DETS

UKAS TESTING
4480

Tim Rudkin
Soils Ltd
Newton House
Cross Road
Tadworth
Surrey
KT20 5SR

DETS Ltd
Unit 1
Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Kent
ME17 2JN
t: 01622 850410

DETS Report No: 20-08992

Site Reference:	Copped Close
Project / Job Ref:	18512
Order No:	18512
Sample Receipt Date:	11/08/2020
Sample Scheduled Date:	11/08/2020
Report Issue Number:	1
Reporting Date:	19/08/2020

Authorised by:

[redacted]

Kevin Old
General Manager

Dates of laboratory activities for each tested analyte are available upon request.

Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

MCERTS UKAS TESTING 4480

Soil Analysis Certificate - Methodology & Miscellaneous Information

DETS Report No: 20-08132
Soils Ltd
Site Reference: Copped Close
Project / Job Ref: 18512
Order No: None Supplied
Reporting Date: 28/07/2020

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	D	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 – C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	D	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	AR	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	D	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	AR	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	D	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	AR	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	D	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	AR	Sulphide	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	D	Sulphur - Total	Determination of sulphide by distillation followed by colorimetry	E018
Soil	AR	SVOC	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	Thiocyanate (as SCN)	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	D	Toluene Extractable Matter (TEM)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Total Organic Carbon (TOC)	Gravimetrically determined through extraction with toluene	E011
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of volatile organic compounds by headspace GC-MS	E001
			Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received

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Unit 1
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Kent
ME17 2JN
t: 01622 850410

DETS Report No: 20-08132

Site Reference:	Copped Close
Project / Job Ref:	18512
Order No:	None Supplied
Sample Receipt Date:	22/07/2020
Sample Scheduled Date:	22/07/2020
Report Issue Number:	1
Reporting Date:	28/07/2020

Authorised by:

[redacted]
Dave Ashworth
Technical Manager

Dates of laboratory activities for each tested analyte are available upon request.

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DETS Ltd
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MCERTS UKAS TESTING 4480

Soil Analysis Certificate						
DETS Report No: 20-08132	Date Sampled	None Supplied	None Supplied			
Soils Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: Copped Close	TP / BH No	WS1	WS1			
Project / Job Ref: 18512	Additional Refs	None Supplied	None Supplied			
Order No: None Supplied	Depth (m)	0.90	2.10			
Reporting Date: 28/07/2020	DETS Sample No	488451	488452			

Determinand	Unit	RL	Accreditation					
pH	pH Units	N/a	MCERTS	7.2	7.7			
Total Sulphate as SO_3	mg/kg	< 200	NONE	466	1196			
Total Sulphate as SO_4	%	< 0.02	NONE	0.05	0.12			
W/S Sulphate as SO_4 (2:1)	mg/l	< 10	MCERTS	128	468			
W/S Sulphate as SO_4 (2:1)	g/l	< 0.01	MCERTS	0.13	0.47			
Total Sulphur	%	< 0.02	NONE	0.02	0.04			
Ammonium as NH_4	mg/kg	< 0.5	NONE	5.3	11.8			
Ammonium as NH_4	mg/l	< 0.05	NONE	0.53	1.18			
W/S Chloride (2:1)	mg/kg	< 1	MCERTS	51	131			
W/S Chloride (2:1)	mg/l	< 0.5	MCERTS	25.6	65.6			
Water Soluble Nitrate (2:1) as NO_3	mg/kg	< 3	MCERTS	3	< 3			
Water Soluble Nitrate (2:1) as NO_3	mg/l	< 1.5	MCERTS	1.5	< 1.5			
W/S Magnesium	mg/l	< 0.1	NONE	4.7	34			

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C. The Samples Descriptions page describes if the test is performed on the dried or as-received portion
Subcontracted analysis (S)

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Soil Analysis Certificate - Sample Descriptions
DETS Report No: 20-08132
Soils Ltd
Site Reference: Copped Close
Project / Job Ref: 18512
Order No: None Supplied
Reporting Date: 28/07/2020

DETS Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
^ 488451	WS1	None Supplied	0.90	5.2	Brown sandy clay with stones
^ 488452	WS1	None Supplied	2.10	16.9	Light brown clay

Moisture content is part of procedure E003 & is not an accredited test

Insufficient Sample I/S

Unsuitable Sample U/S

^ no sampling date provided; unable to confirm if samples are within acceptable holding times

Appendix C Foundation Design

Appendix C.1 Preliminary Pile Design

DETS Ltd
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Tel : 01622 850410

4480

Soil Analysis Certificate - Methodology & Miscellaneous Information

DETS Report No: 20-08992

Soils Ltd

Site Reference: Copped Close

Project / Job Ref: 18512

Order No: 18512

Reporting Date: 19/08/2020

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	D	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 – C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	AR	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	AR	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	D	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	AR	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	D	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	AR	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	D	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	AR	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received

DETS Ltd
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Tel : 01622 850410

MCERTS UKAS TESTING 4480

Soil Analysis Certificate						
DETS Report No: 20-08992	Date Sampled	None Supplied	None Supplied	None Supplied	None Supplied	
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	
Site Reference: Copped Close	TP / BH No	BH1	BH1	BH1	BH1	
Project / Job Ref: 18512	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	
Order No: 18512	Depth (m)	4.00	6.00	8.00	9.50	
Reporting Date: 19/08/2020	DETS Sample No	492007	492008	492009	492010	

Determinand	Unit	RL	Accreditation					
pH	pH Units	N/a	MCERTS	7.6	7.5	7.9	7.9	
Total Sulphate as SO_4	mg/kg	< 200	NONE				2864	
Total Sulphate as SO_4	%	< 0.02	NONE				0.29	
W/S Sulphate as SO_4 (2:1)	mg/l	< 10	MCERTS	2420	2890	1840	1740	
W/S Sulphate as SO_4 (2:1)	g/l	< 0.01	MCERTS	2.42	2.89	1.84	1.74	
Total Sulphur	%	< 0.02	NONE				0.51	
Ammonium as NH_4	mg/kg	< 0.5	NONE				17.9	
Ammonium as NH_4	mg/l	< 0.05	NONE				1.79	
W/S Chloride (2:1)	mg/kg	< 1	MCERTS				381	
W/S Chloride (2:1)	mg/l	< 0.5	MCERTS				190	
Water Soluble Nitrate (2:1) as NO_3	mg/kg	< 3	MCERTS				6	
Water Soluble Nitrate (2:1) as NO_3	mg/l	< 1.5	MCERTS				3.1	
W/S Magnesium	mg/l	< 0.1	NONE				110	

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C. The Samples Descriptions page describes if the test is performed on the dried or as-received portion
Subcontracted analysis (S)

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4480

Soil Analysis Certificate - Sample Descriptions
DETS Report No: 20-08992
Soils Ltd
Site Reference: Copped Close
Project / Job Ref: 18512
Order No: 18512
Reporting Date: 19/08/2020

DETS Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
^ 492007	BH1	None Supplied	4.00	14.5	Brown clay
^ 492008	BH1	None Supplied	6.00	13.8	Brown clay
^ 492009	BH1	None Supplied	8.00	11.5	Brown clay
^ 492010	BH1	None Supplied	9.50	12.4	Brown clay

Moisture content is part of procedure E003 & is not an accredited test

Insufficient Sample I/S

Unsuitable Sample U/S

^ no sampling date provided; unable to confirm if samples are within acceptable holding times

GSTL

NATURAL MOISTURE, LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX
(BS 1377 : Part 2 : 1990 Method 5)

Contract Number	49428
Project Location	Copped Close
Date Tested	28/07/2020

Sample/Hole Reference	Sample Number	Sample Type	Depth (m)			Moisture Content %	Liquid Limit %	Plastic Limit %	Plasticity index %	Passing 0.425mm %	Remarks
WS1		D	1.40	-		6.3		NP		20	
WS2		D	1.80	-		29	78	30	48	100	CV Very High Plasticity
WS3		D	1.30	-		3.2		NP		17	
WS3		D	2.60	-		27	80	33	47	100	CV Very High Plasticity
WS4		D	1.20	-		26	84	30	54	100	CV Very High Plasticity
WS4		D	2.70	-		31	84	34	50	100	CV Very High Plasticity
				-							
				-							
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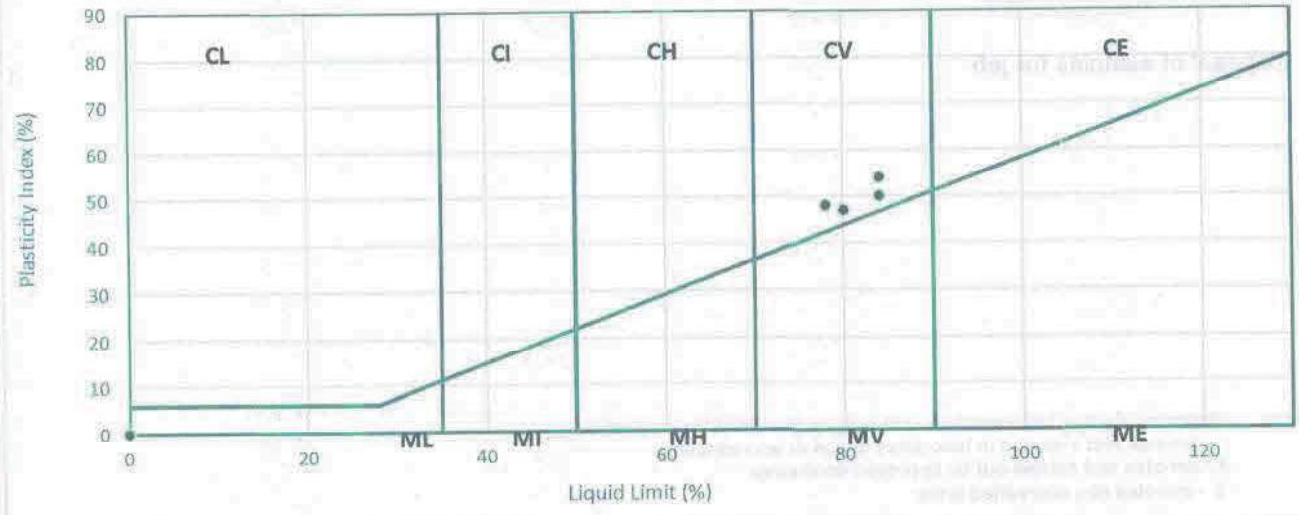
Symbols: NP : Non Plastic # : Liquid Limit and Plastic Limit Wet Sieved

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION
BS 5930:1999+A2:2010



Operators	Checked	30/07/2020	Wayne Honey (Administrative/Quality Assistant)
Daniel Bassett	Approved	30/07/2020	Paul Evans (Quality/Technical Manager)

UKAS TESTING 2788

Laboratory Report

UKAS TESTING
2788

GSTL
GEO Site & Testing Services Ltd

Contract Number: 49757

Client Ref: **18512**
Client PO: **18512**

Report Date: **25-08-2020**

Client **Soils Limited**
Newton House
Cross Road
Tadworth
Surrey
KT20 5SR

Contract Title: **Copped Close**
For the attention of: **Tim Rudkin**

Date Received: **12-08-2020**
Date Completed: **25-08-2020**

Test Description	Qty
Moisture Content BS 1377:1990 - Part 2 : 3.2 - * UKAS	1
1 Point Liquid & Plastic Limit BS 1377:1990 - Part 2 : 4.4 & 5.3 - * UKAS	1
Quick Undrained Triaxial Compression test - single specimen at one confining pressure (100mm or 38mm diameter) BS 1377:1990 - Part 7 : 8 - * UKAS	3
Disposal of samples for job	1

Notes: **Observations and Interpretations are outside the UKAS Accreditation**
*** - denotes test included in laboratory scope of accreditation**
 # - denotes test carried out by approved contractor
@ - denotes non accredited tests

Approved Signatories:
Emma Sharp (Office Manager) - Paul Evans (Quality/Technical Manager) - Richard John (Advanced Testing Manager)
Sean Penn (Administrative/Accounts Assistant) - Shaun Jones (Laboratory manager) - Wayne Honey (Administrative/Quality Assistant)

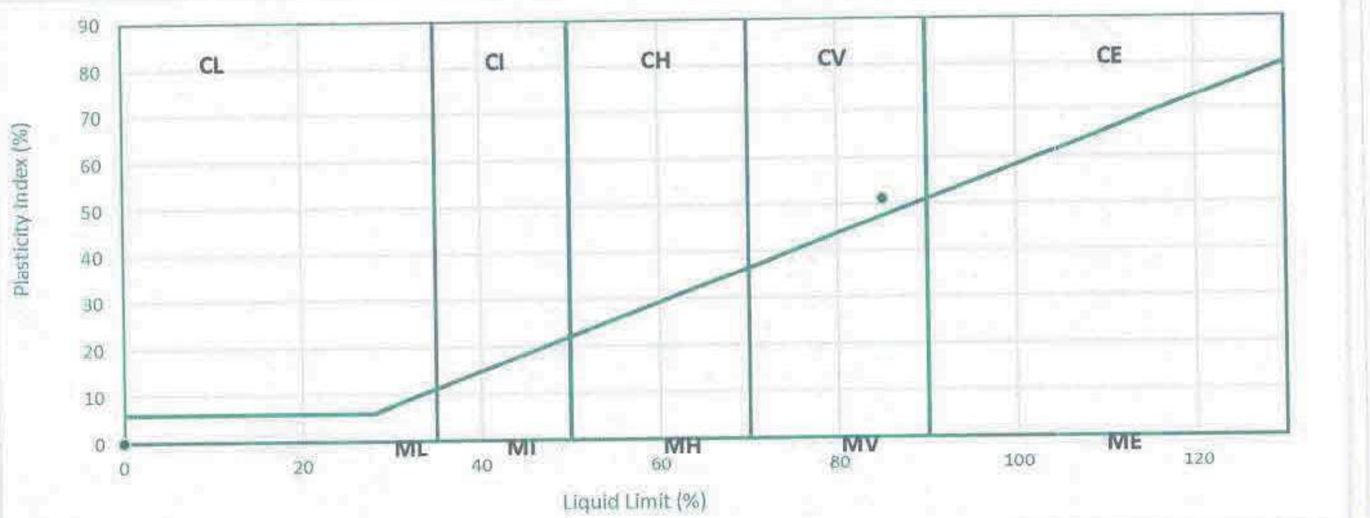
GEO Site & Testing Services Ltd
Unit 3-4, Heol Aur, Dafen Ind Estate, Dafen, Llanelli, Carmarthenshire SA14 8QN
Tel: 01554 784040 Fax: 01554 784041 info@gstl.co.uk gstl.co.uk

GSTL	NATURAL MOISTURE, LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX (BS 1377 : Part 2 : 1990 Method 5)
Contract Number	49757
Project Location	Copped Close
Date Tested	24/08/2020

Sample/Hole Reference	Sample Number	Sample Type	Depth (m)			Moisture Content %	Liquid Limit %	Plastic Limit %	Plasticity index %	Passing 0.425mm %	Remarks
BH1		D	10.00	-		30	85	34	51	100	CV Very High Plasticity

Symbols: NP : Non Plastic # : Liquid Limit and Plastic Limit Wet Sieved

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION
BS 5930:1999+A2:2010



Operators	Checked	25/08/2020	Wayne Honey (Administrative/Quality Assistant)
Daniel Bassett	Approved	25/08/2020	Paul Evans (Quality/Technical Manager)

GSTL	NATURAL MOISTURE, LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX (BS 1377 : Part 2 : 1990 Method 5)	
Contract Number	49757	
Site Name	Copped Close	
Date Tested	24/08/2020	
	DESCRIPTIONS	

Sample/Hole Reference	Sample Number	Sample Type	Depth (m)			Descriptions
BH1		D	10.00	-		Grey silty CLAY
				-		
				-		
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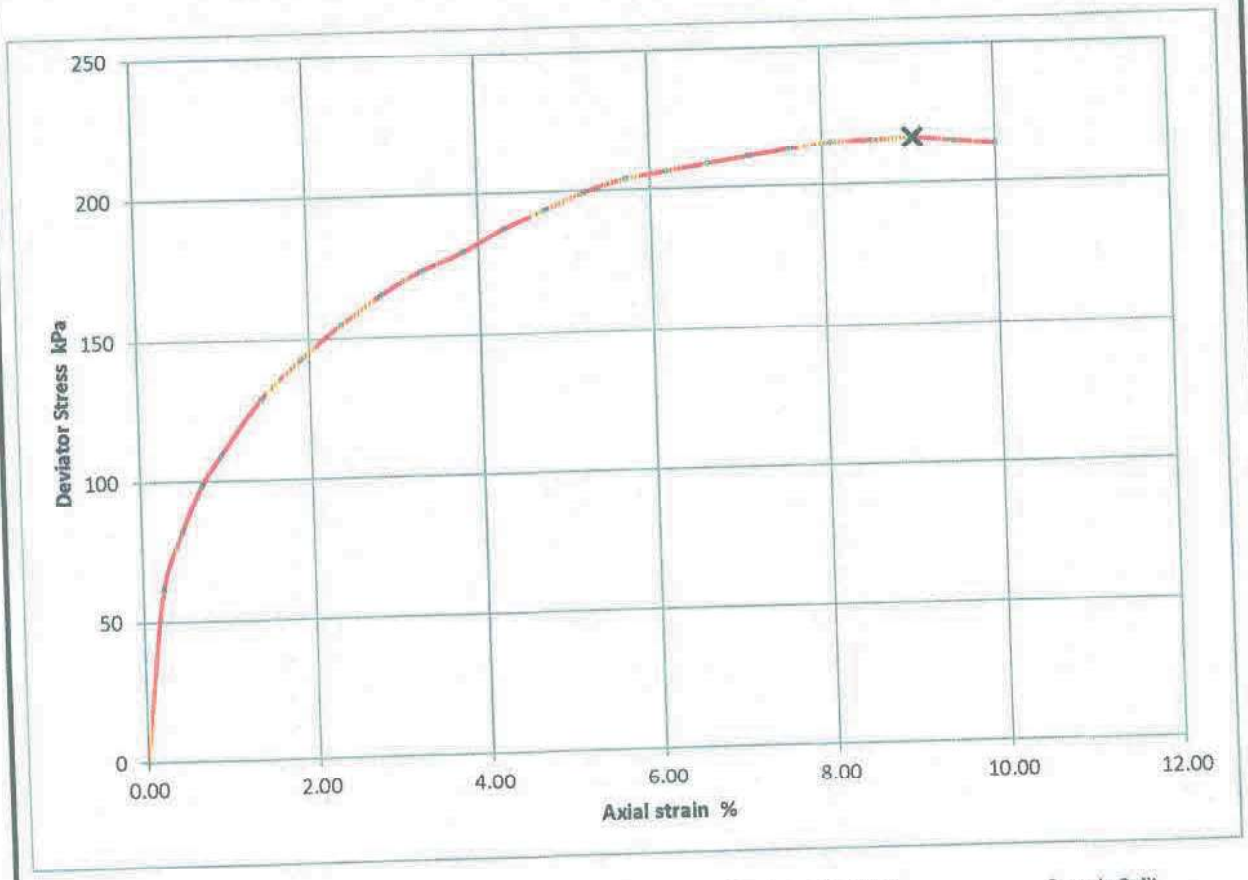
Operators	Checked	25/08/2020	Wayne Honey (Administrative/Quality Assistant)
Daniel Bassett	Approved	25/08/2020	Paul Evans (Quality/Technical Manager)

GSTL	Single Stage Unconsolidated-Undrained Triaxial Test BS 1377 : 1990 Part 7 : 8	Contract Number	49757
		Borehole/Pit No.	BH01
Site Name	Copped Close	Sample No.	
Soil Description	Brown silty CLAY	Depth Top (m)	10.50
		Depth Base (m)	10.95
Date Tested	19/08/2020	Sample Type	U



Moisture Content (%)	24
Bulk Density (Mg/m^3)	1.85
Dry Density (Mg/m^3)	1.49
Specimen Length (mm)	210
Specimen Diamteter (mm)	105
Cell Pressure (kPa)	190
Deviator Stress (kPa)	216
Undrained Shear Strength (kPa)	108
Failure Strain (%)	9
Mode Of Failure	Compound
Membrane Used/Thickness	Rubber/0.3mm
Rate of Strain (%/min)	1.43

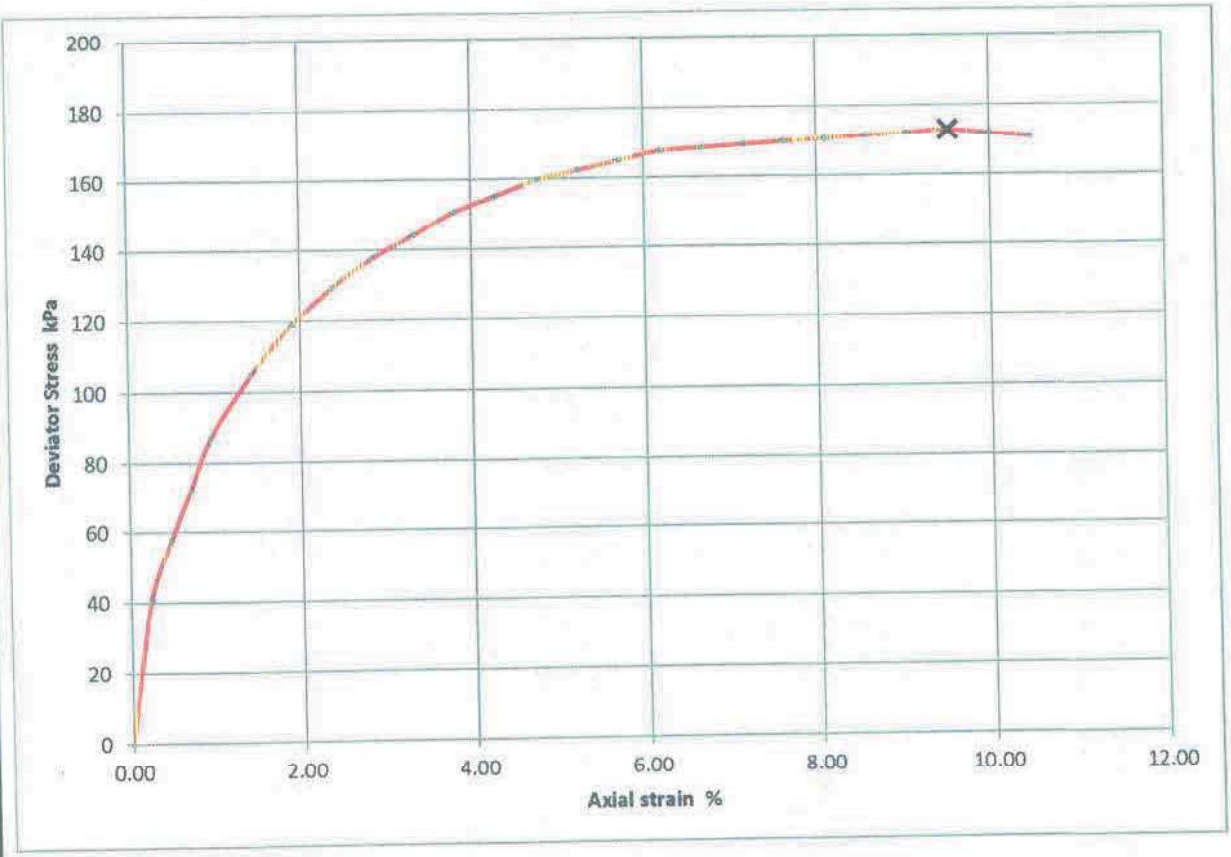
Specimen Post Test

Sample Split

No Photo

Checked	24/08/2020	Emma Sharp	
Approved	25/08/2020	Paul Evans	

GSTL	Single Stage Unconsolidated-Undrained Triaxial Test BS 1377 : 1990 Part 7 : 8	Contract Number	49757
		Borehole/Pit No.	BH01
Site Name	Copped Close	Sample No.	
Soil Description	Brown silty CLAY	Depth Top (m)	7.50
		Depth Base (m)	7.95
Date Tested	19/08/2020	Sample Type	U

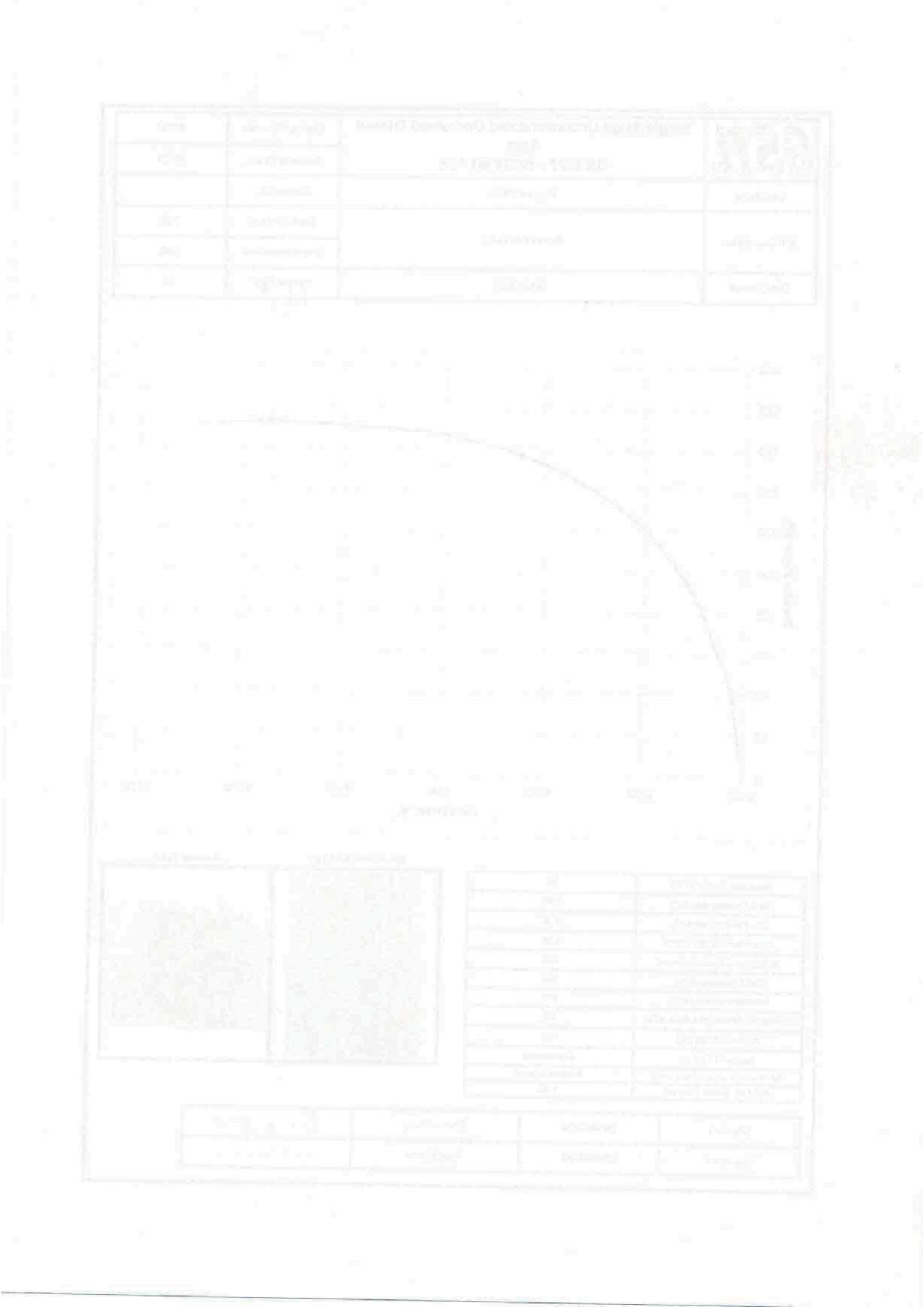


Moisture Content (%)	26
Bulk Density (Mg/m^3)	1.85
Dry Density (Mg/m^3)	1.46
Specimen Length (mm)	210
Specimen Diamteter (mm)	105
Cell Pressure (kPa)	135
Deviator Stress (kPa)	173
Undrained Shear Strength (kPa)	86
Failure Strain (%)	10
Mode Of Failure	Compound
Membrane Used/Thickness	Rubber/0.3mm
Rate of Strain (%/min)	1.43

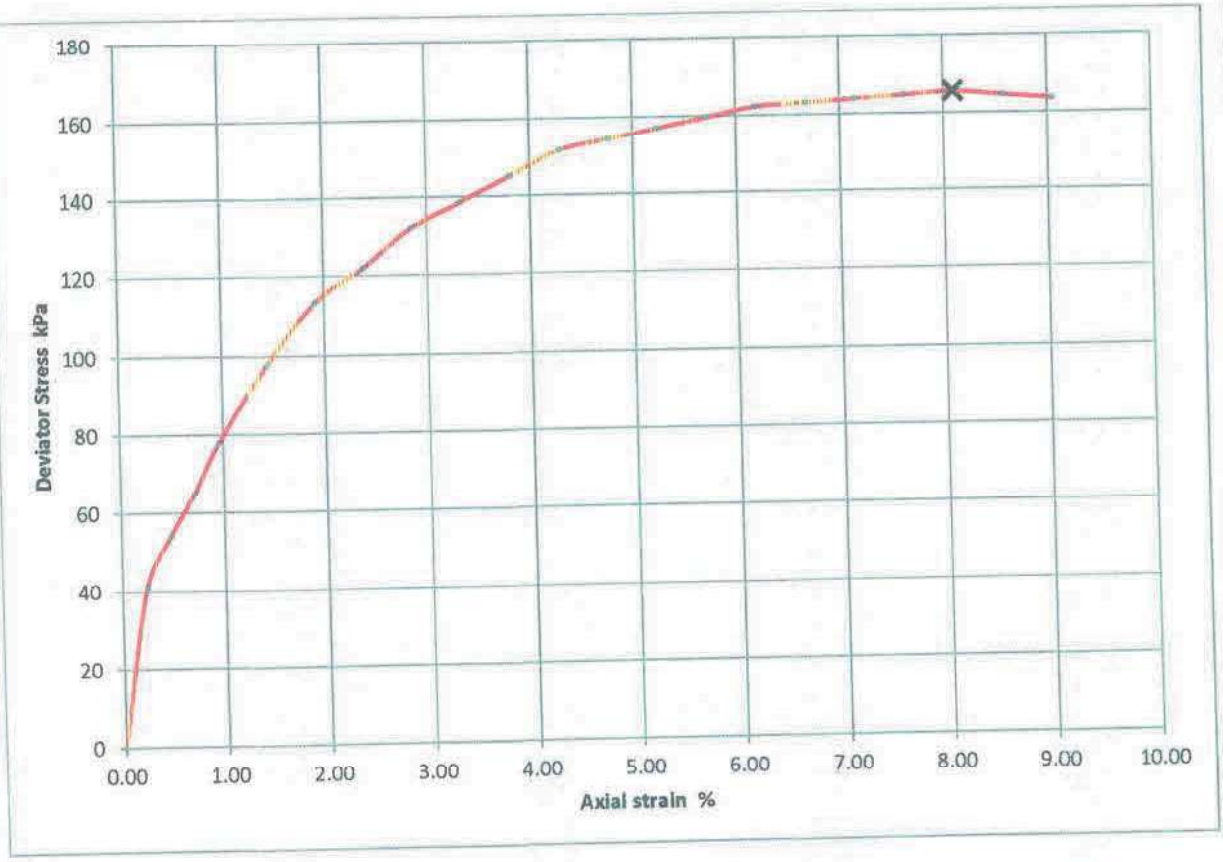
Specimen Post Test

Sample Split

Checked	24/08/2020	Emma Sharp	
Approved	25/08/2020	Paul Evans	



GSTL	Single Stage Unconsolidated-Undrained Triaxial Test BS 1377 : 1990 Part 7 : 8	Contract Number	49757
		Borehole/Pit No.	BH01
Site Name	Copped Close	Sample No.	
Soil Description	Brown silty CLAY	Depth Top (m)	4.50
		Depth Base (m)	4.95
Date Tested	19/08/2020	Sample Type	U



Moisture Content (%)	25
Bulk Density (Mg/m^3)	1.85
Dry Density (Mg/m^3)	1.48
Specimen Length (mm)	210
Specimen Diamteter (mm)	105
Cell Pressure (kPa)	80
Deviator Stress (kPa)	166
Undrained Shear Strength (kPa)	83
Failure Strain (%)	8
Mode Of Failure	Compound
Membrane Used/Thickness	Rubber/0.3mm
Rate of Strain (%/min)	1.43

Specimen Post Test

Sample Split

Checked	24/08/2020	Emma Sharp	
Approved	25/08/2020	Paul Evans	

Laboratory Report

UKAS TESTING
2788

GSTL
GEO Site & Testing Services Ltd

Contract Number: 49428

Client Ref: **18512**
Client PO:

Report Date: **30-07-2020**

Client **Soils Limited**
Newton House
Cross Road
Tadworth
Surrey
KT20 5SR

Contract Title: **Copped Close**
For the attention of: **Tim Rudkin**

Date Received: **23-07-2020**
Date Completed: **30-07-2020**

Test Description	Qty
Moisture Content BS 1377:1990 - Part 2 : 3.2 - * UKAS	6
1 Point Liquid & Plastic Limit BS 1377:1990 - Part 2 : 4.4 & 5.3 - * UKAS	6
Disposal of samples for job	1

Notes: **Observations and Interpretations are outside the UKAS Accreditation**
*** - denotes test included in laboratory scope of accreditation**
 # - denotes test carried out by approved contractor
@ - denotes non accredited tests

Approved Signatories:
Emma Sharp (Office Manager) - Paul Evans (Quality/Technical Manager) - Richard John (Advanced Testing Manager)
Sean Penn (Administrative/Accounts Assistant) - Shaun Jones (Laboratory manager) - Wayne Honey (Administrative/Quality Assistant)

GEO Site & Testing Services Ltd
Unit 3-4, Heol Aur, Dafen Ind Estate, Dafen, Llanelli, Carmarthenshire SA14 8QN
Tel: 01554 784040 Fax: 01554 784041 info@gstl.co.uk gstl.co.uk

GSTL	NATURAL MOISTURE, LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX (BS 1377 : Part 2 : 1990 Method 5)	
Contract Number	49428	
Site Name	Copped Close	
Date Tested	28/07/2020	
	DESCRIPTIONS	

Sample/Hole Reference	Sample Number	Sample Type	Depth (m)			Descriptions
WS1		D	1.40	-		Brown silty clayey fine to coarse GRAVEL.
WS2		D	1.80	-		Brown silty CLAY.
WS3		D	1.30	-		Brown silty clayey fine to coarse GRAVEL.
WS3		D	2.60	-		Brown silty CLAY.
WS4		D	1.20	-		Brown silty CLAY.
WS4		D	2.70	-		Brown silty CLAY.
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
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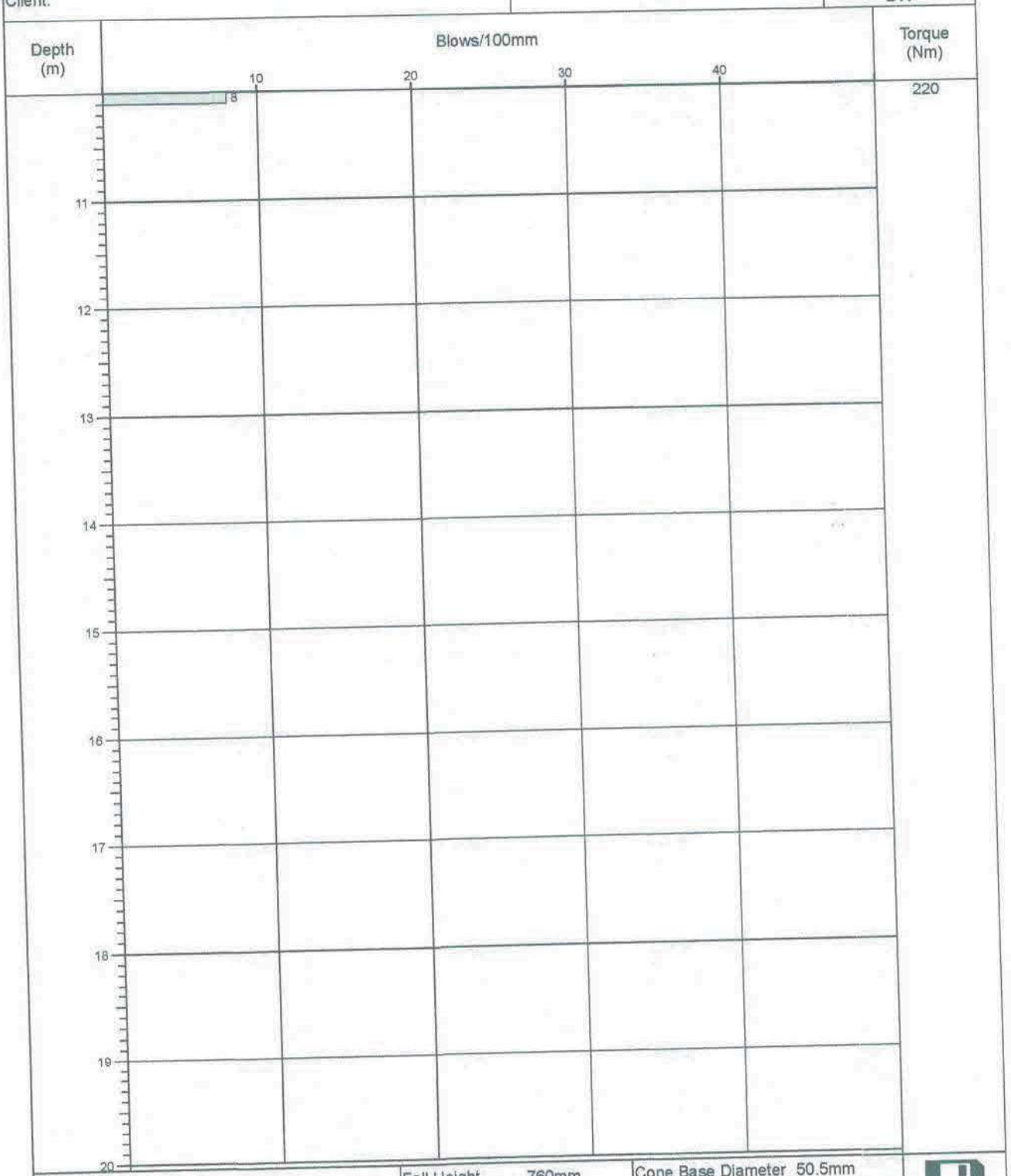
				-		
				-		
				-		
				-		
				-		
				-		
				-		

Operators	Checked	30/07/2020	Wayne Honey (Administrative/Quality Assistant)
Daniel Bassett	Approved	30/07/2020	Paul Evans (Quality/Technical Manager)

UKAS TESTING 2788

Soils Limited Newton House, Cross Road, Tadworth KT20 5SR Tel: 01737 814221 Email: admin@soilslimited.co.uk	Probe Log	Probe No. DP4 Sheet 2 of 2

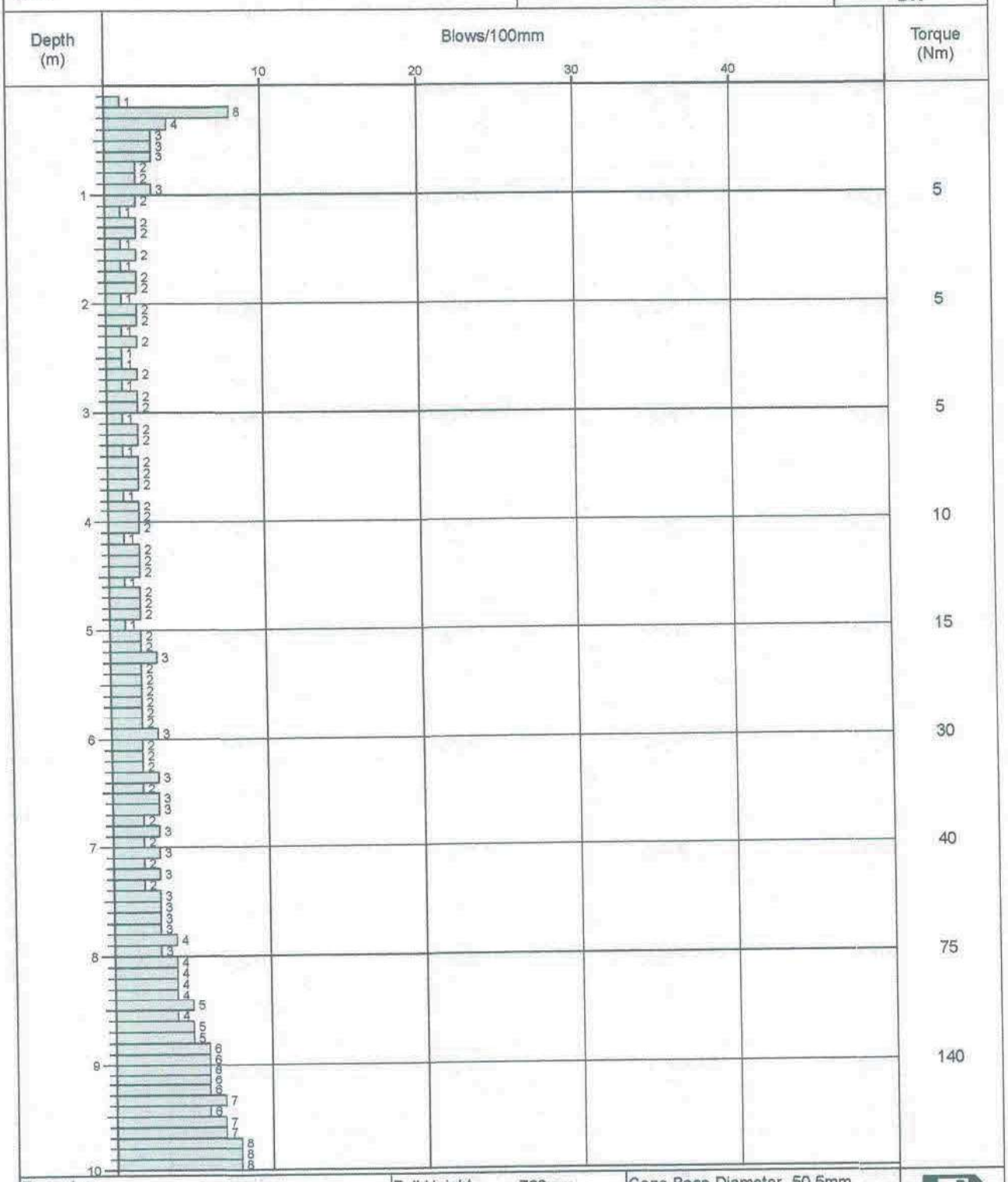
Project Name: Copped Close	Project No. 18512	Co-ords:	Hole Type DP
Location:		Level: m AOD	Scale 1:50
Client:		Dates: 16-07-2020	Logged By DW



Remarks				
	Fall Height	760mm	Cone Base Diameter	50.5mm
	Hammer Weight	63.5kg	Final Depth	10m
	Probe Type	DPSH	Energy Ratio (Er)	79.93%

soils LIMITED	**Soils Limited** Newton House, Cross Road, Tadworth KT20 5SR Tel: 01737 814221 Email: admin@soilslimited.co.uk	**Probe Log**	Probe No. **DP4** Sheet 1 of 2

Project Name: Copped Close	Project No. 18512	Co-ords:	Hole Type DP
Location:		Level: m AOD	Scale 1:50
Client:		Dates: 16-07-2020	Logged By DW



Remarks				
	Fall Height	760mm	Cone Base Diameter	50.5mm
	Hammer Weight	63.5kg	Final Depth	10m
	Probe Type	DPSH	Energy Ratio (Er)	79.93%

AGS

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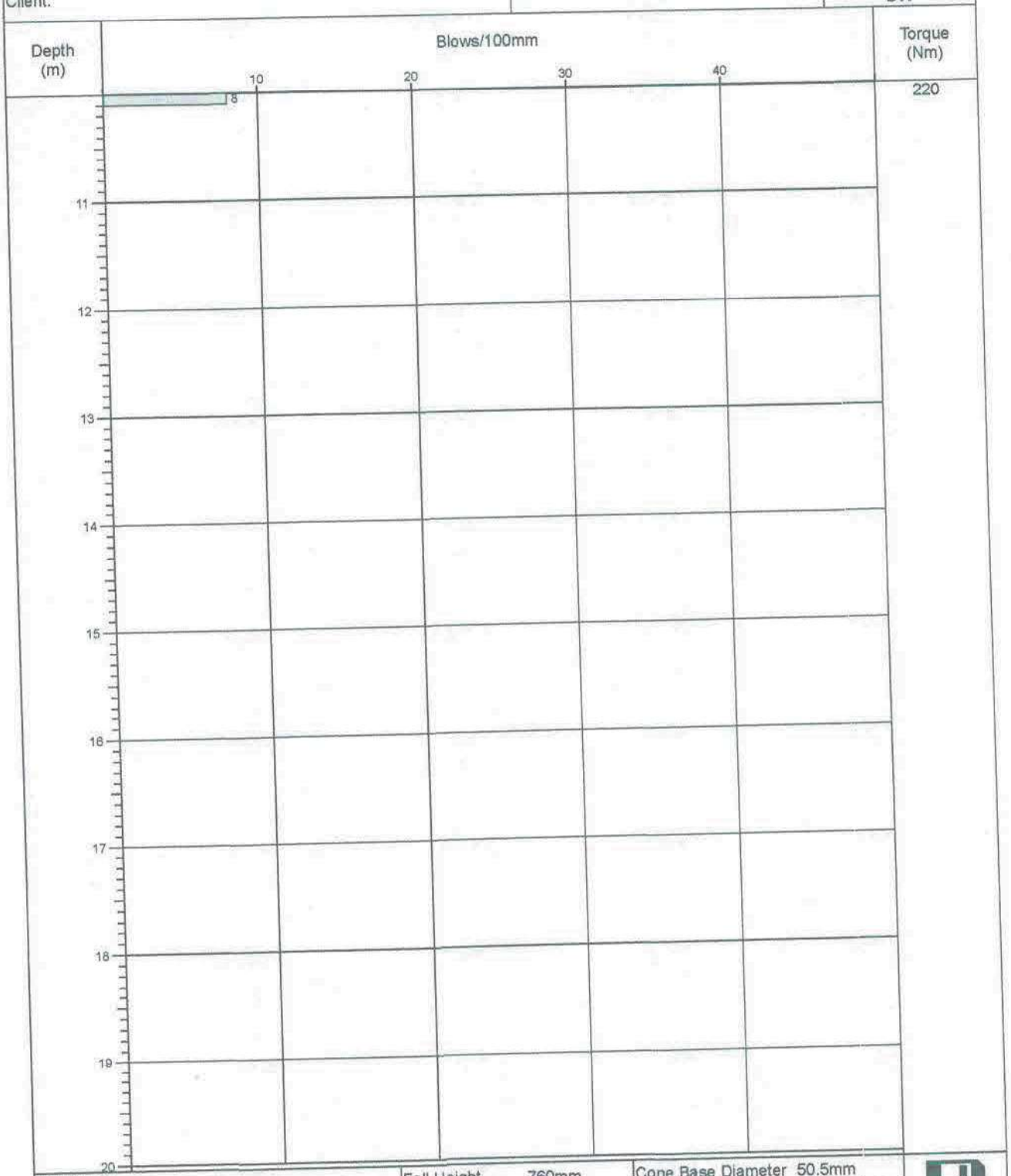
Tel: 01737 814221 Email: admin@soilslimited.co.uk

Probe Log

Probe No. **DP3**
Sheet 2 of 2

Project Name: Copped Close	Project No. 18512	Co-ords:	Hole Type DP
Location:		Level: m AOD	Scale 1:50
Client:		Dates: 16-07-2020	Logged By DW

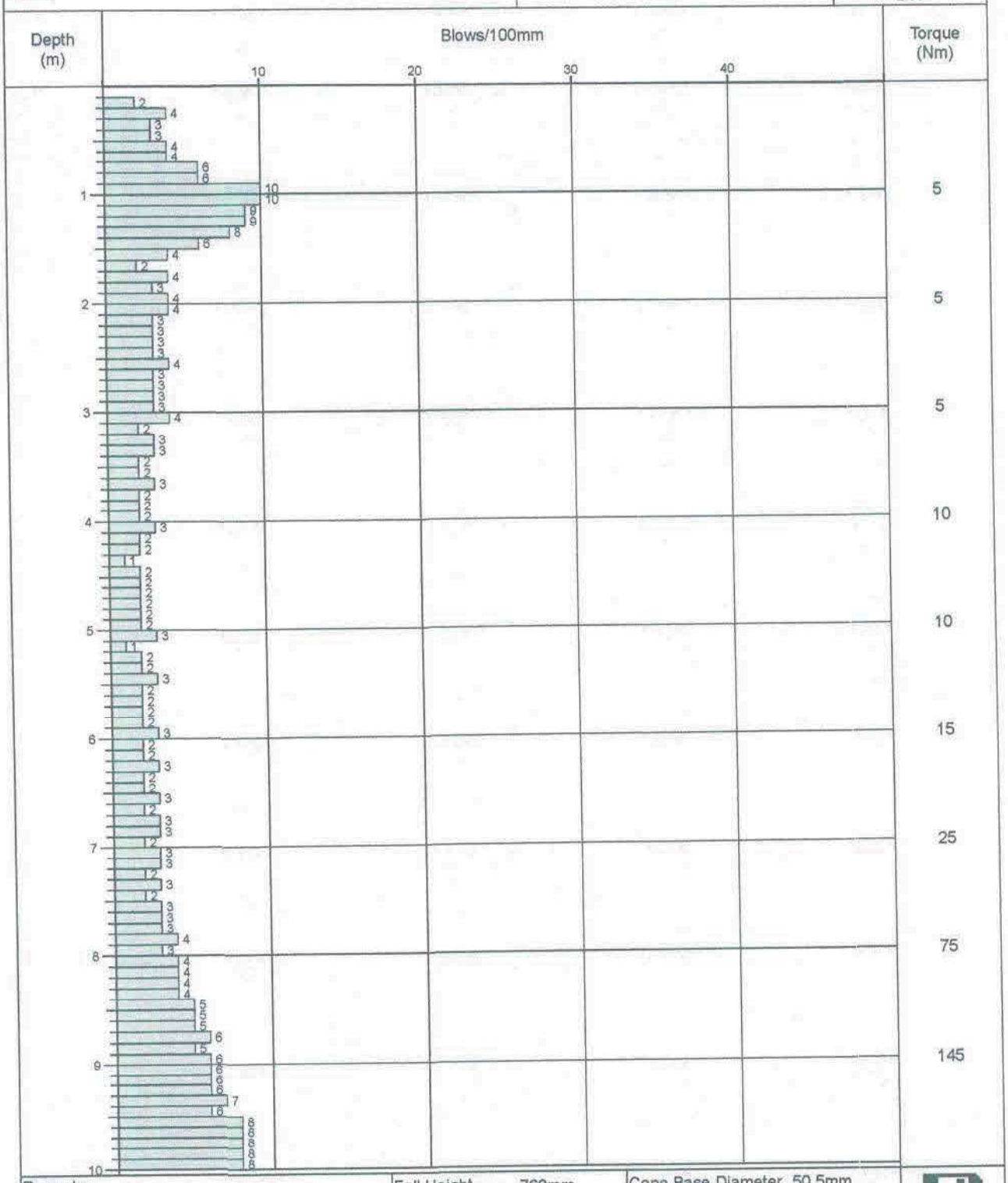


Remarks

Fall Height	760mm	Cone Base Diameter	50.5mm
Hammer Weight	63.5kg	Final Depth	10m
Probe Type	DPSH	Energy Ratio (Er)	79.93%

AGS

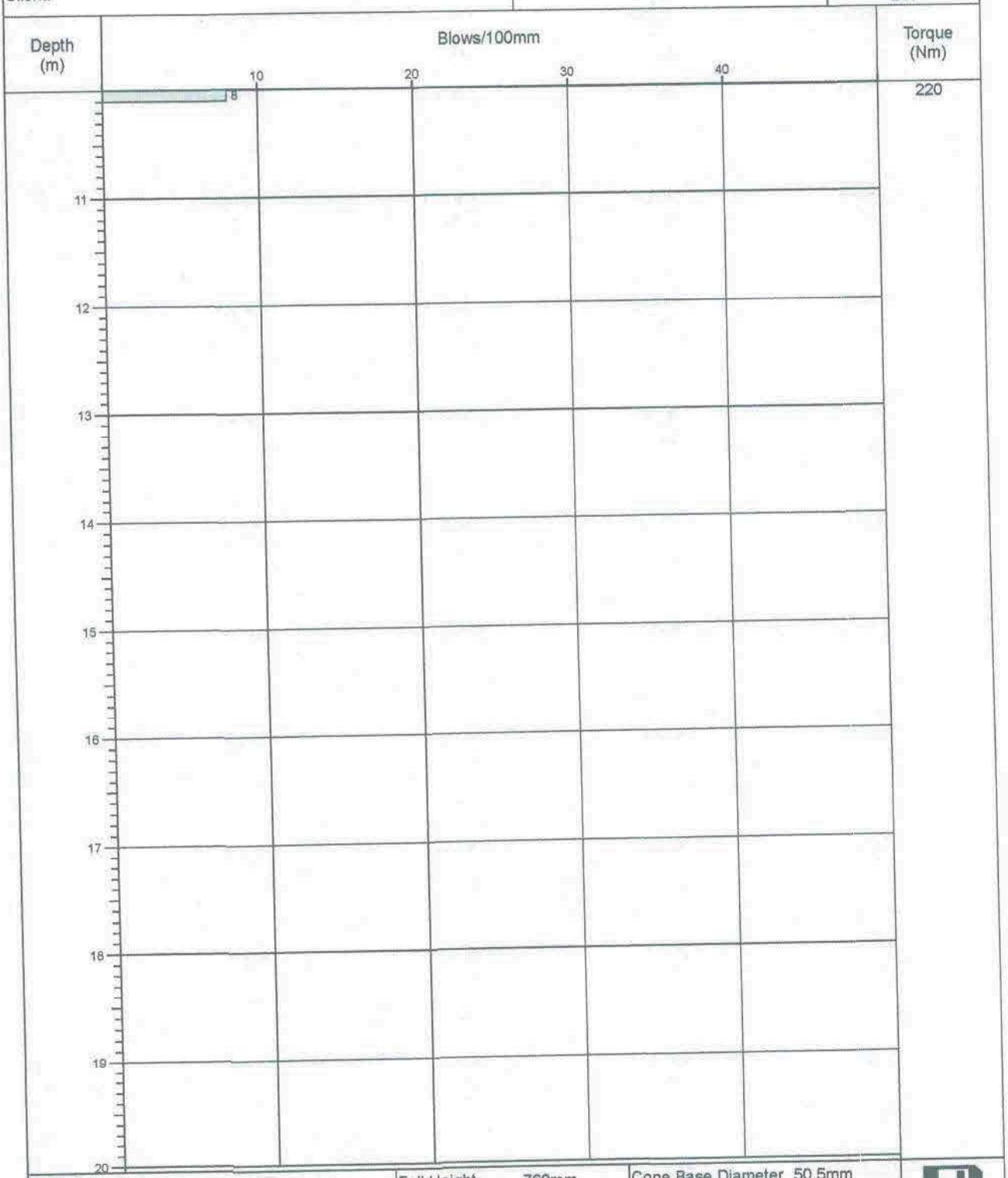
soils LIMITED **Soils Limited** Newton House, Cross Road, Tadworth KT20 5SR Tel: 01737 814221 Email: admin@soilslimited.co.uk		**Probe Log**	Probe No. **DP3** Sheet 1 of 2
Project Name: Copped Close	Project No. 18512	Co-ords:	Hole Type DP
Location:		Level: m AOD	Scale 1:50
Client:		Dates: 16-07-2020	Logged By DW



Remarks	Fall Height 760mm	Cone Base Diameter 50.5mm	AGS
	Hammer Weight 63.5kg	Final Depth 10m	
	Probe Type DPSH	Energy Ratio (Er) 79.93%	

Soils Limited Newton House, Cross Road, Tadworth KT20 5SR Tel: 01737 814221 Email: admin@soilslimited.co.uk	**Probe Log**	Probe No. **DP2** Sheet 2 of 2

Project Name: Copped Close	Project No. 18512	Co-ords:	Hole Type DP
Location:		Level: m AOD	Scale 1:50
Client:		Dates: 16-07-2020	Logged By DW



Remarks			
	Fall Height 760mm	Cone Base Diameter 50.5mm	
	Hammer Weight 63.5kg	Final Depth 10m	
	Probe Type DPSH	Energy Ratio (Er) 79.93%	

Probe Log

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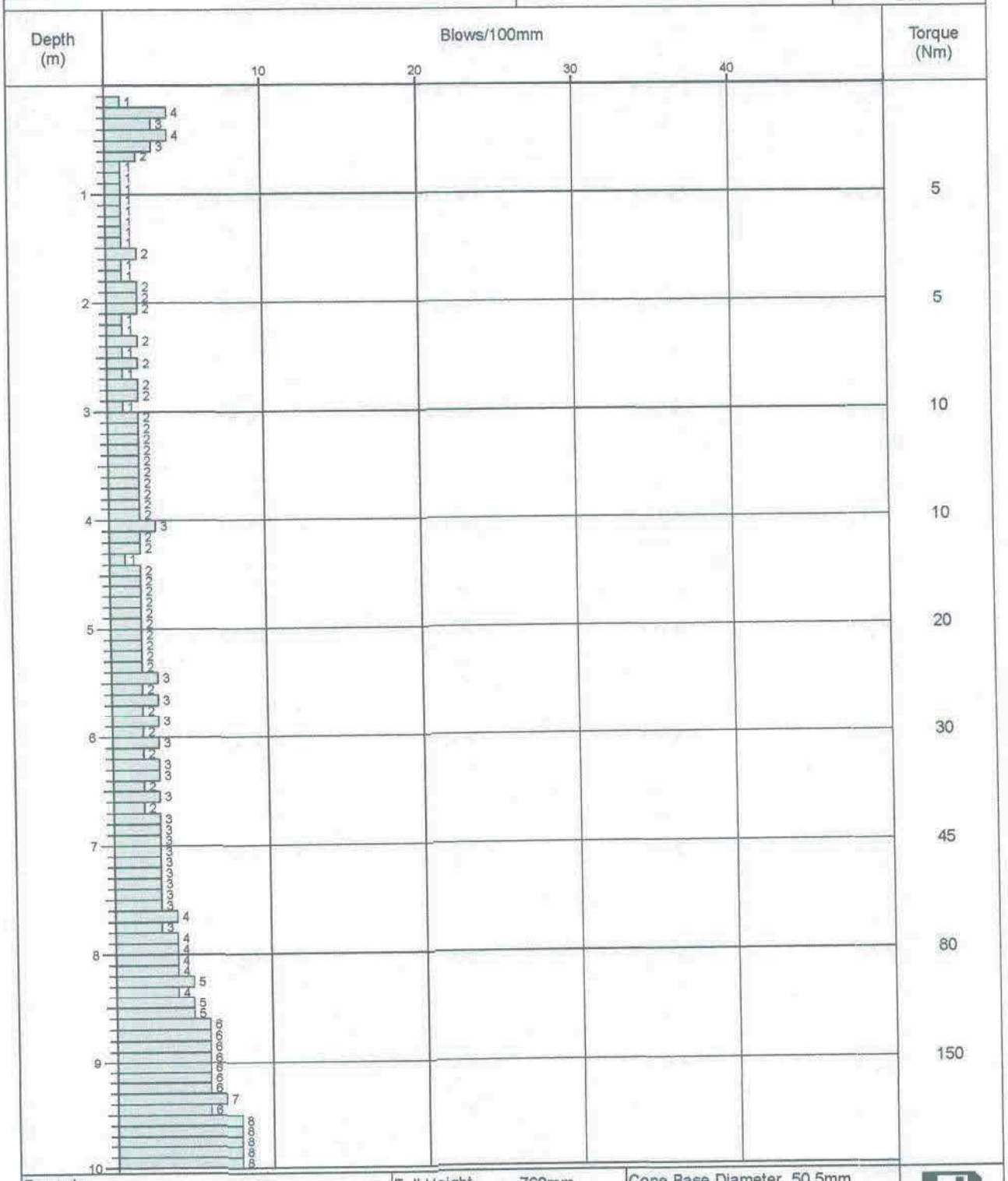
Soils Limited

Newton House, Cross Road, Tadworth KT20 5SR
Tel: 01737 814221 Email: admin@soilslimited.co.uk

Probe Log

Probe No.
DP2
Sheet 1 of 2

Project Name: Copped Close	Project No. 18512	Co-ords:	Hole Type DP
Location:		Level: m AOD	Scale 1:50
Client:		Dates: 16-07-2020	Logged By DW



Remarks

Fall Height	760mm	Cone Base Diameter	50.5mm
Hammer Weight	63.5kg	Final Depth	10m
Probe Type	DPSH	Energy Ratio (Er)	79.93%

AGS

soils LIMITED

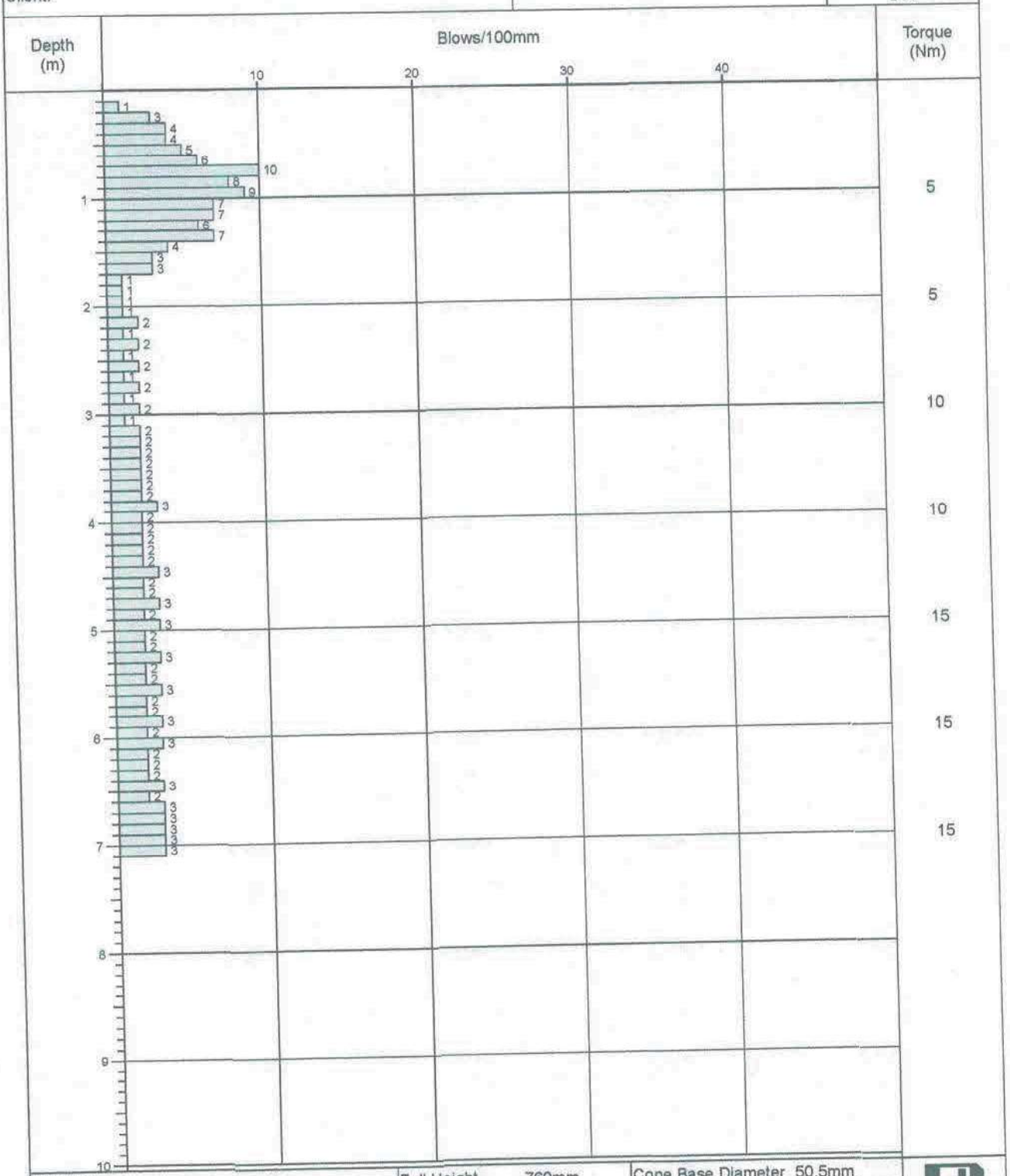
Soils Limited

Newton House, Cross Road, Tadworth KT20 5SR
Tel: 01737 814221 Email: admin@soilslimited.co.uk

Probe Log

Probe No.
DP1
Sheet 1 of 1

Project Name: Copped Close	Project No. 18512	Co-ords:	Hole Type DP
Location:		Level: m AOD	Scale 1:50
Client:		Dates: 16-07-2020	Logged By DW



Remarks

Fall Height	760mm	Cone Base Diameter	50.5mm
Hammer Weight	63.5kg	Final Depth	7m
Probe Type	DPSH	Energy Ratio (Er)	79.93%

AGS

Probe Log

Appendix B.3 Geotechnical In-Situ and Laboratory Results

Table B.2.3 Interpretation of QUU Tests

Location	Stratum	Sample Depth (m bgl)	Moisture Content (%)	Soil Strength	Shear Strength (kPa)
BH1	CLGB	4.50	25	High	83
BH1	CLGB	7.50	26	High	86
BH1	LCF	10.50	24	High	108

Table B.2.4 Interpretation of Atterberg Limit Tests

Stratum	Moisture Content (%)	Plasticity Index (%)	Passing 425µm Sieve (%)	Modified Plasticity Index (%)	Soil Classification	Volume Change Potential	
						BRE	NHBC
CLGB	26 - 31	47 - 54	100	47 - 54	CV	High	High
CLGB(GRAVEL)	3.2 – 6.3				Non-plastic	None	None
LCF	30	51	100	51	CV	High	High

Note: BRE Volume Change Potential refers to BRE Digest 240 (based on Atterberg results)
NHBC Volume Change Potential refers to NHBC Standards Chapter 4.2
Soils Classification based on British Soil Classification System
The most common use of the term clay is to describe a soil that contains enough clay-sized material or clay minerals to exhibit cohesive properties. The fraction of clay-sized material required varies, but can be as low as 15%. Unless stated otherwise, this is the sense used in Digest 240. The term can be used to denote the clay minerals. These are specific, naturally occurring chemical compounds, predominately silicates. The term is often used as a particle size descriptor. Soil particles that have a nominal diameter of less than 2 µm are normally considered to be of clay size, but they are not necessarily clay minerals. Some clay minerals are larger than 2 µm and some particles, 'rock flour' for example, can be finer than 2 µm but are not clay minerals.
(The Atterberg Limit Tests were undertaken in accordance with BS 1377:Part 2:1990 Clauses 3.2, 4.3 and 5)

Appendix B.2 Interpretation

Table B.2.1 Interpretation of SPT Tests

BH	Strata	SPT N60 Blow Counts	Inferred Cohesive Strength
BH1	CLGB 1.20 – 8.50 Silty CLAY	9 – 17	Medium to high (Cu = 45 – 85kPa)
	LCF 8.50 – 15.00 Silty CLAY	19 – 23	High (Cu = 95 – 115kPa)

Note: Energy ratio: 58%

Table B.2.2 Interpretation of DPSH Blow Counts

DP	Strata	Equivalent SPT N60 Blow Counts	Inferred Cohesive Strength/Granular Density
DP1	CLGB 0.40 – 1.50 Clayey GRAVEL	11 – 26	Medium dense
	CLGB[1] 1.50 – 7.00 Silty CLAY	<4 – 11	Very low to medium (C_u = <20 – 55kPa)
DP2	CLGB[1] 0.50 – 7.70 Silty CLAY	<4 – 11	Very low to medium (C_u = <20 – 55kPa)
	LCF[1] 7.70 – 10.00 Silty CLAY	15 – 30	High (C_u = 75 – 150 kPa)
DP3	CLGB 0.50 – 1.50 Clayey GRAVEL	11 – 23	Medium dense
	CLGB 1.50 – 3.00 Silty CLAY	11	Medium (C_u = 55kPa)
	CLGB[1] 3.00 – 7.90 Silty CLAY	7 – 11	Low to medium (C_u = 35 – 55kPa)
	LCF[1] 7.90 – 10.00 Silty CLAY	15 – 30	High (C_u = 75 – 150 kPa)
DP4	CLGB[1] 0.50 – 7.90 Silty CLAY	<4 – 11	Very low to medium (C_u = <20 – 55kPa)
	LCF[1] 7.90 – 10.00 Silty CLAY	15 – 30	High (C_u = 75 – 150 kPa)

Note: [1] Ground conditions inferred past the base of windowless sampler boreholes. Energy ratio: 79.93%

Appendix B Geotechnical In-Situ and Laboratory Testing

Appendix B.1 Classification

Classification based on SPT "N" values:

The inferred undrained strength of the cohesive soils was based on the SPT "N" blow counts, derived from the relationship suggested by Stroud (1974) and classified using Table B.1.1. (Ref: Stroud, M. A. 1974, "The Standard Penetration Test – its application and interpretation", Proc. ICE Conf. on Penetration Testing in the UK, Birmingham. Thomas Telford, London.).

Table B.1.1 SPT "N" Blow Count Cohesive Classification

Classification	Undrained Cohesive Strength C_u (kPa)
Extremely low	<10
Very low	10 – 20
Low	20 – 40
Medium	40 – 75
High	75 – 150
Very high	150 – 300
Extremely high	> 300

Note: (Ref: BS EN ISO 14688-2:2004+A1:2013 Clause 5.3.)

The relative density of granular soils was classified based of the relationship given in Table B.1.2.

The *UK National Annex to Eurocode 7: Geotechnical design – Part 2: Ground investigation and testing, NA 3.7 SPT test, BS EN 1997-2:2007, Annex F* states "Relative density descriptions on borehole records should also be based on uncorrected SPT N values, unless significantly disturbed, using the density classification in BS 5930:2015, Table 7.

Table B.1.2 SPT "N" Blow Count Granular Classification

Classification	SPT "N" blow count (blows/300mm)
Very loose	0 to 4
Loose	4 to 10
Medium dense	10 to 30
Dense	30 to 50
Very dense	Greater than 50

Note: (Ref: The Standard Penetration Test (SPT): Methods and Use, CIRIA Report 143, 1995)

soils LIMITED

Contract Name:		Client:			Hole ID:
Copped Close					BH01
Contract Number:	Start and End Date:	Logged By:	Checked By:	Status:	Hole Type:
18512	06-08-20	DW			CP
Easting:	Northing:	Ground Level:	Plant Used:	Print Date:	Scale:
			DANDO 2000	27-08-2020	1:50

Weather: | Termination: | SPT Hammer: SDA2 Energy Ratio: 58% | Sheet 2 of 2

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
10.50 - 10.95	U	Ublow = 49				Stiff greyish brown slightly sandy silty CLAY. Sand is fine. Very rare fine sand pockets. LONDON CLAY FORMATION.		
11.50	D			11.50		Dark grey mottled brownish slightly sandy silty CLAY. Sand is fine. LONDON CLAY FORMATION.		
12.00 12.00 - 12.45	SPT S	N=23 (4,5/5,6,6,6)						
12.50	D							
13.00	D							
13.50 - 13.95	U	Ublow = 57		(3.95)				
14.00	D							
14.50	D							
15.00 15.00 - 15.45	SPT S	N=24 (4,5/4,6,7,7)						
				15.45		End of Borehole at 15.45m		

11 12 13 14 15 16 17 18 19 20

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)
							2.50	150

Remarks:
Rootlets observed to 2.0m bgl

Chiselling				Installation			
From (m)	To (m)	Duration	Remarks	Top (m)	Base (m)	Type	Dia (mm)

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
			0	0.00	No groundwater strikes recorded.

Hand vane (HV), Hand penetrometer (HP) reported in kPa. PID reported in ppm.

soils LIMITED

Contract Name:		Client:			Hole ID:
Copped Close					BH01
Contract Number:	Start and End Date:	Logged By:	Checked By:	Status:	Hole Type:
18512	06-08-20	DW			CP
Easting:	Northing:	Ground Level:	Plant Used:	Print Date:	Scale:
			DANDO 2000	27-08-2020	1:50

Weather: | Termination: | SPT Hammer: SDA2 Energy Ratio: 58% | Sheet 1 of 2

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
0.25	D					Tarmac over dark brown slightly silty sandy GRAVEL. Gravel is angular to well rounded fine to coarse flint and tarmac. Strong hydrocarbon fuel odour. MADE GROUND		
0.50 - 1.00	B			(1.00)				
1.00	D			1.00		Yellowish brown and black mottled, dark brown, slightly sandy gravelly CLAY. Gravel is angular to subrounded fine to coarse, flint, brick and clinker. Occasional rootlets. MADE GROUND.		
1.20 - 1.50	B			1.20		Black speckled brownish grey mottled brown slightly sandy CLAY with occasional roots and rootlets. Sand is fine. CLAYGATE MEMBER		
1.50	SPT	N=9 (1,2/2,2,3,2)						
1.50 - 1.95	S							
2.00	D			(1.30)				
2.50 - 2.95	U	Ublow = 14		2.50		Orangish brown and blulsh grey mottled, slightly sandy silty CLAY. Sand is fine. Frequent desiccated rootlets. CLAYGATE MEMBER		
3.00	D					Occasional medium to coarse sand sized selenite crystals. Desiccated rootlets observed at 3.5m bgl		
3.50	SPT	N=17 (2,2/3,4,5,5)		(1.50)				
3.50 - 3.95	S							
4.00	D			4.00		Brown slightly sandy CLAY. Sand is fine. Occasional medium sand to fine gravel sized selenite crystals. CLAYGATE MEMBER		
4.50 - 4.95	U	Ublow = 44						
5.00	D							
5.50	D							
6.00	SPT	N=18 (2,3/3,4,5,6)						
6.00 - 6.45	S			(4.50)				
6.50	D							
7.00	D							
7.50 - 7.95	U	Ublow = 47						
8.00	D							
8.50	D			8.50		Stiff greyish brown slightly sandy silty CLAY. Sand is fine. Very rare fine sand pockets. LONDON CLAY FORMATION.		
9.00	SPT	N=20 (3,3/4,4,5,7)						
9.00 - 9.45	S			(3.00)				
9.50	D							
10.00	D							

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)
							2.50	150

Remarks:
Rootlets observed to 2.0m bgl

Chiselling				Installation			
From (m)	To (m)	Duration	Remarks	Top (m)	Base (m)	Type	Dia (mm)

Water Strikes					
Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
			0	0.00	No groundwater strikes recorded.

Hand vane (HV), Hand penetrometer (HP) reported in kPa. PID reported in ppm.

soils LIMITED

Contract Name:		Client:				Hole ID:
Copped Close						WS4
Contract Number:	Start and End Date:	Logged By:	Checked By:	Status:		Hole Type:
18512	16-07-20	DW				WS
Easting:	Northing:	Ground Level:	Plant Used:	Print Date:		Scale:
			Archway	27-08-2020		1:50

Weather: | Termination: | Sheet 1 of 1

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
0.30	D			(0.50)		Greyish brown, slightly sandy, gravelly desiccated silty CLAY. Gravel is sub-angular to well rounded, fine to coarse flint, brick, and rare clinker and glass. Frequent rootlets. MADE GROUND.		
0.60	ES D			0.50		Very stiff, orangish brown and grey mottled, greyish brown, slightly sandy, gravelly silty CLAY. Gravel is angular to well rounded, fine to coarse flint. Frequent rootlets. CLAYGATE MEMBER		
0.90	ES D			(0.60)		Rare sub-angular to well rounded fine to medium fine gravel from 0.9 - 1.1m bgl		
1.20	ES D			1.10		Orangish brown and grey mottled brown, slightly sandy, silty CLAY. Sand is fine. Occasional decomposing roots and rootlets. Rare medium sand sized selenite crystals. CLAYGATE MEMBER.		
1.70	D			(1.20)				
2.40	D			2.30 (0.30)		Greyish brown calcareous MUDSTONE. Recovered as angular, fine to coarse gravel with calcite veins (likely formerly a septarian nodule). CLAYGATE MEMBER.		
2.70	D			2.60 (0.40)		Orangish brown and grey mottled brown, slightly sandy, silty CLAY. Sand is fine. Occasional decomposing roots and rootlets. Occasional medium sand to fine gravel sized selenite crystals. CLAYGATE MEMBER.		
				3.00		End of Borehole at 3.00m		

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)

Chiselling			
From (m)	To (m)	Duration	Remarks

Installation			
Top (m)	Base (m)	Type	Dia (mm)

Remarks:
Disused gas pipe at 0.5m bgl. Rootlets observed to 3.0m bgl.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
2.50			0	0.00	

Hand vane (HV), Hand penetrometer (HP) reported in kPa. PID reported in ppm.

soils LIMITED

Contract Name:		Client:			Hole ID:
Copped Close					WS3
Contract Number:	Start and End Date:	Logged By:	Checked By:	Status:	Hole Type:
18512	16-07-20	DW			WS
Easting:	Northing:	Ground Level:	Plant Used:	Print Date:	Scale:
			Archway	27-08-2020	1:50

Weather: | Termination: | Sheet 1 of 1

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
0.20	D ES			(0.45)		Orangish brown mottled, dark brown, slightly sandy, slightly gravelly desiccated silty CLAY. Gravel is sub-angular to well rounded, fine to coarse flint, brick, and rare clinker. Frequent rootlets. MADE GROUND.		
0.60	D ES			0.45		Orangish brown and grey mottled, greyish brown, slightly sandy, gravelly CLAY. Gravel is angular to well rounded, fine to coarse flint and rare sandstone. Occasional rootlets. Possibly re-worked material.		
0.80	D ES			0.70		Orange, yellowish brown, and light grey mottled very clayey sandy GRAVEL. Gravel is angular to well rounded, fine to coarse flint and rare sandstone. Occasional rootlets. Occasional pockets of medium to coarse sand. CLAYGATE MEMBER.		
1.30	D			(0.80)		Slight gravelly and very sandy from 0.7-1.0m bgl continuing down.		
1.60	D			1.50		Orangish brown and grey mottled brown, slightly sandy, silty CLAY. Sand is fine, and features in occasional laminations. Rare angular medium to coarse sand sized selenite crystals with a zone of fine gravel sized selenite crystals at 3.85m bgl. Occasional decomposing roots. Rare well rounded medium flint gravel in top 10cm. Very rare rootlets. CLAYGATE MEMBER.		
2.10	D					Grades very stiff, grey mottled and less sandy from 2.3m bgl.		
2.60	D			(2.50)				
3.10	D							
3.60	D							
				4.00		End of Borehole at 4.00m		

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)

Remarks:
Rootlets observed to 2.9m bgl.

Chiselling				Installation			
From (m)	To (m)	Duration	Remarks	Top (m)	Base (m)	Type	Dia (mm)

Water Strikes					
Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
			0	0.00	No groundwater encountered.

Hand vane (HV), Hand penetrometer (HP) reported in kPa. PID reported in ppm.

soils LIMITED

Contract Name:	Client:	Hole ID:
Copped Close		WS2

Contract Number:	Start and End Date:	Logged By:	Checked By:	Status:	Hole Type:
18512	16-07-20	DW			WS

Easting:	Northing:	Ground Level:	Plant Used:	Print Date:	Scale:
			Archway	27-08-2020	1:50

Weather: | Termination: | Sheet 1 of 1

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
0.20	D ES			(0.50)		Orangish brown mottled, dark brown, slightly sandy, slightly gravelly desiccated silty CLAY. Gravel is sub-angular to well rounded, fine to coarse flint. Frequent rootlets. TOPSOIL.		
0.60	D ES			0.50		Black speckled and slightly orangish brown mottled, brown, slightly sandy silty CLAY. Sand is fine. Frequent rootlets. CLAYGATE MEMBER.		
0.90	D ES			(0.80)				
1.30	D			1.30		Orangish brown and grey mottled brown, slightly sandy, silty CLAY. Sand is fine, and features in occasional laminations. Rare becoming occasional zones of angular medium sand to fine gravel sized selenite crystals from 3.0m bgl. Occasional decomposing roots. Rare rootlets. CLAYGATE MEMBER. Becomes stiff around 2.0m bgl. Selenite becomes occasional from 3.0m bgl		
1.80	D							
2.30	D							
2.80	D			(2.70)				
3.30	D							
3.80	D							
				4.00		End of Borehole at 4.00m		

1 2 3 4 5 6 7 8 9 10

Start & End of Shift Observations				
Date	Time	Depth (m)	Casing (m)	Water (m)

Borehole Diameter		Casing Diameter	
Depth (m)	Dia (mm)	Depth (m)	Dia (mm)

Remarks:
Rootlets observed to 2.8m bgl.

Chiselling			
From (m)	To (m)	Duration	Remarks

Installation			
Top (m)	Base (m)	Type	Dia (mm)

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
			0	0.00	No groundwater encountered.

Hand vane (HV), Hand penetrometer (HP) reported in kPa. PID reported in ppm.

soils LIMITED

Contract Name:	Client:	Hole ID:
Copped Close		WS1

Contract Number:	Start and End Date:	Logged By:	Checked By:	Status:	Hole Type:
18512	16-07-20	DW			WS

Easting:	Northing:	Ground Level:	Plant Used:	Print Date:	Scale:
			Archway	27-08-2020	1:50

Weather: | Termination:

Sheet 1 of 1

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Type	Results	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
0.20	D ES			(0.40)		Yellowish brown mottled, dark brown, slightly sandy, desiccated silty CLAY. Frequent rootlets. Occasional well rounded, fine to medium flint gravel. Decomposing woody plant crown at 0.3m bgl. TOPSOIL.		
0.60	D ES			0.40		Orange, yellowish brown, and light blueish grey mottled very clayey sandy GRAVEL. Gravel is angular to well rounded, fine to coarse flint and rare sandstone. Occasional rootlets. Occasional pockets of medium to coarse sand. CLAYGATE MEMBER		
0.90	D ES			(1.10)				
1.40	D							
1.60	D			1.50		Orangish brown and grey mottled, yellowish brown to brown with depth, slightly sandy, silty CLAY. Sand is fine, and features in occasional laminations. Rare becoming frequent zones of angular medium sand to fine gravel sized selenite crystals from 2.0m bgl. Occasional decomposing roots. Rare rootlets. CLAYGATE MEMBER.		
2.10	D							
2.60	D			(2.50)				
3.10	D							
3.60	D							
				4.00		End of Borehole at 4.00m		

1 2 3 4 5 6 7 8 9 10

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)

Remarks:
Rootlets observed to 2.0m bgl.

Chiselling				Installation			
From (m)	To (m)	Duration	Remarks	Top (m)	Base (m)	Type	Dia (mm)

Water Strikes					
Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
			0	0.00	No groundwater encountered.

Hand vane (HV), Hand penetrometer (HP) reported in kPa. PID reported in ppm.

Appendix A Field Work

Appendix A.1 Engineers Logs

soils
LIMITED

Main Investigation Report

at
Copped Close, 15 Totteridge Village, London N20 8PN

for
Benellie Construction Ltd.

Reference: 18512/MIR_R27
August 2020

Control Document

Project
Copped Close, 15 Totteridge Village, London N20 8PN

Document Type
Main Investigation Report

Document Reference
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Final

Date
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[redacted]

This is not a valid document for use in the design of the project unless it is titled Final in the document status box.

Current regulations and good practice were used in the preparation of this report. The recommendations given in this report must be reviewed by an appropriately qualified person at the time of preparation of the scheme design to ensure that any recommendations given remain valid in light of changes in regulation and practice, or additional information obtained regarding the site.

Commission

Benellie Construction Ltd. commissioned Soils Limited to undertake an intrusive ground investigation and prepare a Main Investigation Report on land at Copped Close, 15 Totteridge Village, London N20 8PN. The scope of the investigation was outlined in the Soils Limited quotation reference Q23169, dated 9th July 2020.

Following the initial findings from the windowless sampler borehole and dynamic probe intrusive investigation, a supplementary deep borehole was requested as outlined in Soils Limited quotation reference Q23265, dated 30th July 2020.

This document comprises the Main Investigation Report and incorporates the results, discussion and conclusions to all the above intrusive works.

No Preliminary Investigation Report (Phase I Desk Study) was commissioned for the site.

Standards

The site works, soil descriptions and geotechnical testing was undertaken in accordance with the following standards:

- BS 5930:2015+A1:2020 and BS EN ISO 22476-2&3:2005+A1:2011
- BS EN 1997-1:2004+A1:2013 Eurocode 7. Geotechnical design
- BS EN ISO 14688-1:2002+A1:2013 - Geotechnical investigation and testing - Identification and description
- BS EN ISO 14688-2:2004+A1:2013 - Geotechnical investigation and testing - Principles for a classification
- NHBC Standards 2020
- BRE Digest 240:1993
- BRE Special Digest 1:2005

The geotechnical laboratory testing was performed by GEO Site & Testing Services Ltd (GSTL) in accordance with the methods given in BS 1377:1990 Parts 1 to 8 and their UKAS accredited test methods.

For the preparation of this report, the relevant BS code of practice was adopted for the geotechnical laboratory testing technical specifications, in the absence of the relevant Eurocode specifications (ref: ISO TS 17892).

The sulphate analyses were undertaken by Derwentside Environmental Testing Services (DETS) in accordance with their UKAS and MCERTS accredited test methods or their documented in-house testing procedures. This investigation did not comprise an environmental audit of the site or its environs.

Trial hole is a generic term used to describe a method of direct investigation. The term trial pit, borehole or window sample borehole implies the specific technique used to produce a trial hole.

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Section 1 Introduction

1.1 Objective of Investigation

Benellie Construction Ltd. commissioned Soils Limited to undertake an intrusive ground investigation and to prepare a Main Investigation Report to supply the client and their designers with information regarding ground conditions, to assist in preparing a foundation scheme for development that was appropriate to the settings present on the site.

The investigation was to be undertaken to provide comment on appropriate foundation options for the proposed residential development. The investigation was to be made by means of in-situ testing and geotechnical laboratory testing undertaken on soil samples taken from the trial holes.

No Preliminary Investigation Report (Phase I Desk Study) was commissioned.

1.2 Location

The site was located at Copped Close, 15 Totteridge Village, London N20 8PN and had an approximate O.S Land Ranger Grid Reference of TQ 24789 93950.

The site location plan is given in Figure 1.

1.3 Site Description

The site comprised a vacant three storey residential dwelling with detached garage with soft-landscaped garden to the rear and tarmac driveway at the front. The site was relatively flat with a gradual slope down to the southwest. Numerous mature and semi-mature trees were located onsite and along the west and east site perimeter and the site was bounded by residential land use.

An aerial photograph showing the site and its close environs has been included in Figure 2.

1.4 Proposed Development

The proposed development was to comprise demolition of existing structures onsite and subsequent erection of two detached dwellings and double garage with associated driveways and private gardens.

In compiling this report reliance was placed on drawing number 120-002G, dated April 2016, prepared by Shaun Knight Architecture. Any change or deviation from the scheme outlined in the drawing could invalidate the foundation design and remediation recommendations presented within this report. Soils Limited must be notified about any such changes.

Development plans provided by the client are presented in Appendix D.

1.5 Anticipated Geology

The 1:50,000 BGS map showed the site to be located upon the bedrock Claygate Member with no recorded overlying superficial deposits.

1.5.1 Claygate Member

The Claygate Member comprises a finely interbedded and thinly laminated sequence of clay, silt and fine grained sand with numerous interbeds of planar and lenticular bedded fine grained fine laminated sands up to 1m thick.

1.6 Limitations and Disclaimers

This Main Investigation Report relates to the site located at Copped Close, 15 Totteridge Village, London N20 8PN and was prepared for the sole benefit of Benellie Construction Ltd. (The "Client"). The report was prepared solely for the brief described in Section 1.1 of this report.

Soils Limited disclaims any responsibility to the Client and others in respect of any matters outside the scope of the above.

This report has been prepared by Soils Limited, with all reasonable skill, care and diligence within the terms of the Contract with the Client, incorporation of our General Conditions of Contract of Business and taking into account the resources devoted to us by agreement with the Client.

The report is personal and confidential to the Client and Soils Limited accept no responsibility of whatever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies on the report wholly at its own risk.

The Client may not assign the benefit of the report or any part to any third party without the written consent of Soils Limited.

The ground is a product of continuing natural and artificial processes. As a result, the ground will exhibit a variety of characteristics that vary from place to place across a site, and also with time. Whilst a ground investigation will mitigate to a greater or lesser degree against the resulting risk from variation, the risks cannot be eliminated.

The investigation, interpretations, and recommendations given in this report were prepared for the sole benefit of the client in accordance with their brief. As such these do not necessarily address all aspects of ground behaviour at the site.

Current regulations and good practice were used in the preparation of this report. An appropriately qualified person must review the recommendations given in this report at

the time of preparation of the scheme design to ensure that any recommendations given remain valid in light of changes in regulation and practice, or additional information obtained regarding the site.

The depth to roots and/or of desiccation may vary from that found during the investigation. The client is responsible for establishing the depth to roots and/or of desiccation on a plot by plot basis prior to the construction of foundations. Supplied site surveys may not include substantial shrubs or bushes and is also unlikely to have data or any trees, bushes or shrubs removed prior to or following the site survey.

Where trees are mentioned in the text this means existing trees, substantial bushes or shrubs, recently removed trees (approximately 20 years to full recovery on cohesive soils) and those planned as part of the site landscaping).

It should be noted that a detailed survey of the possible presence or absence of invasive species, such as Japanese Knotweed, is outside of the scope of investigation.

Ownership of land brings with it onerous legal liabilities in respect of harm to the environment. "Contaminated Land" is defined in Section 57 of the Environment Act 1995 as:

"Land which is in such a condition by reason of substances in, on or under the land that significant harm is being caused or that there is a significant possibility of such harm being caused or that pollution of controlled waters is being, or is likely to be caused".

The investigation, analysis or recommendations in respect of contamination are made solely in respect of the prevention of harm to vulnerable receptors, using where possible best practice at the date of preparation of the report. The investigation and report do not address, define or make recommendations in respect of environmental liabilities. A separate environmental audit and liaison with statutory authorities is required to address these issues.

Ownership of copyright of all printed material including reports, laboratory test results, trial pit and borehole log sheets, including drillers log sheets remains with Soils Limited. License is for the sole use of the client and may not be assigned, transferred or given to a third party.

Section 2 Site Works

2.1 Proposed Project Works

The proposed intrusive investigation was designed to provide information on the ground conditions and to aid the design of foundations for the proposed residential development. The intended investigation, as outlined within the Soils Limited quotation Q23169, dated 9th July 2020, was to comprise the following items:

- 4No. windowless sampler boreholes
- 4No. super heavy dynamic probes
- Geotechnical laboratory testing.

Following the findings of the above investigation, a cable percussive borehole was requested, outlined in Soils Limited quotation Q23265, dated 30th July 2020, to inform a piled foundation solution. The supplementary works was to comprise the following items:

- 1No. 15m deep cable percussive borehole with alternate SPT/U100 testing at 1m intervals for the top 5m and at 1.5m intervals thereafter
- Geotechnical laboratory testing.

2.1.1 Actual Project Works

The first phase of testing was undertaken on 16th July 2020 and the second phase on 6th August 2020 and the investigation comprised:

- 4No. windowless sampler boreholes (WS1 – WS4)
- 4No. super heavy dynamic probes (DP1 – DP4)
- 1No. 15m deep cable percussive borehole (BH1)
- Geotechnical laboratory testing.

All trial holes were backfilled with bentonite and arisings on completion.

All trial hole locations have been presented in Figure 3.

Following completion of site works, soil cores were logged and sub sampled so that samples could be sent to the laboratory for geotechnical laboratory testing.

2.2 Ground Conditions

On 16th July 2020, four windowless sampler boreholes (WS1 – WS4) were drilled to depths ranging between 3.00m and 4.00m below ground level (bgl) at locations selected by Soils Limited using a development plan provided by the client.

Four super heavy dynamic probes (DP1 – DP4) were driven prior and adjacent to their

corresponding windowless sampler borehole to depths ranging between 7.00m and 10.00m bgl.

On 6th August 2020, a single cable percussive borehole (BH1) was drilled to a depth of 15.00m bgl at the front of the property given the access restrictions to the rear. Alternate SPT/U100 testing was undertaken at 1m intervals for the top 5m bgl and at 1.5m intervals thereafter.

The maximum depths of trial holes have been included in Table 2.1.

All trial holes were scanned with a Cable Avoidance Tool (C.A.T.) and signal generator (Genny) prior to excavation to ensure the health and safety of the operatives.

Table 2.1 Final Depth of Trial Holes

Trial Hole	Depth (m bgl)	Trial Probe	Depth (m bgl)
WS1	4.00	DP1	7.00
WS2	4.00	DP2	10.00
WS3	4.00	DP3	10.00
WS4	3.00	DP4	10.00
BH1	15.00		

The approximate trial hole locations are shown on Figure 3.

The soil conditions encountered were recorded and soil sampling commensurate with the purposes of the investigation was carried out. The depths given on the trial hole logs and quoted in this report were measured from ground level.

The soils encountered from immediately below ground surface have been described in the following manner. Where the soil incorporated an organic content such as either decomposing leaf litter or roots, or has been identified as part of the in-situ weathering profile, it has been described as Topsoil both on the logs and within this report. Where man has clearly either placed the soil, or the composition altered, with say greater than an estimated 5% of a non-natural constituent, it has been referred to as Made Ground both on the log and within this report.

For more complete information about the soils encountered within the general area of the site reference should be made to the detailed records given within Appendix A, but for the purposes of discussion, the succession of conditions encountered in the trial holes in descending order can be summarised as:

Made Ground/Topsoil (MG/TS)
Claygate Member (CLGB)
London Clay Formation (LCF)

The ground conditions encountered in the trial holes are summarised in Table 2.2.

Table 2.2 Ground Conditions

Strata	Epoch	Depth Encountered (m bgl)		Typical Thickness (m)	Typical Description
		Top	Bottom		
MG/TS	Anthropocene	0.00	0.40 – 1.20	0.60	MG: Orange and brown slightly sandy gravelly CLAY with brick and clinker. TS: Yellowish brown mottled dark brown slightly sandy silty CLAY with frequent rootlets.
CLGB	Eocene	0.40 – 1.20	7.70[1] – 8.50	7.50	Orangish brown and grey mottled yellowish brown interlaminated slightly fine sandy silty CLAY with occasional selenite crystals.
LCF	Eocene	7.70[1] – 8.50	>15.00[2]	Not proven[3]	Greyish brown becoming dark grey slightly fine sandy silty CLAY

Note: [1] Inferred from dynamic probe [2] Final depth of trial hole. [3] Base of strata not encountered. 0.00 denotes ground level.

2.3 Ground Conditions Encountered in Trial Holes

The ground conditions encountered in trial holes have been described below in descending order. The engineering logs are presented in Appendix A.1.

2.3.1 Made Ground and Topsoil

Soils described as Made Ground were encountered in three of the five trial holes from ground level to depths ranging between 0.45m and 1.20m bgl. The Made Ground typically comprised orange and brown slightly sandy gravelly CLAY. Gravel comprised fragments of flint, brick and clinker.

Soils described as Topsoil were encountered in the remaining two trial holes from ground level and persisted to depths ranging between 0.40m and 0.50m bgl. The Topsoil comprised yellowish brown mottled dark brown slightly sandy silty CLAY with frequent rootlets.

The depths of Made Ground/Topsoil have been included in Table 2.3.

Table 2.3 Final Depth of Made Ground/Topsoil

Trial Hole	Strata	Depth (m bgl)
WS1	TS	0.40
WS2	TS	0.50
WS3	MG	0.45
WS4	MG	0.50
BH1	MG	1.20

2.3.2 Claygate Member

Soils described as Claygate Member were encountered in all five trial holes underlying the Made Ground/Topsoil and persisted to a depth of 8.50m bgl as encountered within BH1. The lower horizon was inferred at depths between 7.70m and 7.90m bgl within dynamic probes DP2 – DP4, where the blow counts recover into stiffer soils.

The Claygate Member typically comprised orangish brown and grey mottled yellowish brown interlaminated slightly fine sandy silty CLAY with occasional selenite crystals. A potential septarian nodule concretion was observed at a depth of 2.30m to 2.60m bgl in WS4.

A granular unit comprising medium dense orange, yellowish brown and bluish grey mottled very clayey sandy angular to well-rounded flint and sandstone GRAVEL was encountered in WS1 and WS3, persisting to a depth of 1.50m bgl.

The depth of Claygate Member has been included in Table 2.4.

Table 2.4 Final Depth of Claygate Member

Trial Hole	Depth (m bgl)
WS1 / DP1	>4.00[1] / >7.00[1,2]
WS2 / DP2	>4.00[1] / 7.70[2]
WS3 / DP3	>4.00[1] / 7.90[2]
WS4 / DP4	>3.00[1] / 7.90[2]
BH1	8.50

Note: [1] Final depth of trial hole. [2] Depth inferred from dynamic probe

2.3.3 London Clay Formation

Soils described as the London Clay Formation were encountered in BH1 underlying the Claygate Member from a depth of 8.50m bgl and persisted to the full investigatory depth of 15.00m bgl. The upper horizon was inferred at depths between 7.70m and 7.90m within dynamic probes DP2 – DP4, where the blow counts recover into stiffer soils.

The London Clay Formation comprised greyish brown becoming dark grey slightly fine sandy silty CLAY.

The depth of London Clay Formation has been included in Table 2.5.

Table 2.5 Final Depth of London Clay Formation

Trial Hole	Depth (m bgl)
BH1	>15.00[1]

Note: [1] Final depth of trial hole.

2.4 Roots

Roots/rootlets were observed in all five trial holes encountered to depths ranging between 2.00m and 3.00m bgl. The depths of root penetration have been included in Table 2.6.

Table 2.6 Depth of Root Penetration

Trial Hole	Depth (m bgl)
WS1	2.00
WS2	2.80
WS3	2.90
WS4	3.00
BH1	2.00

Roots may be found to greater depth at other locations on the site particularly close to trees and/or trees that have been removed both within the site and its close environs.

It must be emphasised that the probability of determining the maximum depth of roots from a narrow diameter borehole is low. A direct observation such as from within a trial pit is necessary to gain a better indication of the maximum root depth.

Numerous mature and semi-mature trees were located onsite and along the west and east site perimeter.

2.5 Groundwater

Seepage was recorded at a depth of 2.50m bgl in WS4. No water "strikes" were recorded during construction of the remining trial holes.

Changes in groundwater level occur for a number of reasons including seasonal effects and variations in drainage. The investigation was conducted in July and August (2020), when groundwater levels should be reducing from their annual maximum (highest) elevation which typically occurs around March.

Groundwater equilibrium conditions may only be conclusively established, if a series of observations are made via groundwater monitoring wells.

Section 3 Discussion of Geotechnical In-Situ and Laboratory Testing

3.1 Standard Penetration Tests

Standard Penetration Tests (SPTs) were undertaken in BH1. The results were interpreted based on the classifications outlined in Appendix B.1.

The SPT "N60" values presented have been corrected in accordance with BS EN 22476 Part 3, to account for the rig efficiency, borehole depth, overburden factors etc. Further correction of the 'N' values should therefore not be necessary. The energy ratio for each location is presented on the individual logs within Appendix A.1.

The Claygate Member recorded SPT "N60" values between 9 and 17, increasing with depth. Classifying the cohesive soils as medium becoming high strength and inferred undrained cohesive strengths between 45kPa and 85kPa.

The London Clay Formation recorded SPT "N60" values between 19 and 23, increasing with strength. Classifying the cohesive soils as high strength with inferred undrained cohesive strengths between 95kPa and 115kPa.

A full interpretation of the SPT results are outlined in Appendix B.2, Table B.2.1.

3.2 Dynamic Probe Tests

Dynamic probing (DPSH) was undertaken at four locations (DP1 – DP4) prior and adjacent to their corresponding windowless sampler borehole locations. The results were converted to equivalent SPT "N60" values based on dynamic energy using commercial computer software (Geostru). The results were then interpreted based on the classifications outlined in Appendix B.1.

The SPT "N60" values presented have been corrected in accordance with BS EN 22476 Part 3, to account for the rig efficiency, borehole depth, overburden factors etc. Further correction of the 'N' values should therefore not be necessary. The energy ratio for each location is presented on the individual logs within Appendix A.1.

The Claygate Member recorded equivalent SPT "N60" values between 4 and 11, classifying the cohesive soils as low to medium strength with inferred undrained cohesive strengths 20kPa to 55kPa. The clayey gravel unit encountered locally in DP1 and DP3 recorded equivalent SPT "N60" values ranging 11 to 26, classifying the granular unit with a medium dense relative density.

The London Clay Formation inferred at depth within DP2 to DP4 recorded equivalent SPT "N60" values between 15 and 30, increasing with depth, classifying the cohesive soils as high strength with undrained cohesive strengths between 75kPa and 150kPa.

A full interpretation of the DPSH tests are outlined in Appendix B.2, Table B.2.2.

3.3 Quick Unconsolidated Undrained Triaxial Compression Tests

Quick Unconsolidated Undrained Triaxial Compression Tests (QUU) were performed on two samples obtained from the Claygate Member and one sample from the London Clay Formation. The strength interpretation was based on the classification outlined in Table B.2.3.

The QUU testing indicated soils of the Claygate Member were of a high strength with undrained cohesions of 83kPa to 86kPa.

Soils of the London Clay Formation were of a high strength with an undrained cohesion of 108kPa.

A full interpretation of the QUU tests are outlined Table B.2.3, Appendix B.2 and the laboratory report in Appendix B.3.

3.4 Atterberg Limit Tests

Atterberg Limit tests were performed on six samples from the Claygate Member and one sample from the London Clay Formation. The results were classified in accordance with BRE Digest 240 and NHBC Standards Chapter 4.2.

The Claygate Member was classified as high volume change potential in accordance with BRE Digest 240 and NHBC Standards Chapter 4.2. Atterberg testing undertaken on the granular unit determined the soil to be non-plastic.

The London Clay Formation was classified as high volume change potential in accordance with BRE Digest 240 and NHBC Standards Chapter 4.2.

A full interpretation of the Atterberg Limit tests are outlined in Table B.2.4, Appendix B.2 and the laboratory report in Appendix B.3.

3.5 Sulphate and pH Tests

Two samples were taken from the Claygate Member and one from the London Clay Formation for water soluble sulphate (2:1) and pH testing in accordance with Building Research Establishment Special Digest 1, 2005, 'Concrete in Aggressive Ground'. w/s sulphate and pH testing was undertaken on an additional three samples from the Claygate Member.

The test results have been summarised in Table 3.1.

Table 3.1 W/S Sulphate and pH Test Results Summary

Stratum	No. of Tests	W/S Sulphate (mg/l)	pH
CLGB	5	128 - 2890	7.2 – 7.9
LCF	1	1740	7.9

The significance of the sulphate and pH test results are discussed in Section 4.4 and the laboratory report in Appendix B.3.

Section 4 Foundation Design

4.1 General

An engineering appraisal of the soil types encountered during the site investigation and likely to be encountered during the redevelopment of this site is presented. Soil descriptions are based on analysis of disturbed samples taken from the trial holes.

4.1.1 Made Ground and Topsoil

The terms *Fill* and *Made Ground (non-engineered fill)* are used to describe material, which has been placed by man either for a particular purpose e.g. to form an embankment, or to dispose of unwanted material. For the former use, the Fill and/or Made Ground may well have been selected for the purpose and placed and compacted in a controlled manner. With the latter, great variations in material type, thickness and degree of compaction invariably occur and there can be deleterious or harmful matter, as well as potentially methanogenic organic material.

The BSI Code of Practice for Foundations, BS 8004:2015, Clause 4.1.2.2 states, *'Spread foundations should not be placed on non-engineered fill unless such use can be justified on the basis of a thorough ground investigation and detailed design.'*

Soils described as Made Ground were encountered in three of the five trial holes from ground level to depths ranging between 0.45m and 1.20m bgl. The Made Ground typically comprised orange and brown slightly sandy gravelly CLAY. Gravel comprised fragments of flint, brick and clinker.

Soils described as Topsoil were encountered in the remaining two trial holes from ground level and persisted to depths ranging between 0.40m and 0.50m bgl. The Topsoil comprised yellowish brown mottled dark brown slightly sandy silty CLAY with frequent rootlets.

A result of the inherent variability, particularly of uncontrolled Topsoil, Fill and/or Made Ground is that it is usually unpredictable in terms of bearing capacity and settlement characteristics. Foundations should, therefore, be taken through any Topsoil and/or Made Ground and either into, or onto a suitable underlying natural stratum of adequate bearing characteristics.

4.1.2 Claygate Member

Soils described as Claygate Member were encountered in all five trial holes underlying the Made Ground/Topsoil and persisted to a depth of 8.50m bgl as encountered within BH1. The lower horizon was inferred at depths between 7.70m and 7.90m bgl within dynamic probes DP2 – DP4, where the blow counts recover into stiffer soils.

The Claygate Member typically comprised orangish brown and grey mottled yellowish brown interlaminated slightly fine sandy silty CLAY with occasional selenite crystals. A potential septarian nodule concretion was observed at a depth of 2.30m to 2.60m bgl in WS4.

A granular unit comprising medium dense orange, yellowish brown and bluish grey mottled very clayey sandy angular to well-rounded flint and sandstone GRAVEL was encountered in WS1 and WS3, persisting to a depth of 1.50m bgl.

The results from SPT testing inferred that the cohesive soils of the Claygate Member were of medium becoming high strength with inferred undrained cohesions of between 45kPa and 85kPa.

The results from DPSH testing inferred that the cohesive soils of the Claygate Member were of low to medium strength with inferred undrained cohesions of between 20kPa and 55kPa.

The results from QUU testing indicated the soils of the Claygate Member were of high strength with undrained cohesive strengths of 83kPa to 86kPa.

The results from Atterberg Limit tests showed that the soils of the Claygate Member had **high volume change potential** in accordance with BRE Digest 240 and NHBC Standards Chapter 4.2. The granular soils encountered locally were determined to be non-plastic.

Soils of the Claygate Member are heavily overconsolidated predominantly cohesive soils and expected to display moderate bearing and settlement characteristics. The soils of the Claygate Member were considered a suitable bearing stratum for adopting a deep foundation solution founding below unsuitable root penetrated cohesive soils, observed to depths of up to 3.00m bgl within the narrow diameter boreholes.

4.1.3 London Clay Formation

Soils described as the London Clay Formation were encountered in BH1 underlying the Claygate Member from a depth of 8.50m bgl and persisted to the full investigatory depth of 15.00m bgl. The upper horizon was inferred at depths between 7.70m and 7.90m within dynamic probes DP2 – DP4, where the blow counts recover into stiffer soils. The London Clay Formation comprised greyish brown becoming dark grey slightly fine sandy silty CLAY.

The results from SPT testing inferred that the cohesive soils were of high strength with undrained cohesive strengths between 95kPa and 115kPa.

The results from DPSH testing inferred that the cohesive soils were of high strength with undrained cohesive strengths between 75kPa and 150kPa.

The results from QUU testing indicated the soils of the London Clay Formation were of high strength with an undrained cohesive strength of 108kPa.

The results from an Atterberg Limit test classified the stratum as having high volume change potential in accordance with BRE Digest 240 and NHBC Standards Chapter 4.2.

Soils of the London Clay Formation are heavily overconsolidated cohesive soils and expected to display moderate bearing and settlement characteristics. The London Clay Formation was considered a suitable bearing stratum for the proposed development, adopting a deep foundation solution.

4.1.4 Roots

Roots/rootlets were observed in all five trial holes encountered to depths ranging between 2.00m and 3.00m bgl. Roots may be found to greater depth at other locations on the site particularly close to trees and/or trees that have been removed both within the site and its close environs.

Numerous mature and semi-mature trees were located onsite and along the west and east site perimeter.

4.1.5 Groundwater

Seepage was recorded at a depth of 2.50m bgl in WS4. No water "strikes" were recorded during construction of the remining trial holes. Changes in groundwater level occur for a number of reasons including seasonal effects and variations in drainage. The investigation was conducted in July and August (2020), when groundwater levels should be reducing from their annual maximum (highest) elevation which typically occurs around March.

Groundwater equilibrium conditions may only be conclusively established, if a series of observations are made via groundwater monitoring wells.

4.2 Foundation Scheme General

The proposed development was to comprise demolition of existing structures onsite and subsequent erection of two detached dwellings and double garage with associated driveways and private gardens.

In compiling this report reliance was placed on drawing number 120-002G, dated April 2016, prepared by Shaun Knight Architecture. Any change or deviation from the scheme outlined in the drawing could invalidate the foundation design and remediation recommendations presented within this report. Soils Limited must be notified about any such changes.

Development plans provided by the client are presented in Appendix D.

4.2.1 Guidance on Shrinkable Soils

The Building Research Establishment (BRE) Digests 240, 241 and 242 provide guidance on 'best practice' for the design and construction of foundations on shrinkable soils.

The results from Atterberg Limits Tests showed that the cohesive Claygate Member and London Clay Formation had high volume change potential in accordance with both BRE Digest 240 and NHBC Standards Chapter 4.2.

The BRE Digest 241 states: "An increasingly common, potentially damaging situation is where trees or hedges have been cut down prior to building. The subsequent long-term swelling of the zone of clay desiccated by the roots, as moisture slowly returns to the ground, can be substantial. The rate at which the ground recovers is very difficult to predict and if there is any doubt that recovery is complete then bored pile foundations with suspended beams and floors should be used".

The stated intention of the NHBC is to ensure that shrinkage and swelling of plastic soils does not adversely affect the structural integrity of foundations to such a degree that remedial works would be required to restore the serviceability of the building. It must be borne in mind that adherence to the NHBC tables and design recommendations may not, in all cases, totally prevent foundation movement and cracking of brickwork might occur.

The BRE Digest 240 suggests: *"Two courses of action are open:*

Estimate the potential for swelling or shrinkage and try to avoid large changes in the water content, for example by not planting trees near the foundations.

Accept that swelling or shrinkage will occur and take account of it. The foundations can be designed to resist resulting ground movements or the superstructure can be designed to accommodate movement without damage."

The design of foundations suitable to withstand movements is presented in BRE Digest 241 "Low-rise buildings on shrinkable clay soils: Part 2"

4.3 Foundation Scheme

Foundations must not be constructed within any Made Ground/Topsoil and Claygate Member due to the likely variability and potential for large load induced settlements both total and differential.

Roots/rootlets were observed in all five trial holes reaching depths of up to 3.00m bgl. If roots are encountered during the construction phase foundations must not be placed within any live root penetrated or desiccated cohesive soils or those with a volume change potential. Should the foundation excavations reveal such materials, the

excavations must be extended to greater depth in order to bypass these unsuitable soils. Excavations must be checked by a suitable person prior to concrete being poured.

Given the significant depth of roots/rootlets observed within the area of the building footprint and presence of cohesive soils of the Claygate Member classified as high volume change potential, a piled foundation solution was considered the most suitable.

4.3.1 Piled Foundations

If adopted the piled foundations must be taken through any Made Ground into suitable strength soils of the Claygate Member/London Clay Formation.

The construction of a piled foundation is a specialist job with the actual pile working load depending on the particular type pile and installation method. Prior to finalising the foundation design the advice from a reputable contractor who is familiar with the ground and groundwater conditions present at the site should be sought.

The vertical load capacities are provided for varying diameters and lengths of bored piles taken into the Claygate Member and London Clay Formation, based on SPT "N60" values and triaxial test results and must only be used for preliminary design purposes. A factor of safety of three was applied to both the shaft and base and depicted by the design line outlined in Appendix C.1. An Nc value of 9 and alpha value of 0.45 was adopted for the clay soils.

The bearing values given in Appendix C.1., are applicable to single piles. Where piles are to be constructed in groups the bearing value of each individual pile should be reduced by a factor of about 0.8 and a calculation made to check the factor of safety against block failure.

From ground level the upper 4m of the pile shaft has been ignored in the preliminary pile design given.

To prevent necking of the green concrete, temporary casing may be required where the pile passes through the Made Ground or granular Claygate Member and below the groundwater table (if encountered). To achieve the full bearing value a pile should penetrate the bearing stratum by at least five times the pile diameter.

No allowance has been made for negative skin friction that could be generated where piles pass through Made Ground and weathered Claygate Member deposits underlying the site. The negative skin friction must be applied to the pile working load and must not be factored.

4.3.2 Ground Floor Slab

NHBC Standards 2019 states ground floors should be constructed as suspended floors where:

- *"the foundation depth dictated by the NHBC Standards 2019, Chapter 4.2.10 would exceed 1.5m bgl;"*
- *"ground floor construction is undertaken when the surface soils are seasonally desiccated;"*
- *"the depth of fill exceeds 600mm;"*
- *"there is shrinkable soil that could be subject to movement, expansive material or other unstable soils;"*
- *"the ground has been subject to vibratory improvement;" or*
- *"ground or fill is not suitable to support ground-bearing slabs."*

Given the presence of root penetrated cohesive soils with a high-volume change potential, suspended floor slabs would be required for the proposed development.

4.4 Subsurface Concrete

Sulphate concentration measured in 2:1 water/soil extracts fell into Class **DS-3** of the BRE Special Digest 1 2005, *'Concrete in Aggressive Ground'*. Table C2 of the Digest indicated ACEC (Aggressive Chemical Environment for Concrete) site classifications of **AC-3**. The pH of the soils tested ranged between 7.2 and 7.9. The classification given was determined using the mobile groundwater case, in the view of groundwater being encountered. The laboratory results are presented in Appendix B.3.

Concrete to be placed in contact with soil or groundwater must be designed in accordance with the recommendations of Building Research Establishment Special Digest 1 2005, *'Concrete in Aggressive Ground'* taking into account any possible exposure of potentially pyrite bearing natural ground and the pH of the soils.

4.5 Excavations

Shallow excavations in the Made Ground/Topsoil and granular Claygate Member are likely to be marginally stable in the short term at best.

Deeper excavations taken into the cohesive Claygate Member are likely to be stable in the short term, depending on the thickness of overlying granular soils, where present. Unsupported earth faces formed during excavation may be liable to collapse without warning and suitable safety precautions should therefore be taken to ensure that such earth faces are adequately supported or battered back to a safe angle of repose before excavations are entered by personnel.

Excavations beneath the groundwater table are likely to be unstable and dewatering of trenches may be necessary.

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Figure 1 – Site Location Map

Job Number 18512	**Project** Copped Close, 15 Totteridge Village, London N20 8PN
Client Benellie Construction Ltd.	**Date** August 2020

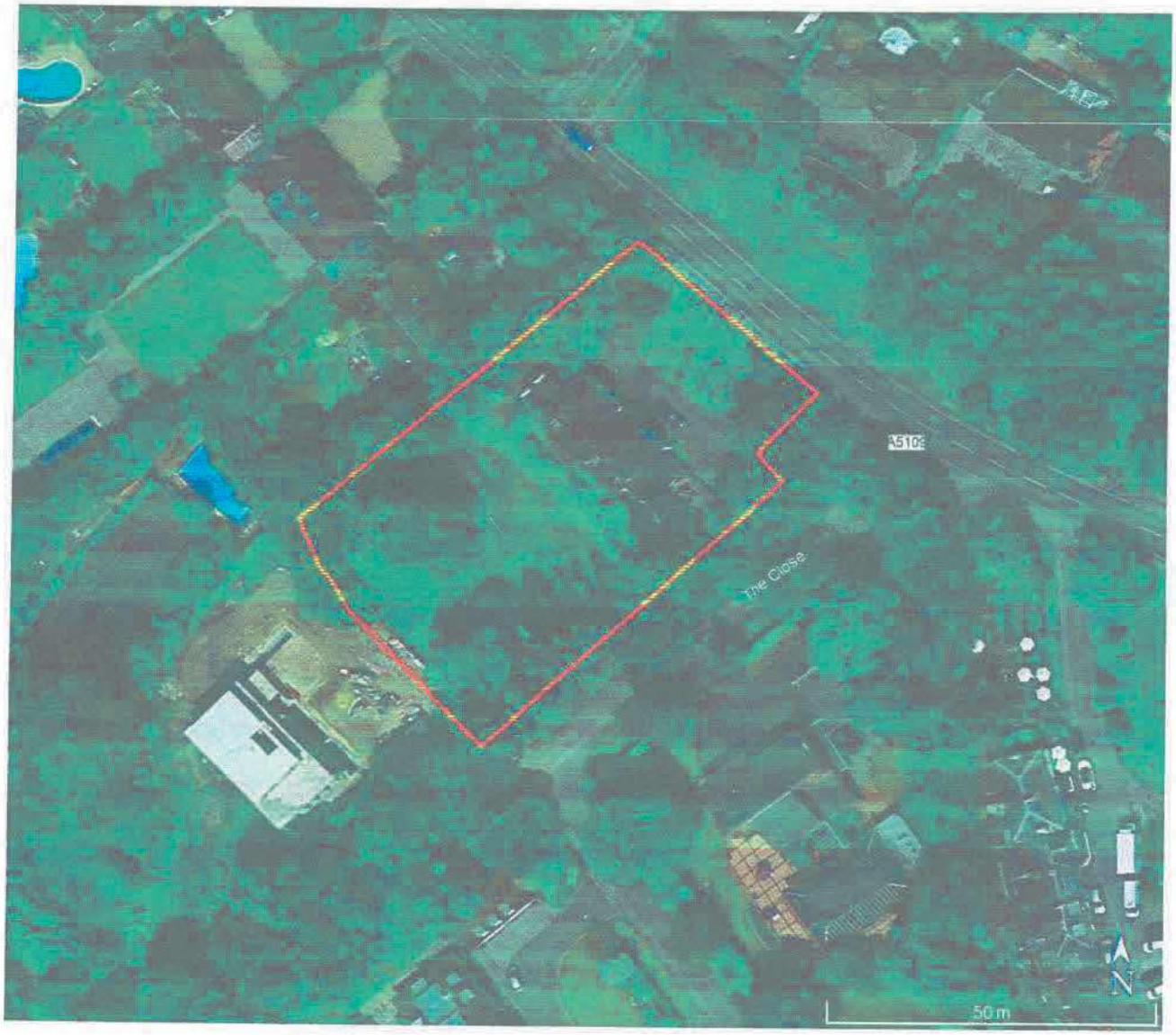

Figure 2 – Aerial Photograph

Project
Copped Close, 15 Totteridge Village, London N20 8PN

Client
Benellie Construction Ltd.

Date
August 2020

Job Number
18512

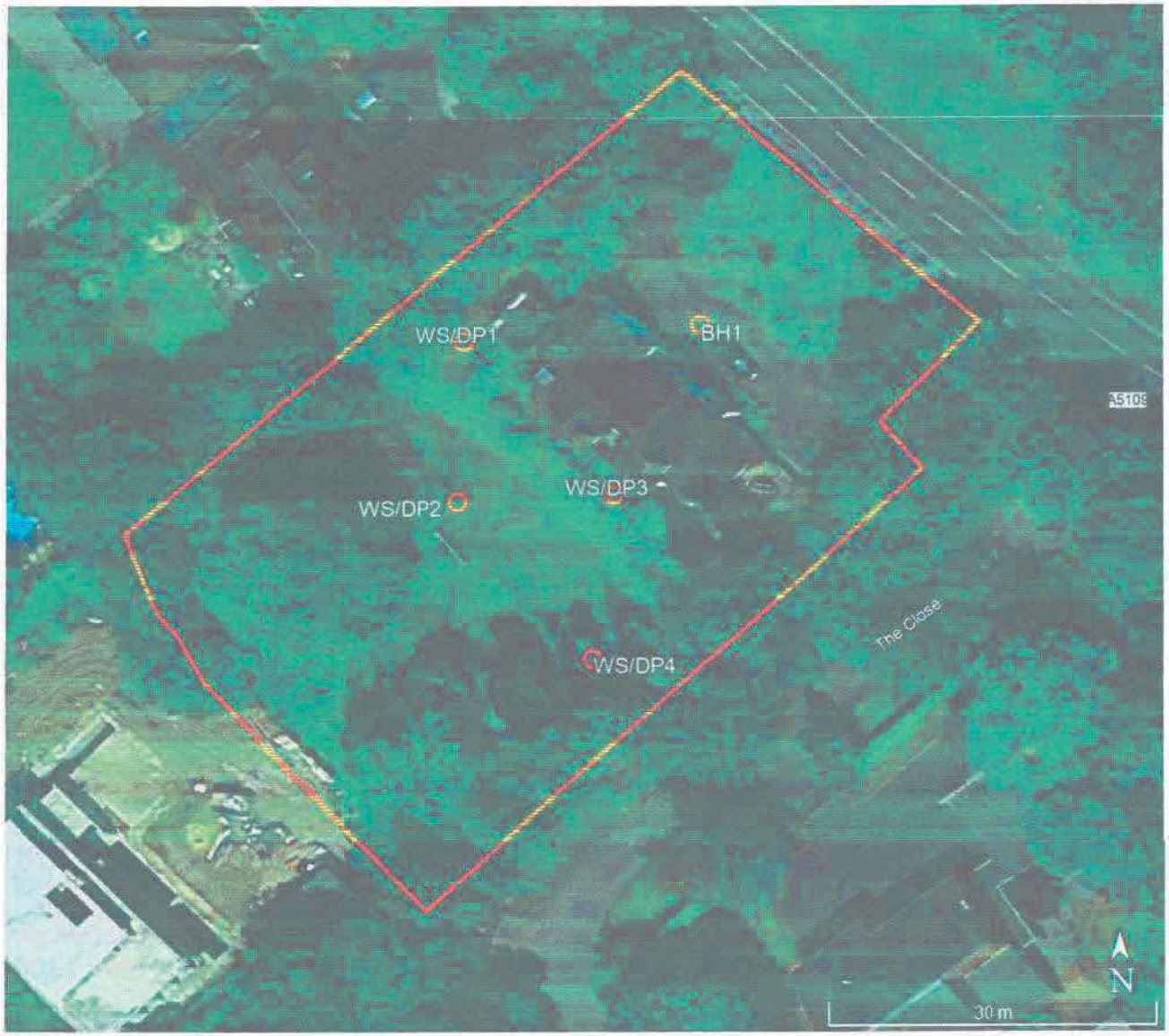

Figure 3 – Trial Hole Plan

Project
Copped Close, 15 Totteridge Village, London N20 8PN

Client
Benellie Construction Ltd.

Date
August 2020

Job Number
18512

PLANNING

REV A	21/10/2016	REDECTIONS FOLLOWING OFFICERS COMMENTS
REV B	06/11/2016	FURTHER REDUCTIONS
REV C	16/02/2017	BIN STORES SHOWN
REV D	21/04/2017	P1 AND P2 HOUSES REDUCED IN DEPTH, P1 HOUSE REDUCED IN WIDTH, P1 HOUSE MOVED BACK 1275 INTO SITE,NOTIONAL BUILDING LINE INDICATED
REV E	02/05/2017	P1 EAST STEP IN FRONT FACADE REMOVED, PORCH MOVED EAST
REV F	04/05/2017	P1 FRONT WALL MOVED FURTHER 350MM BACK FROM GABLE WALL
REV G	08/06/2017	HOUSES MOVED BACK IN SITE

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PROJECT: 15 TOTTERIDGE VILLAGE

TITLE : PROPOSED SITE PLAN

Date: APRIL 2016

Scale: 1:200 at A1 Drawn: SDK

DRAWING NUMBER: 120-002G

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Geotechnical & Environmental Consultants

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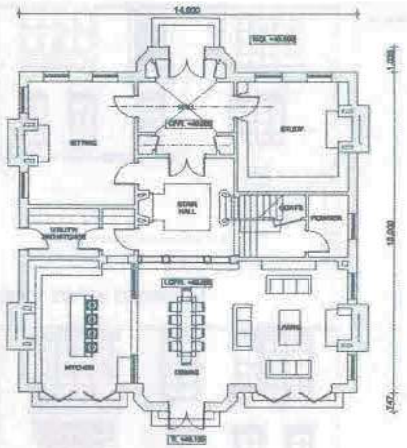
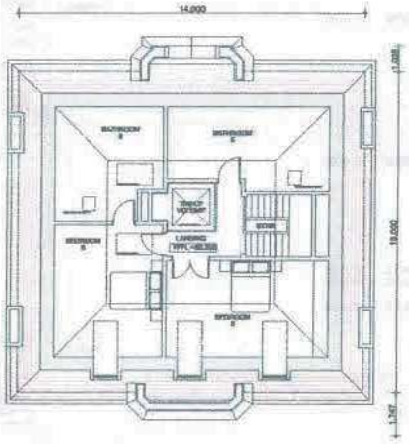
REV A	21/10/2016	REVISIONS FOLLOWING OFFICER'S COMMENTS
REV B	09/11/2016	FURTHER REDUCTIONS

PLANNING

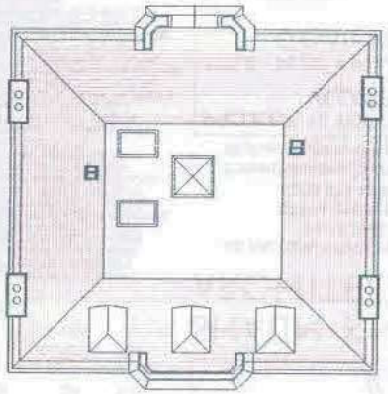


PROPOSED GROUND FLOOR PLAN

PROPOSED FIRST FLOOR PLAN

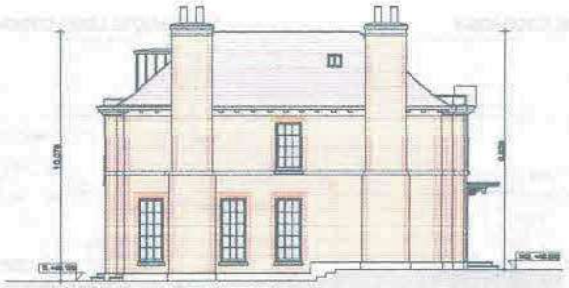


PROPOSED SECOND FLOOR PLAN

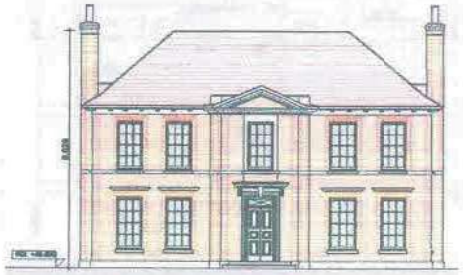


PROPOSED ROOF PLAN

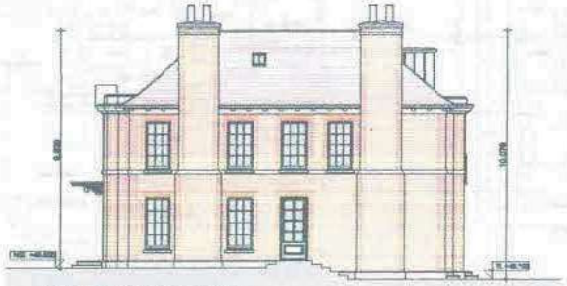
REAR, SOUTH ELEVATION



SIDE, EAST ELEVATION

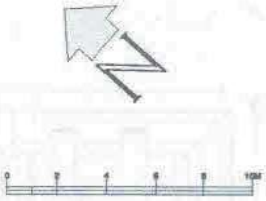


FRONT, NORTH ELEVATION



SIDE, WEST ELEVATION

REV A	21/10/2016	REVISIONS FOLLOWING OFFICER'S COMMENTS
REV B	09/11/2016	FURTHER REDUCTIONS
REV C	21/04/2017	DEPTH REDUCED 1M FRONT DORMER OMITTED ROOF WINDOWS QUANTITY AND SIZE REDUCED TWO DORMERS ADDED TO REAR



15 TOTTERIDGE VILLAGE

PLOT 2 GIAs

	M^2	FT^2
GROUND	168	1808
FIRST	164	1765
SECOND	111	1194
TOTAL	443	4767
GARAGE	30	297

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PROJECT: 15 TOTTERIDGE VILLAGE

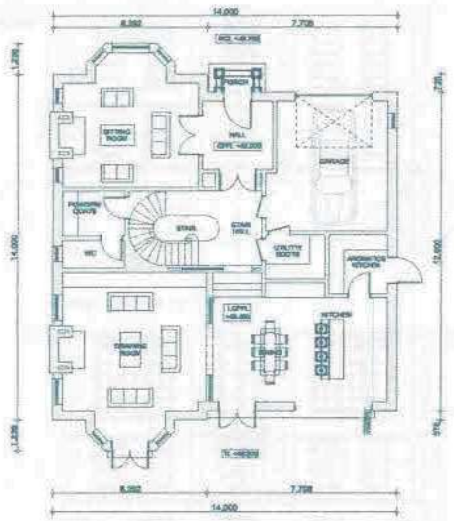
TITLE : PLOT 2 PLANS AND ELEVATIONS

Date: APRIL 2016

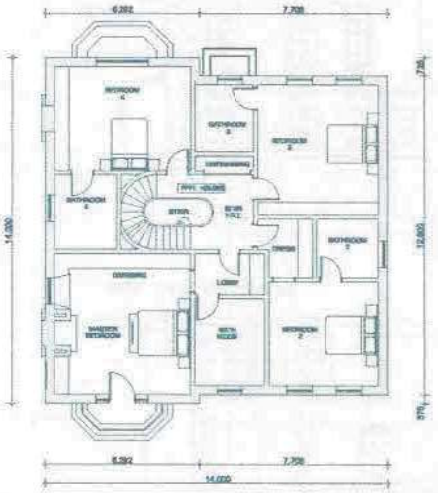
Scale: 1:100 at A1 Drawn: SDK

DRAWING NUMBER: 120-004C

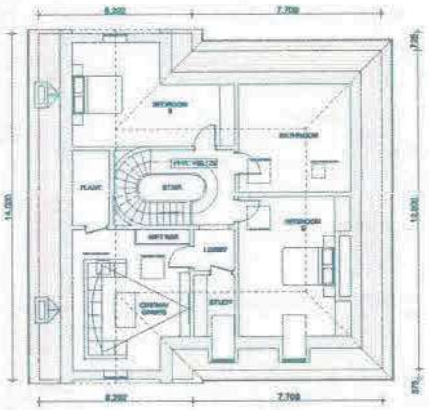
PLANNING



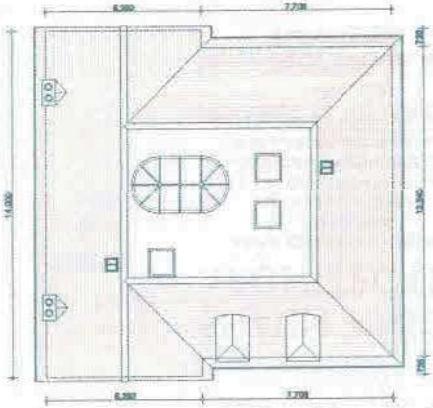
PROPOSED GROUND FLOOR PLAN



PROPOSED FIRST FLOOR PLAN

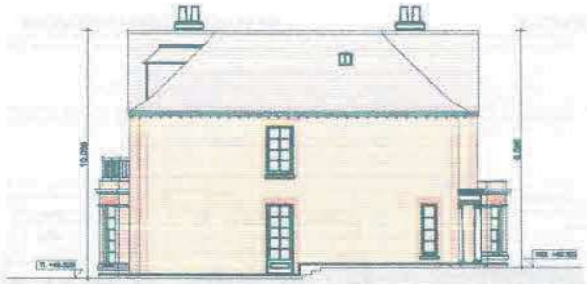


PROPOSED SECOND FLOOR PLAN



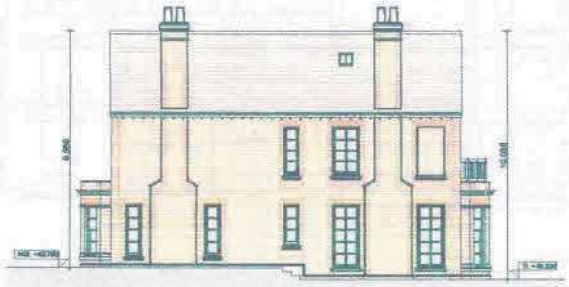
PROPOSED ROOF PLAN

REAR, SOUTH ELEVATION

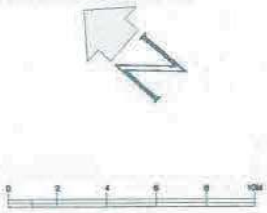


SIDE, EAST ELEVATION

FRONT, NORTH ELEVATION



SIDE, WEST ELEVATION



15 TOTTERIDGE VILLAGE

PLOT 1 GIAs

	M²	FT²
GROUND	147	1582
FIRST	165	1775
SECOND	124	1334
TOTAL	436	4691

REV A	21/10/2016	REVISIONS FOLLOWING OFFICER'S COMMENTS
REV B	05/11/2016	FURTHER REDUCTIONS
REV C	21/04/2017	DEPTH REDUCED 0.73M WIDTH REDUCED 1.785M SIDE S/S ELEMENT REMOVED FRONT DORMER OMITTED GABLE ADDED TO FRONT ROOF WINDOWS REDUCED IN QUANTITY AND SIZE HOUSE MOVED 1.275M BACK INTO SITE GARAGE TO SINGLE, EAST STEP IN FRONT FACADE OMITTED, EAST GABLE OMITTED WITH HIP PROVIDED IN LIEU, PORCH MOVED TO EAST WITH OPENINGS ON THIS CENTRELINE ALSO MOVING, NEW WINDOW IN GARAGE, BEDROOM 6 AND BATHROOM HANDED, CONSERVATION ROOFLIGHT TO 2ND FLOOR BATHROOM
REV D	02/05/2017	
REV E	04/05/2017	FRONT WALL MOVED FURTHER 350MM BACK FROM GABLE WALL

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PROJECT: 15 TOTTERIDGE VILLAGE

TITLE : PLOT 1 PLANS AND ELEVATIONS

Date: APRIL 2016

Scale: 1:100 at A1 Drawn: SDK

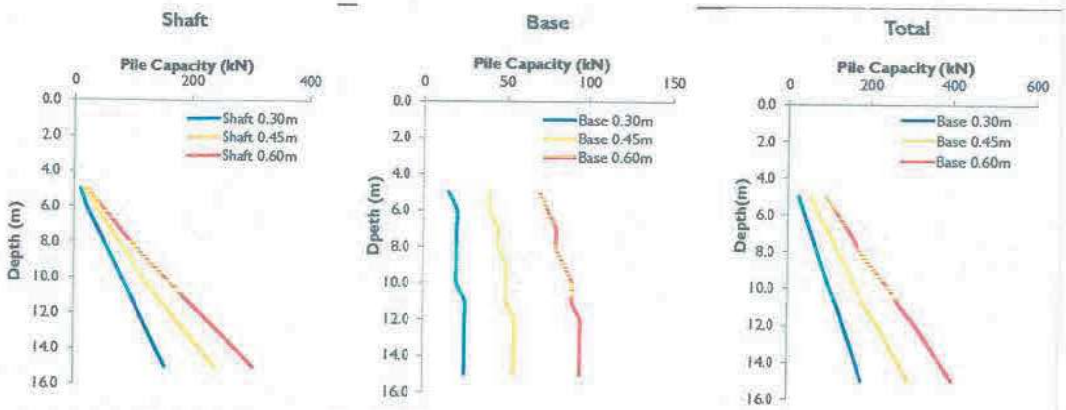
DRAWING NUMBER: 120-003E

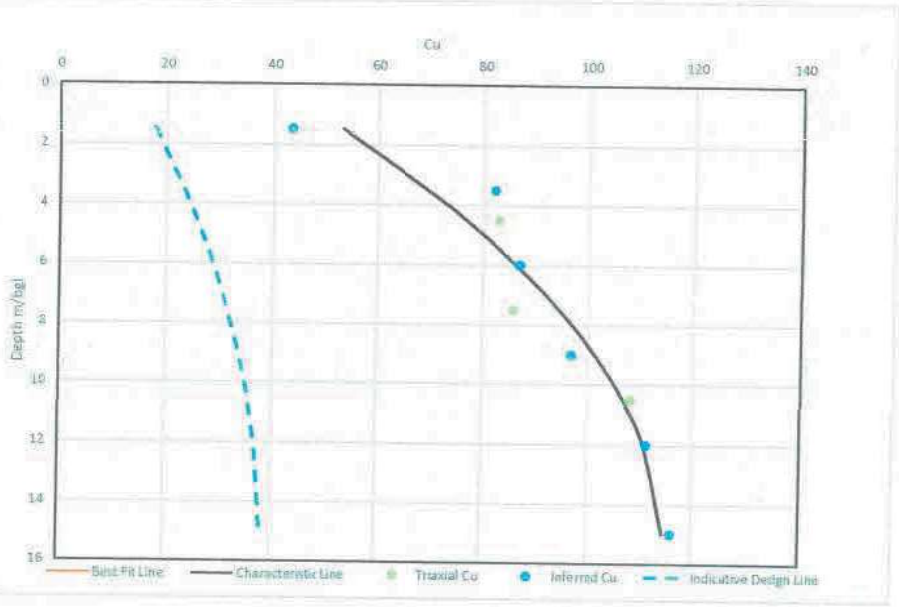
Appendix D Information Provided by the Client

Preliminary Pile Working Loads

Single Vertically Loaded Pile (kN)

Name:	TR	N_c value	9	Pile Start Depth:	4	FOS	
Job No:	18512	α value:	0.45	Pile Final Depth:	15	Shaft	Base
Date:	27.8.20			Pile Increment:	1	3	3





	Pile Diameter (m):								
Pile Depths	0.30			0.45			0.60		
(m bgl)	Shaft	Base	Total	Shaft	Base	Total	Shaft	Base	Total
4.0									
5.0	10	15	25	15	40	55	20	70	90
6.0	20	20	40	35	40	75	45	75	120
7.0	35	20	55	55	45	100	70	80	150
8.0	50	20	70	75	45	120	95	80	175
9.0	65	20	85	95	50	145	125	85	210
10.0	80	20	100	115	50	165	155	90	245
11.0	95	25	120	140	50	190	185	90	275
12.0	110	25	135	165	55	220	215	95	310
13.0	125	25	150	190	55	245	245	95	340
14.0	140	25	165	215	55	270	275	95	370
15.0	155	25	180	240	55	295	305	95	400