.80m
Sample Type B
Sample Ref C52797

Sample Description

Brown very silty very sandy gravel.[MADE GROUND]



Classification	CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	Cobbles	Boulders
		SILT			SAND			Gravel				

Classification	% of each
CLAY	4
SILT	20
SAND	26
GRAVEL	50
COBBLES	0
BOULDERS	0

Size	Percentage Finer
125mm	100
100mm	100
75mm	100
63mm	100
50mm	86
37.5mm	-
28mm	-
20mm	68
14mm	65
10mm	62
6.3mm	-
5mm	54
3.35mm	-

Size	Percentage Finer
2mm	50
1.18mm	49
600µ m	47
425µ m	-
300µ m	43
212µ m	-
150µ m	35
75µ m	-
63µ m	24
20µ m	16
6µ m	8
2µ m	4

Uniformity Coefficient	
1132.54	
Sieving Method	
Wet sieve	
Fine Particle Analysis	
Method	Pipette
Pre-treated with	Hydrogen Peroxide
% loss on Pre-treatment	1.91
Particle Density	2.65 (Assumed)

Remarks  Test performed in accordance with BS 1377: Part 2: 1990

15/06/2011



LABORATORY RESULTS - Particle Size Distribution

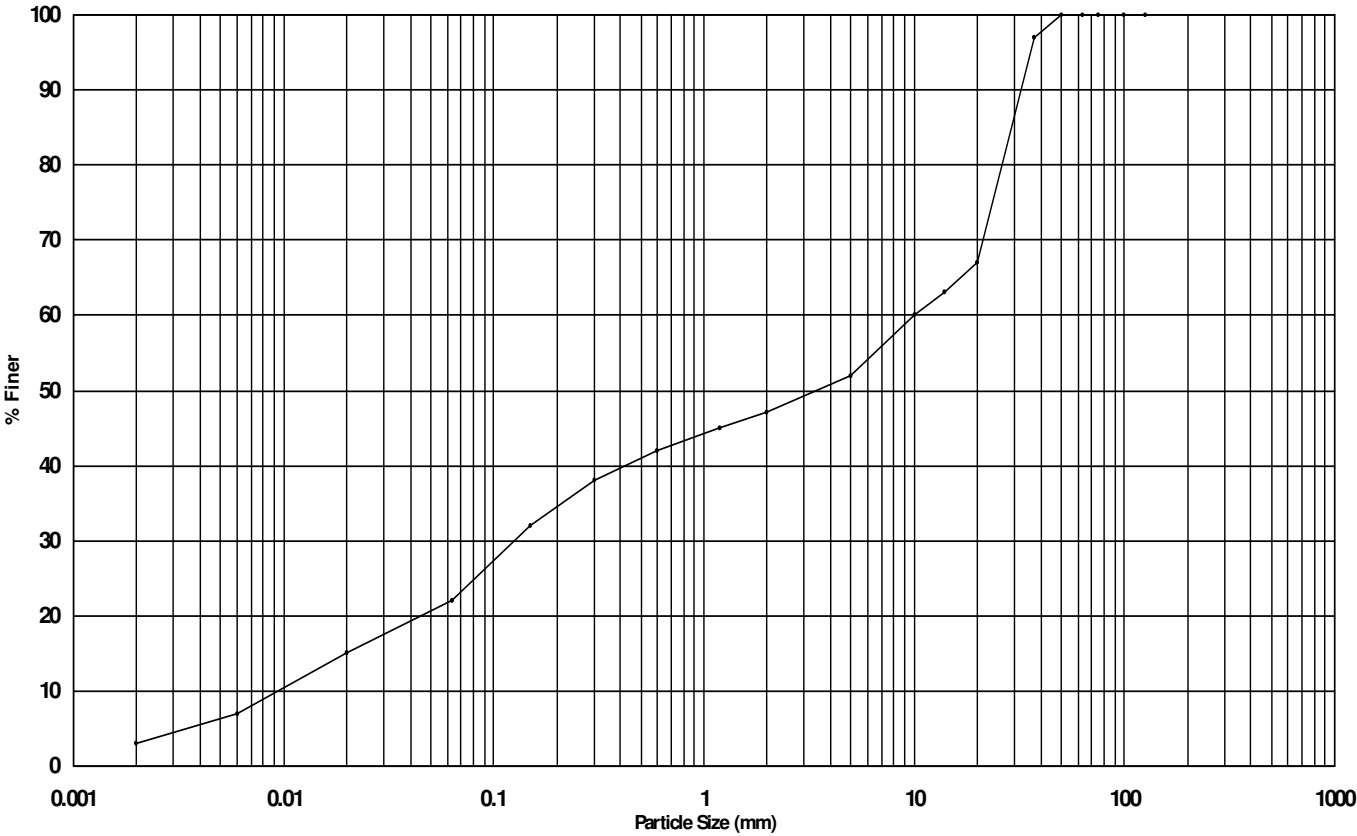
Project: COED DARCY N SITE RESERVOIR

Hole TP02
Sample Depth 0.80-1.20m
Sample Type B
Sample Ref C52798

Project No: PC114596

Sample Description

Orangish brown silty very sandy gravel. [MADE GROUND]



Classification	CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	Cobbles	Boulders
		SILT			SAND			Gravel				

Classification	% of each
CLAY	3
SILT	19
SAND	25
GRAVEL	53
COBBLES	0
BOULDERS	0

Size	Percentage Finer
125mm	100
100mm	100
75mm	100
63mm	100
50mm	100
37.5mm	97
28mm	-
20mm	67
14mm	63
10mm	60
6.3mm	-
5mm	52
3.35mm	-

Size	Percentage Finer
2mm	47
1.18mm	45
600µ m	42
425µ m	-
300µ m	38
212µ m	-
150µ m	32
75µ m	-
63µ m	22
20µ m	15
6µ m	7
2µ m	3

Uniformity Coefficient	
1012.85	
Sieving Method	
Wet sieve	
Fine Particle Analysis	
Method	Pipette
Pre-treated with	Hydrogen Peroxide
% loss on Pre-treatment	0.00
Particle Density	2.65 (Assumed)

Remarks Test performed in accordance with BS 1377: Part 2: 1990

15/06/2011



LABORATORY RESULTS - Particle Size Distribution

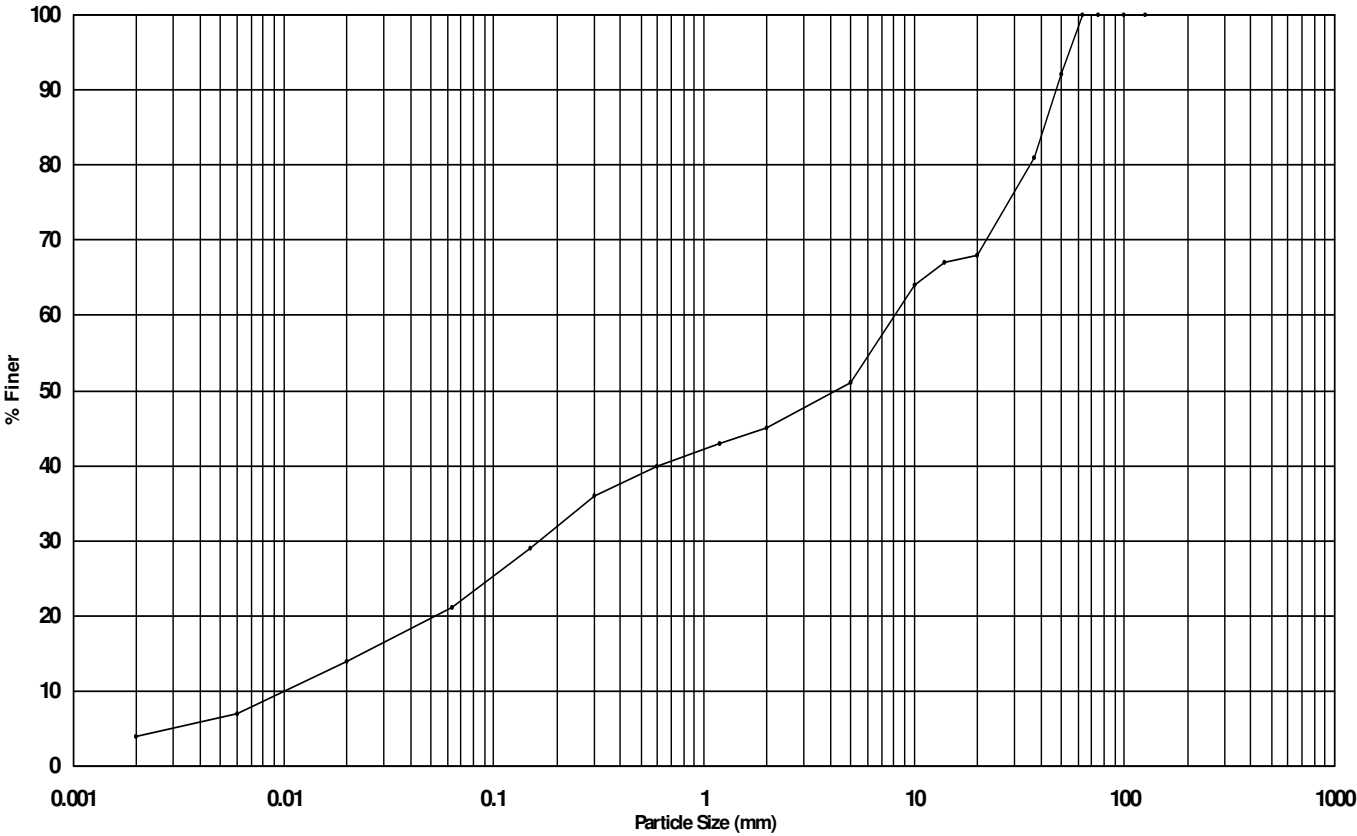
Project: COED DARCY N SITE RESERVOIR

Hole TP04
Sample Depth 0.40-1.00m
Sample Type B
Sample Ref C52800

Project No: PC114596

Sample Description

Brown silty very sandy gravel. [MADE GROUND]



Classification	CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	Cobbles	Boulders
		SILT			SAND			Gravel				

Classification	% of each
CLAY	4
SILT	17
SAND	24
GRAVEL	55
COBBLES	0
BOULDERS	0

Size	Percentage Finer
125mm	100
100mm	100
75mm	100
63mm	100
50mm	92
37.5mm	81
28mm	-
20mm	68
14mm	67
10mm	64
6.3mm	-
5mm	51
3.35mm	-

Size	Percentage Finer
2mm	45
1.18mm	43
600µm	40
425µm	-
300µm	36
212µm	-
150µm	29
75µm	-
63µm	21
20µm	14
6µm	7
2µm	4

Uniformity Coefficient	
763.65	
Sieving Method	
Wet sieve	
Fine Particle Analysis	
Method	Pipette
Pre-treated with	Hydrogen Peroxide
% loss on Pre-treatment	2.19
Particle Density	2.65 (Assumed)

Remarks  Test performed in accordance with BS 1377: Part 2: 1990

15/06/2011



APPENDIX 8

Investigation Techniques and General Notes

INVESTIGATION TECHNIQUES

INTRODUCTION

The following brief review of Ground Investigation techniques, generally used as part of most Site Investigations in the UK, summarises their methodology, advantages and limitations. Detailed descriptions of the techniques are available and can be provided on request. This review should be read in conjunction with the accompanying General Notes.

TRIAL PITS

The trial pit is amongst the most simple yet effective means of identifying shallow ground conditions on a site. Its advantages include simplicity, speed, potential accuracy and cost-effectiveness. The trial pit is most commonly formed using a backacting excavator which can typically determine ground conditions to some 4 metres below ground level. Hand excavation is often used to locate, expose and detail existing foundations, features or services. In general, it is difficult to extend pits significantly below the water table in predominantly granular soils, where flows can cause instability. Unless otherwise stated, the trial pits will not have been provided with temporary side support during their construction. Under such circumstances ground conditions to some 1.20 metres can be closely inspected, subject to stability assessment, but below this depth, entrance into the pit is not permitted in the absence of shoring and hence observations will have been made from ground surface and samples taken from the excavator bucket.

Trends in strata type, level and thickness can be determined, shear surfaces identified and the behaviour of plant, excavation sides and excavated materials can be related to the construction process. They are particularly valuable in land slip investigations. Some types of *insitu* test can be undertaken in such pits and large disturbed or block samples obtained.

CABLE PERCUSSION BORING

The light Cable Percussion technique of soft ground boring, typically at a diameter of 150mm, is a well established simple and flexible method of boring vertical holes and generally allows data to be obtained in respect of strata conditions other than rock. A tubular cutter (for cohesive soils) or shell with a flap valve (for granular soils) is repeatedly lifted and dropped using a winch and rope operating from an "A" frame. Soil which enters these tools is regularly removed and either sampled for subsequent examination or test, or laid to one side for backfilling. Steel casing will have been used to prevent collapse of the borehole sides where necessary. A degree of disturbance of soil and mixing of layers is inevitable and the presence of very thin layers of different soils within a particular stratum may not be identified. Changes in strata type can only be detected on recognition of a change in soil samples at surface, after the interface has been passed. For the foregoing reasons, depth measurements should not be considered to be more accurate than 0.10 metre.

In cohesive soils cylindrical samples are retrieved by driving or pushing in 100mm nominal diameter tubes. In soft soils, piston sampling or vane testing may be undertaken. In granular soils and often in cohesive materials, *insitu* Standard Penetration Tests (SPT's) are performed. The SPT records the number of standard blows required to drive a 50mm diameter open or cone ended probe for 300mm after an initial 150mm penetration. A modified method of recording is used in more dense strata. Small disturbed samples are obtained throughout.

The technique can determine ground conditions to depths in excess of 30 metres under suitable circumstances and usually causes less surface disturbance than trial pitting.

ROTARY DRILLING

Rotary Drilling to produce cores by rotating an annular diamond-impregnated tube or barrel into the ground is the technique most appropriate to the forming of site investigation boreholes through rock or other hard strata. It has the advantage of being able to be used vertically or at an angle. Core diameters of less than 100mm are most common for site investigation purposes. Core is normally retrieved in plastic lining tubes. A flushing fluid such as air, water or foam is used to cool the bit and carry cuttings to the surface.

Examination of cores allows detailed rock description and generally enables angled discontinuity surfaces to be observed. However, vertical holes do not necessarily reveal the presence of vertical or near-vertical fissures or joint discontinuities. The core type and/or techniques used. Where open hole rotary drilling is employed, descriptions of strata result from examination at surface of small particles ejected from the borehole in the flushing medium. In consequence, no indication of fissuring, bedding, consistency or degree of weathering can be obtained. Small scale plant can be used for auger drilling to limited depths where access is constrained.

Depths in excess of 60 metres can be achieved under suitable circumstances using rotary techniques, with minimal surface disturbance.

WINDOW SAMPLING

This technique involves the driving of an open-ended tube into the ground and retrieval of the soil which enters the tube. The term "window sample" arose from the original device which had a "window" or slot cut into the side of the tube through which samples were taken. This has now been superseded by the use of a thin-walled plastic liner within a sampler which has a solid wall. Diameters range from 36 to 86mm. Such samples can be used for qualitative logging, selection of samples for classification and chemical analysis and for obtaining a rudimentary assessment of strength.

Driving devices can be hand-held or machine mounted and the drive tubes are typically in 1m lengths. The hole formed is not cased, however, and hence the success of this technique is limited when soils and groundwater conditions are such that the sides of the hole collapse on withdrawal of the sampler. Obstructions within the ground, the density of the material or its strength can also limit the depth and rate of penetration of this light-weight investigation technique. Nevertheless, it is a valuable tool where access is constrained such as within buildings or on embankments. Depths of up to 8m can be achieved in suitable circumstances but depths of 4m to 6m are more common.

EXPLORATORY HOLE RECORDS

The data obtained by these techniques are generally presented on Trial Pit, Borehole, Drillhole or Window Sample Records. The descriptions of strata result from information gathered from a number of sources which may include published geological data, preliminary field observations and descriptions, *insitu* test results, laboratory test results and specimen descriptions. A key to the symbols and abbreviations used accompanies the records. The descriptions on the exploratory hole records accommodate but may not necessarily be identical to those on any preliminary records or the laboratory summaries.

The records show ground conditions at the exploratory hole locations. The degree to which they can be used to represent conditions between or beyond such holes, however, is a matter for geological interpretation rather than factual reporting and the associated uncertainties must be recognised.

DYNAMIC PROBING

This technique typically measures the number of blows of a standard weight falling over a standard height to advance a cone-ended rod over sequential standard distances (typically 100mm). Some devices measure the penetration of the probe per standard blow. It is essentially a profiling tool and is best used in conjunction with other investigation techniques where site-specific correlation can be used to delineate the distribution of soft or loose soils or the upper horizon of a dense or strong layer such as rock.

Both machine-driven and hand-driven equipment is available, the selection depending upon access restrictions and the depth of penetration required. It is particularly useful where access for larger equipment is not available, disturbance is to be minimised or where there are cost constraints. No samples are recovered and some techniques leave a sacrificial cone head in the ground. As with other lightweight techniques, progress is limited in strong or dense soils. The results are presented both numerically and graphically. Depths of up to 10m are commonly achieved in suitable circumstances.

The hand-driven DCP probing device has been calibrated by the TRL to provide a profile of CBR values over a range of depths of up to 1.50m.

INSTRUMENTATION

The most common form of instrument used in site investigation is either the standpipe or else the standpipe piezometer which can be installed in investigation holes. They are used to facilitate monitoring of groundwater levels and water sampling over a period of time following site work. Normally a standpipe would be formed using rigid plastic tubing which has been perforated or slotted over much of its length whilst a standpipe piezometer would have a filter tip which would be placed at a selected level and the hole sealed above and sometimes below to isolate the zone of interest. Groundwater levels are determined using an electronic "dipmeter" to measure the depth to the water surface from ground level. Piezometers can also be used to measure permeability. They are simple and inexpensive instruments for long term monitoring but response times can limit their use in tidal areas and access to the ground surface at each instrument is necessary. Remote reading requires more sophisticated hydraulic, electronic or pneumatic equipment.

Settlement can be monitored using surface or buried target plates whilst lateral movement over a range of depths is monitored using slip indicator or inclinometer equipment.

GENERAL NOTES

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4. The assessment of the significance of the factual data, where called for, is provided to assist the Client and his Engineer and/or Advisers in the preparation of their designs.
5. The report is based on the ground conditions encountered in the exploratory holes together with the results of field and laboratory testing in the context of the proposed development. The data from any commissioned desk study and site reconnaissance are also drawn upon. There may be special conditions appertaining to the site, however, which are not revealed by the investigation and which may not be taken into account in the report.
6. Methods of construction and/or design other than those proposed by the designers or referred to in the report may require consideration during the evolution of the proposals and further assessment of the geotechnical and any geoenvironmental data would be required to provide discussion and evaluations appropriate to these methods.
7. The accuracy of results reported depends upon the technique of measurement, investigation and test used and these values should not be regarded necessarily as characteristics of the strata as a whole (see accompanying notes on Investigation Techniques). Where such measurements are critical, the technique of investigation will need to be reviewed and supplementary investigation undertaken in accordance with the advice of the Company where necessary.
8. The samples selected for laboratory test are prepared and tested in accordance with the relevant Clauses of BS 1377 Parts 1 to 8, where appropriate, in Geotechnics Limited's UKAS accredited Laboratory, where possible. A list of tests is given.
9. Tests requiring the use of another laboratory having UKAS accreditation where possible are identified.
10. Any unavoidable variations from specified procedures are identified in the report.
11. Specimens are cut vertically, where this is relevant and can be identified, unless otherwise stated.
12. All the data required by the test procedures are recorded on individual test sheets but the results in the report are presented in summary form to aid understanding and assimilation for design purposes. Where all details are required, these can be made available.
13. Whilst the report may express an opinion on possible configurations of strata between or beyond exploratory holes, or on the possible presence of features based on either visual, verbal, written, cartographical, photographic or published evidence, this is for guidance only and no liability can be accepted for its accuracy.
14. Classification of materials as Made Ground is based on the inspection of retrieved samples or exposed excavations. Where it is obvious that foreign matter such as paper, plastic or metal is present, classification is clear. Frequently, however, for fill materials that arise from the adjacent ground or from the backfilling of excavations, their visual characteristics can closely resemble those of undisturbed ground. Other evidence such as site history, exploratory hole location or other tests may need to be drawn upon to provide clarification. For these reasons, classification of soils on the exploratory hole records as either Made Ground or naturally occurring strata, the boundary between them and any interpretation that this gives rise to should be regarded as provisional and subject to re-evaluation in the light of further data.
15. The classification of materials as Topsoil is generally based on visual description and should not be interpreted to mean that the material so described complies with the criteria for Topsoil used in BS 3882 (2007). Specific testing would be necessary where such definition is a requirement.
16. Ground conditions should be monitored during the construction of the works and the report should be re-evaluated in the light of these data by the supervising geotechnical engineers.
17. Any comments on groundwater conditions are based on observations made at the time of the investigation, unless specifically stated otherwise. It should be noted, however, that the observations are subject to the method and speed of boring, drilling or excavation and that groundwater levels will vary due to seasonal or other effects.
18. Any bearing capacities for conventional spread foundations which are given in the report and interpreted from the investigation are for bases at a minimum depth of 1m below finished ground level in naturally occurring strata and at broadly similar levels throughout individual structures, unless otherwise stated. The foundations should be designed in accordance with the good practice embodied in BS 8004:1986 - Foundations, supplemented for housing by NHBC Standards. Foundation design is an iterative process and bearing pressures may need adjustment or other measures may need to be taken in the context of final layouts and levels prior to finalisation of proposals.
19. Unless specifically stated, the investigation does not take account of the possible effects of mineral extraction or of gases from fill or natural sources within, below or outside the site.
20. The costs or economic viability of the proposals referred to in the report, or of the solutions put forward to any problems encountered, will depend on very many factors in addition to geotechnical or geoenvironmental considerations and hence their evaluation is outside the scope of the report.



Coed Darcy Urban Village
Former BP Llandarcy Oil Refinery
Neath/Port Talbot,

East Bay – Verification Report

September 2011

R1434/11/4067



Client: **St Modwen Developments PLC**

Report Number: **R1434/11/4067**

Report Title: **East Bay – Verification Report**

Report Status: **Revision 1**

Author(s): **N Hopkins**

(Signature & Date)

Project Manager **J Hearing**

(Signature & Date)

QA Approved: **M Holmes**

(Signature & Date)

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The report is only valid when it is used in its entirety.

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CONTENTS

1.0	INTRODUCTION	1
1.1	Site Background	1
1.2	Previous Investigation	1
2.0	CONCEPTUAL SITE MODEL	3
3.0	REMEDIATION WORKS	6
3.1	Objectives	6
3.2	Mobile Treatment Licence	6
3.3	Environmental Monitoring	6
3.4	Delineation	7
3.5	Works Access	7
3.6	Water Management	8
3.6.1	Surface Water Diversion	8
3.6.2	NSR Inflow	9
3.7	Separator Removal	10
3.8	De-watering of East Bay	13
3.8.1	Surface Water Monitoring	14
3.9	Removal of Hydrocarbon Impacted Material	14
3.9.1	Section 1	15
3.9.2	Section 2	17
3.9.3	Section 3	20
3.10	Removal of Man-made Pier/ Embankment	24
3.11	Hydrocarbon Seepages – Dam between East Bay and NSR	26
3.12	Potentially Contaminated Material – Eastern Boundary	27
3.13	Reinstatement works	30
3.14	Post Works Survey	30
3.15	Quarantine	30
3.16	Quantification of the amount of Hydrocarbon Impacted Material / Removed	30
3.17	Integration of Works with Materials Management Plan	31
3.18	Integration of Works with Site Waste Management Plan	31
4.0	BIOREMEDIATION	32
5.0	VERIFICATION	33

5.1	Verification Criteria	33
5.2	Chemical Verification Data	34
5.3	Visual and Olfactory Assessment	35
5.4	Post Works Water Monitoring	37
6.0	CONCLUSION	38

APPENDICES

APPENDIX A DRAWINGS

- A1 – Site Location**
- A2 – Pre-remediation Layout**
- A3 – Specific area of works**
- A4 – East Bay Work Sections**
- A5 – Sample Location Plan**
- A6 – Post Works Topographic Survey**

APPENDIX B DETAILED POST WORKS PHOTOGRAPHS

APPENDIX C POST WORKS VERIFICATION DATA

- C1 – Visual and Olfactory Results**
- C2 – Verification Sample Photographs**
- C3 – Laboratory Certificates of Analysis**
- C4 – Trial Pit Logs**

APPENDIX D SURFACE WATER MONITORING

- D1 – Discharge Water Monitoring (during works)**
- D2 – Post Works Water Monitoring**

APPENDIX E PROJECT CORRESPONDENCE

1.0 INTRODUCTION

CELTIC Technologies Ltd (Celtic) has been commissioned by St. Modwen Developments PLC (The Client) to undertake the remediation of an area known as East Bay at the Coed Darcy Urban Development.

The Coed Darcy Urban Village development is located on the site of the former BP Llandarcy Refinery, South Wales. A site location plan is presented in Appendix A, Drawing A1.

These works were designed and completed to achieve sign-off for the Remedial Action Plan (RAP) requirements only. It is understood that further work will be carried out to achieve sign-off against the redevelopment requirements.

1.1 Site Background

East Bay measures approximately 0.8 hectares and is located to the north of the main former refinery process area. It bounds the North Site Reservoir (NSR) along the western boundary. It is believed that East Bay was constructed during the operational phase of the refinery to provide a separation lagoon between site discharges and the NSR.

East Bay is separated from the NSR by a dam which runs in a North/South orientation along the western margin of East Bay. The precise construction details of the dam have not been provided. However, during the remediation works several large diameter, low level pipes were noted to run through the dam linking the two water bodies (discussed further in Section 3.8).

In addition to water inflows from the NSR, East Bay also acts as a catchment for surface water run-off from the adjacent M4 motorway that runs along the eastern boundary and a spring line at the south eastern corner.

The location and layout (pre-remediation) of East Bay is presented in Appendix A, Drawing A2.

1.2 Previous Investigation

An intrusive ground investigation was undertaken at East Bay, prior to the commencement of the remediation works, the main objectives of the investigation were to:

- develop an understanding of the physical composition of the underlying materials (made ground and natural);
- collect samples of the underlying material for laboratory analysis; and
- quantify the likely volume of material requiring removal and remediation.

The ground investigation comprised a combination of mechanically excavated trial pits and direct sludge sampling. Samples were obtained and scheduled for a range of organic

and inorganic contaminants (for further details refer to R1357/09/3730 – Factual Site Investigation Report).

Following the ground investigation it was estimated that approximately 5,000 m³ of hydrocarbon impacted material was present at the base of East Bay.

Laboratory analysis indicated significantly elevated concentrations of Total Petroleum Hydrocarbon (TPH), with an average concentration of 115,000 mg/kg, ranging to a maximum of 170,000 mg/kg.

2.0 Conceptual Site Model

A Conceptual Site Model has been prepared for East Bay following completion of the intrusive investigation and prior to commencement of the remediation works in order to assess potential risks to the surrounding environment.

Three main factors have been considered during the assessment, which are:

- The presence of a SOURCE of contamination;
- The presence of a PATHWAY linking the source to the receptor; and
- The presence of a RECEPTOR which may be affected by the source of contamination.

The identified potential sources, pathways and receptors are listed in Table 1, along with an assessment of the likelihood and environmental consequence of all three factors being present. Details on the methodology used to assign the consequence are presented in Table 2. Groundwater has not been considered as a potential source of contamination as discussions with Atkins indicate that it is not impacted by contaminants, however Celtic have not got access to any groundwater monitoring data (undertaken by Atkins), so this cannot be confirmed.

Table 1 – Source-Pathway-Receptor Risk Assessment

Potential Receptors	Potential Sources	Potential Pathways	Comments	Consequence	Likelihood
Groundwater	Hydrocarbon Impacted material	Leaching of contamination from impacted material	A site investigation undertaken by Celtic confirms the presence of a significant thickness of highly contaminated material lying at the base of East Bay. Groundwater is understood to be relatively shallow and so it is considered likely that contaminants may leach out of the contaminated material and into the underlying groundwater.	Moderate	Likely
Surface Water (East Bay)	Hydrocarbon Impacted material	Leaching of contamination from impacted material	Site investigation confirms the presence of significantly contaminated material lying at the base of East Bay, which is in direct contact with the surface water contained within.	Moderate	Likely
	Hydrocarbon Impacted Materials at North Site Reservoir	Lateral flow through the dam wall dividing East Bay and North Site Reservoir	Site Investigations indicates the presence of significantly contaminated material at the base of North Site Reservoir, which could enter East Bay through the dam.	Moderate	Possible
	Surface water inflows from M4 and spring line	Direct inflow of contamination	There is potential for contaminants associated with the M4 run-off and spring ling may impact East Bay	Moderate	Possible
	Hydrocarbon Impacted material at East Bay	Leaching of contamination from impacted material	It is understood that East Bay and NSR are connected by low level pipes and so it is likely that any water within East Bay impacted by the contaminated material may directly pass into NSR.	Moderate	Likely

Potential Receptors	Potential Sources	Potential Pathways	Comments	Consequence	Likelihood
Surface Water (NSR) - which drains into the Crymlyn Bog SSSI	Contaminated Groundwater	Horizontal flow	NSR is adjacent to East Bay and so any impacts on the ground water at East Bay are likely to affect the water quality in NSR. However, NSR is also understood to have hydrocarbon impacted material at its base and so the consequence of contaminated water from East Bay affecting the surface water in NSR is considered Mild. It is understood that North Site Reservoir discharges into the Crymlyn Bog SSSI. Although Celtic are not aware of the specific discharge regime, separation systems, etc.	Mild	Likely

Table 2 – Guide to Assigning Consequences

Classification	Human Health	Controlled Water	Ecological	Built Environment
Severe	Irreversible damage to human health - high concentrations/frequency or sensitivity.	Substantial pollution of sensitive water resources	Significant harm as defined in Part IIa i.e. irreversible or substantial adverse change to Part IIa eco receptor	Irreparable damage to buildings, structures or the environment
Moderate	Non-permanent health effects to humans - lower concentrations/frequency or sensitivity.	Pollution of non-sensitive water resources or small scale pollution of sensitive water resources	Irreversible or substantial adverse change in the functioning of an ecosystem of land without the required ecological/habitat status for Part IIa	Damage to sensitive buildings, structures or the environment
Mild	Slight short term health effects to humans	Slight pollution to non-sensitive water resources	Some change to population densities but with no negative effects on the function of the ecosystem	Easily repairable effects of damage to buildings or structures
Negligible	No measurable effects on humans	Insubstantial pollution to non-sensitive water resources	No significant changes to population densities in the environment or in any ecosystem	Very slight non-structural damage or cosmetic harm to buildings or structures

3.0 REMEDIATION WORKS

3.1 Objectives

The objectives of the East Bay remediation works were to:

- Divert water inflows;
- Remove a redundant oil/water separator structure;
- Remove hydrocarbon impacted materials from East Bay to mitigate risk of further impacts to the receptors identified in the Conceptual Site Model; and
- Remediation of the excavated hydrocarbon impacted material to a recreational end-use standard allowing it to be incorporated within the main site. Verification of these materials will be dealt under the cover of a separate report.

These works are in accordance with the requirements of the Section 106 agreement and the specification supplied by Atkins, which states the performance criteria as being:

“Removal and treatment to achieve restoration quality standards agreed with the Environment Agency of hydrocarbon contaminated surface and near surface soil and sediment to the satisfaction of EA”

The works were undertaken in full consultation with the EA, although no written correspondence has been returned to Celtic. It is understood that Atkins have consulted with the EA and distributed the agreed remediation strategy.

The remediation and verification works detailed within this report only apply to the RAP elements and not to the requirements for redevelopment sign-off. The verification of the works is limited to East Bay only and does not allow for verification of the surrounding area. The specific area of the works is detailed in Appendix A, Drawing A2.

Works at East Bay started week commencing 15th November 2010 (including enabling works) and were completed on the week of the 25th April 2011.

3.2 Mobile Treatment Licence

The East Bay remediation works were undertaken in accordance with Celtic’s Mobile Treatment Licence (MTL) EAWML 30379. During the works there was no official Environment Agency licence inspections conducted at the site.

3.3 Environmental Monitoring

A condition of the mobile treatment licence that was deployed to the site was that environmental monitoring was undertaken on a daily basis, whilst works were being undertaken. This monitoring included the following assessments:

- Dust
- Noise
- Odour

During the works there were no recorded exceedances of the predetermined environmental exposure limits. Please refer to remediation strategy document R1434-10-3960 for a full description of the monitoring protocols. All recorded environmental monitoring data is retained on site and is available on request.

3.4 Delineation

The lateral extents of the East Bay Lagoon were clearly defined by the surrounding landform. The vertical delineation of the removal of hydrocarbon impacted material was undertaken on a visual basis by experienced engineers.

The removal of hydrocarbon impacted material progressed until the natural underlying soils were exposed. The natural base was validated by a visual and olfactory assessment, which was supplemented by laboratory analysis.

3.5 Works Access

In order to undertake the remediation works at East Bay, an access road was created that linked the main refinery to East Bay. The road crosses farmland to the south of East Bay and enters the site from the south eastern corner. The road was created by stripping an area approximately 6 m wide and 0.3 m deep (exposing the subsoil). A geomembrane was placed and covered by imported granular material (see Photograph 1).

Photograph 1 – East Bay Access Road



Two man-made piers that were already present within East Bay were used as access points to undertake the removal of the majority of the impacted material. The remaining material was removed by creating additional roads directly onto the natural base (glacial deposits).

3.6 Water Management

3.6.1 Surface Water Diversion

East Bay was fed by two main inflows, the first was a spring line that entered the site from the south eastern corner and the second was surface run-off from the M4 that entered the site from the east. Two open diversion trenches were installed around the perimeter of East Bay that diverted the two identified inflows directly into the NSR (Photograph 2 and 3).

Photograph 2 – Motorway Drainage Diversion



Photograph 3 – Spring-line Diversion

3.6.2 NSR Inflow

During the remediation works three large diameter low level pipes were encountered running through the embankment between NSR and East Bay. A clay plug was placed over the pipe inlet on the NSR side, however this only reduced the inflow as water continued to seep through the pipes but also through the surrounding embankment (see Photograph 4).

Photograph 4 – Low level pipe linking East Bay to NSR

The water inflow entering East Bay from NSR was controlled by creating a low permeability bund around the area of the most significant inflow to prevent it from impacting the wider works (see Photograph 5).

Photograph 5 – Low permeability bund, in the top right, created within East Bay



3.7 Separator Removal

As part of the remediation works Celtic were required to clean and dismantle a redundant oil/ water separator located within the south eastern corner of East Bay (Photograph 6).

Photograph 6 – Separators prior to Demolition



Hydrocarbon impacted material within the separators was mixed with wood fines (Photograph 7), which were then transported to a treatment pad. The base of the separators comprised a significant thickness of concrete with no visible cracking or damage noted. It is therefore unlikely that any of the hydrocarbon impacted material contained within the separators have impacted the underlying material.

Prior to demolition the base of the separators were scrapped to ensure that the hydrocarbon impacted material had been removed (Photograph 8). The concrete base to separator was then broken up (Photograph 9) and the remaining concrete from the sides placed on top.

Photograph 7 – Mixing and removal of material within the separators



Photograph 8 – Scraping of concrete base of separators



Photograph 9 – Demolition of the base following sludge removal

