REPORT ON A GROUND INVESTIGATION AT 1 HAVERSHAM PLACE, HIGHGATE, LONDON, N6 6NG

Murray Rix Limited
Civil and Geotechnical Engineers
13 Willow Park
Upton Lane
Stoke Golding
Nuneaton
CV13 6EU

Tel: 01455 213311
Fax: 01455 213969

Vsjob/11-2109r
January 2012

REPORT ON A GROUND INVESTIGATION AT 1 HAVERSHAM PLACE, HIGHGATE, LONDON, N6 6NG

Contents

REPORT ON A GROUND INVESTIGATION AT 1 HAVERSHAM PLACE, HIGHGATE, LONDON, N6 6NG

1. INTRODUCTION AND OBJECTIVES

1.1 This report has been prepared on instructions given by David Banks Ltd (Consulting Civil and Structural Engineers, Pantiles, Salter's Meadow, Tolleshunt D'Arcy, Maldon, Essex, CM9 8UE) on behalf of the Client, Mr and Mrs Fafalios.

1.2 The aims of the investigation were to:

- Investigate the ground and groundwater conditions so that suitable methods of design and construction may be adopted for the foundations and ground floor slabs for the proposed extension to the existing house. It is understood that piled foundations are to be adopted.
- Undertake material property testing of samples recovered from an intrusive investigation.
- Present an interpretative report on the findings.

The scope of the works was in accordance with the requirements of David Banks Limited and did not include for any contamination testing.

1.3 As shown on Figure 1, Appendix (iv), the site comprises the existing house and grounds of 1 Haversham Place, Highgate. The site is located on the south-western side of Haversham Place adjacent to Merton Lane. The site is at and around National Grid Reference 527885 186910 (Reference 1).

1.4 The geotechnical investigation, assessment and reporting has been carried out in general accordance with the following:

- BS EN ISO 14688-1:2002. Geotechnical investigation and testing – Identification and classification of a soil – Part 1: Identification and description.
- BS EN ISO 14688-1:2005. Geotechnical investigation and testing – Identification and classification of a soil – Part 2: Principles for a classification.
- BS En ISO 22476-3:2005. Geotechnical investigation and testing – Field testing – Part 3: Standard Penetration Test.
- BS EN ISO 14689-1:2003. Geotechnical investigation and testing – Identification and classification of rock – Part 1: Identification and description.
- BS EN ISO 22475-1:2006. Geotechnical investigation and testing – Sampling methods and groundwater measurements – Part 1: Technical principles for execution.
- BS EN 1997-1:2004 Eurocode 7: Geotechnical design – Part 1: General Rules.
- NA to BS EN 1997-1:2004. UK National Annex to Eurocode 7: Geotechnical design – Part 1: General Rules.
- BS EN 1997-2:2007. Eurocode 7: Geotechnical design – Part 2: Ground investigation and testing.
- NA to BS EN 1997-2:2007. UK National Annex to Eurocode 7: Geotechnical design – Part 2: Ground investigation and testing.

2. SITE WORK

2.1 Two exploratory holes (WS1 and WS2) were undertaken at the site by windowless sampling techniques. The exploratory holes were drilled to 12.0m depth and Standard Penetration Tests (SPTs) were undertaken at 1m centres. Continuous samples were recovered from the full depth of the exploratory hole and small disturbed samples were also taken from the SPT split spoon.

2.2 The investigation and sampling strategy was to obtain representative samples of any fill, natural deposits and groundwater, where encountered, and to recover materials for soil property and contamination analysis and appraisal. Laboratory testing was undertaken to assess the ground conditions and material properties for foundation design. The investigation was in general accordance with the documents of section 1.4.

2.3 Details of the strata encountered are given on the borehole logs (Appendix (i)). The position of the exploratory holes are shown on Figure 1, Appendix (v).

2.4 All of the samples were transported to the laboratory for detailed examination and selected samples were programmed for testing.

2.5 The site work was undertaken on 30 November 2011.

3. LABORATORY WORK

3.1 The following laboratory tests to determine material properties were carried out on selected samples recovered from the exploratory hole:

Natural Moisture Contents;
Liquid and Plastic Limits;
Soluble Sulphate Contents;
pH Values.

3.2 The laboratory testing was undertaken during the period 02 to 19 December 2011.

3.3 The results of the laboratory testing are presented as Appendix (ii).

3.4 The testing was undertaken at a UKAS accredited laboratory.

4. PUBLISHED GEOLOGY, SITE DESCRIPTION AND REVEALED STRATA

4.1 Published geological information (Reference 2) indicates that the site lies in an area where the general downwards strata succession is as follows:

Claygate Member	-	Eocene Age
London Clay	-	Eocene Age

No faulting is shown in the vicinity of the site.

4.2 Published sources on the occurrence of radon and the need for protection measures in new dwellings (Reference 3) indicate that the site does not lie in an area where radon protective measures are necessary.

4.3 As shown on Figure 1, Appendix (v), the site comprises the existing house and grounds of 1 Haversham Place. The site is accessed via a gateway north-west from Haversham Place. The house, which is of three storey brick construction, is located at the northern end of the site. The site itself slopes down significantly from north-east to south-west with a fall of around 5m. The existing house is cut partly into the slope and is to be extended on the south-eastern side. The remainder of the site comprises sloping garden areas other than close to the southern end of the house where a relatively level area has been created. The extreme northern end of the site, beyond the house, is also fairly level.

There are a number of trees, including beech, ash, birch, holly, and cherry, around the perimeter of the site and at the northern end close to the entrance driveway.

The site lies in a residential area with parkland (Parliament Hill) to the west and Highgate Cemetery some distance to the east.

4.4 The topography of the site and surrounding area slopes down to the south-west.

4.5 The proposals are to construct a large extension on the south-eastern side of the existing house. It is understood piled foundations are to be adopted.

4.6 The following strata were revealed as present in the exploratory hole:

Made Ground:	Topsoil over a sand fill with occasional brick fragments.
Claygate Beds:	Firm slightly sandy slightly silty clays.
London Clay:	Firm and stiffer clays with occasional selenite crystals.

5. ENGINEERING ASSESSMENT AND RECOMMENDATIONS

5.1 Soil Profile

In both exploratory holes made ground comprising topsoil was encountered from ground surface. The topsoil was around 0.30 to 0.40m thick and was underlain by a horizon of sand fill with occasional brick fragments to 0.80 to 0.90m depth.

Underlying the shallow made ground were natural deposits thought to represent the Claygate Beds. These deposits comprised slightly sandy slightly silty clays of firm and firm to stiff consistency (medium strength). The assessment of strength is based on an interpretation of the in-situ Standard Penetration Test results (SPT tests) in accordance with Stroud and Butler (Reference 4) and detailed examination of the materials. Occasional sand/silt partings and roots were noted in the clays. The Claygate Beds were proved to 5.0m depth in WS1 and 5.4m in WS2. WS1 was drilled at a lower elevation than WS2.

Laboratory testing indicates that the clays of the Claygate Beds are of intermediate to high plasticity (CI to CH Soils) and are of medium to high shrinkability in comparison with the NHBC Standards (Reference 4).

Beneath the Claygate Beds were natural strata thought to represent the London Clay. These deposits comprised clays of firm and stiffer consistency (medium to high strength) with occasional fossil shell debris and selenite crystals. The London Clay was proved to the full depth of the investigation (12m) and can be expected to continue to significant depth below the site.

Laboratory testing indicates that the clays of the London Clay are of intermediate to very high plasticity (CI to CV Soils) and are of medium to high shrinkability.

5.2 Groundwater Conditions

Groundwater seepages were encountered at depths of 5.00 and 6.00m in WS1 and WS2 respectively. A shallowest standing water level of 4.95m was recorded in WS1. No long-term monitoring of groundwater has been undertaken as part of this investigation.

It should be borne in mind that groundwater conditions can vary with seasonal and other effects and thus at times may be at variance with the conditions noted during the site work.

5.3 Excavations

The stability of excavations is time dependent. The near-surface soils comprise clays with only a limited covering of made ground. Excavations within cohesive materials may stand unsupported for short periods of time. However, in deepened vertical sided excavations where personnel are required to enter, as a minimum precaution the adoption of intermittent support should be considered. The adequacy of excavation support should be continually assessed by experienced personnel.

5.4 Structural Foundations

It is understood that proposals are to construct a large extension to the existing house. The extension is to be supported on piled foundations. The piles should be taken down into the stiff clays of the London Clay below the site. Given the sloping nature of the site, the potentially limited working room and the need to minimise vibrations close to the existing house a cfa pile is likely to prove the favoured option, but the advice of a specialist contractor should be sought.

Calculations which assess the Ultimate Limit State (ULS) of the ground (Geo Limit State) and the Serviceability Limit State (SLS) (settlements) have been undertaken and are presented in Appendix (iv). The assessments examine the bearing resistance of the soils in relation to acceptable levels of settlement.

The upper natural strata comprise the Claygate Beds of medium strength. The characteristic geotechnical parameters for the clays are based an assessment of the reported standard penetration tests and an average characteristic undrained shear strength of 55kPa has been adopted in the Claygate Beds. The underlying London Clay is of medium to high strength and an average strength of 75kPa has been adopted. A plot of strength against depth based on the SPT results is presented in Appendix (iii). The calculations suggest a preliminary design load of 378kN for a 0.6m diameter cfa pile 12m

in length bearing in the London Clay in the absence of pile testing. It would be expected that settlement of piles under such conditions would not exceed 10mm.

As the extension is to be built across sloping ground consideration needs to be given to the potential for heave/uplift due to removal of overburden and the influence this may have on pile design.

In addition, there are a number of trees in proximity to the proposed extension. Foundations on cohesive soils within influencing distance of trees should be designed to take account of seasonal volume change in accordance with the recommendations of Reference 5. For the upper clays of the Claygate Beds high shrinkability conditions should be assumed and the piles should be designed to take account of this which may include sleeving the top of the piles and the placement of compressible materials below ground beams in accordance with Reference 5.

5.5 Ground Floor Slabs

Given the presence of cohesive soils and the proximity of the trees, ground floor slabs within influencing distance of trees would best be constructed over a suitable void in accordance with the recommendations of Reference 5. Elsewhere at the site ground bearing floor slabs would be acceptable. Where significant volumes of soil are removed from below floor slabs account should be taken of the potential for heave.

5.6 Chemical Attack on Concrete

Laboratory determinations of soluble sulphate content have been undertaken on samples of the soil present at the site. Reported concentrations of SO_3 were between 0.06 and 0.44g/l in association with acidic to near neutral pH values.

In accordance with BRE Special Digest 1 (Reference 6) the site has been classed as 'natural ground' and the groundwater regime is considered 'mobile' which is a worst case scenario as groundwater seepages were encountered at depth within the boreholes. Comparison of the characteristic sulphate content (based on the mean of the two highest results) and pH concentrations with Table C1 of Reference 6 suggests the ACEC class for the site is AC-3z.

R. Jones BSc, MSc, CGeol, FGS

REFERENCES

1. Ordnance Survey 1:50,000 Series Sheet 176 West London 1974.

2. British Geological Survey 1:50,000 Series Sheet 256 North London Solid and Drift Edition 1994.

3. Building Research Establishment 2007 Radon: guidance on protective measures for new dwellings. BRE.

4. Stroud, M. A. and Butler, F. G. 1975. 'The Standard Penetration Test and the Engineering Properties of Glacial Materials' Proceedings of the Symposium of University of Birmingham 21-23 April 1975.

5. NHBC Standards Chapter 4.2 2006 'Building Near Trees' National House Building Council.

6. BRE Special Digest 1:2005 Third Edition Concrete in Aggressive Ground. BRE Construction Division.

GENERAL NOTES

The copyright of this report and other plans and documents prepared by Murray Rix Limited are owned by them. The copyright in the written materials shall remain the property of Murray Rix Limited but with a royalty-free perpetual license to the client deemed to be granted on payment in full to Murray Rix Limited by the client of the outstanding monies.

The report is provided for the sole use of the client and is confidential to them, their professional advisors, no responsibility whatsoever for the contents of the report will be accepted to any person other than the client.

New information, improved practices, changes in legislation, or changes in guidelines from Statutory Bodies may necessitate a re-interpretation of the report in whole or part after its original submission.

The report and/or opinion will be prepared and written for the specific purposes and/or development stated in the document and in relation to the nature and extent of proposals made available to us at the time of writing. The recommendations should not be used for other schemes on or adjacent to the site.

The report is based on the ground conditions encountered in the exploratory holes together with the results of field and laboratory testing in the context of the proposed development. Conditions between exploratory holes have been interpolated, however soil conditions are highly variable and may differ from the interpolation. There may be conditions, appertaining to the site, which may not be revealed by the investigation, and which may not be taken into account in the report.

The accuracy of the results reported will depend on the technique of measurement, investigation and test used and these values should not be regarded necessarily as characteristic of the strata as a whole. Where such measurements are critical, the technique of the investigation will need to be reviewed and supplementary investigation undertaken in accordance with the advice of the company where necessary.

The economic viability of the proposal referred to in the report, or of the solutions put forward to any problems encountered, will depend on very many factors in addition to the geotechnical considerations hence its evaluation will be outside the scope of the report.

Where any data supplied by the Client or from other sources, including previous site investigations, have been used it has been assumed that the information is correct. No responsibility can be accepted by Murray Rix Limited for inaccuracies in the data supplied by any other party.

The investigation does not include the identification of Japanese Knotweed. Any such survey should be undertaken by a specialist.

Appendix (i)
Windowless Sample Hole Logs

BOREHOLE LOG - MURRAY RIX GEOTECHNICAL

HOLE NO. WS1
Sheet 1 of 2

CLIENT	SITE
David Banks/Mr & Mrs Fafalios	1 Haversham Place, Highgate

DATE OF FIELDWORK	SCALE	LEVEL/POSITION	OPERATOR	LOGGED BY	JOB NO.
30/11/11	1:50	AS LOCATION PLAN	BC	RJ	VSJOB/11-2109

SAMPLE DEPTH	RECORD TYPE	SPT N (Cu-kN/m^2)	Standp/ Piezo	DESCRIPTION OF STRATUM (thickness)	DEPTH	LEGEND
0.00 - 1.00	U1			Dark brown silty fine sandy topsoil. (0.30)		
				MADE GROUND: Dark brown fine to medium sand with occasional brick fragments. (0.50)	0.30	
1.00 - 1.45	S1	12		Firm locally firm to stiff orange brown, brown and grey slightly sandy, slightly silty CLAY with occasional roots. (Claygate Beds) (4.20)	0.80	
1.00 - 1.45	D1					
1.00 - 2.00	U2					
2.00 - 2.45	S2	12				
2.00 - 2.45	D2					
2.00 - 3.00	U3					
3.00 - 3.45	S3	12				
3.00 - 3.45	D3					
3.00 - 4.00	U4					
4.00 - 4.45	S4	9				
4.00 - 4.45	D4					
4.00 - 5.00	U5					
5.00 - 5.45	S5	13		Firm brown CLAY with occasional orange brown silty partings (London Clay). (1.50)	5.00	
5.00 - 5.45	D5					
5.00 - 6.00	U6					
6.00 - 6.45	S6	15				
6.00 - 6.45	D6					
6.00 - 7.00	U7					
				Firm to stiff dark grey silty CLAY with rare fossil fragments. (London Clay) (1.90)	6.50	
7.00 - 7.45	S7	12				
7.00 - 7.45	D7					
7.00 - 8.00	U8					
8.00 - 8.45	S8	16				
8.00 - 8.45	D8					
8.00 - 9.00	U9					
				Stiff dark grey silty CLAY with occasional fossil shell fragments. (London Clay). (3.60)	8.40	
9.00 - 9.45	S9	20				
9.00 - 9.45	D9					
9.00 -10.00	U10					
10.00-10.45	S10	21				

GROUNDWATER AND CASING INFORMATION

DEPTH STRUCK	DEPTH CASED	ELAPSED TIME	WATER LEVEL	DEPTH SEALED	REMARKS ON GROUNDWATER AND CASING
5.00	1.00	5 MINS	4.95	-	Groundwater sepages.

BORING METHOD AND REMARKS

Hole drilled by windowless sample rig, cased to 1.0m depth.
U Continuous Sample
D Disturbed Sample
S Standard Penetration Test

All dimensions are in metres unless otherwise stated

BOREHOLE LOG - MURRAY RIX GEOTECHNICAL

HOLE NO. WS1
Sheet 2 of 2

CLIENT	SITE
David Banks/Mr & Mrs Fafalios	1 Haversham Place, Highgate

DATE OF FIELDWORK	SCALE	LEVEL/POSITION	OPERATOR	LOGGED BY	JOB NO.
30/11/11	1:50	AS LOCATION PLAN	BC	RJ	VSJOB/11-2109

SAMPLE DEPTH	RECORD TYPE	SPT N (Cu-kN/m^2)	Standp/ Piezo	DESCRIPTION OF STRATUM (thickness)	DEPTH	LEGEND
10.00-10.45	D10			Stiff dark grey silty CLAY with occasional fossil shell fragments. (London Clay)		
10.00-11.00	U11					
11.00-11.45	S11	17				
11.00-11.45	D11					
11.00-12.00	U12					
					12.00	
				Borehole Complete		

GROUNDWATER AND CASING INFORMATION

DEPTH STRUCK	DEPTH CASED	ELAPSED TIME	WATER LEVEL	DEPTH SEALED	REMARKS ON GROUNDWATER AND CASING
5.00	1.00	5 MINS	4.95	-	Groundwater sepages.

BORING METHOD AND REMARKS

Hole drilled by windowless sample rig, cased to 1.0m depth.
U Continuous Sample
D Disturbed Sample
S Standard Penetration Test

All dimensions are in metres unless otherwise stated

BOREHOLE LOG - MURRAY RIX GEOTECHNICAL

HOLE NO. WS2
Sheet 1 of 2

CLIENT	SITE
David Banks/Mr & Mrs Fafalios	1 Haversham Place, Highgate

DATE OF FIELDWORK	SCALE	LEVEL/POSITION	OPERATOR	LOGGED BY	JOB NO.
30/11/11	1:50	AS LOCATION PLAN	BC	RJ	VSJOB/11-2109

SAMPLE DEPTH	RECORD TYPE	SPT N (Cu-kN/m^2)	Standp/ Piezo	DESCRIPTION OF STRATUM (thickness)	DEPTH	LEGEND
0.00 - 1.00	U1			Dark brown silty fine sandy topsoil. (0.40)		
				MADE GROUND: Dark brown clayey sand with occasional brick fragments. (0.50)	0.40	
1.00 - 1.45	S1	14		Firm to stiff dark brown mottled orange brown slightly silty slightly sandy CLAY with occasional silt and sand partings. (Claygate Beds) (4.50)	0.90	
1.00 - 1.45	D1					
1.00 - 2.00	U2					
2.00 - 2.45	S2	21				
2.00 - 2.45	D2					
2.00 - 3.00	U3					
3.00 - 3.45	S3	14				
3.00 - 3.45	D3					
3.00 - 4.00	U4					
4.00 - 4.45	S4	14				
4.00 - 4.45	D4					
4.00 - 5.00	U5					
5.00 - 5.45	S5	15				
5.00 - 5.45	D5					
5.00 - 6.00	U6					
				Firm dark brown silty CLAY. (London Clay) (1.10)	5.40	
6.00 - 6.45	S6	13				
6.00 - 6.45	D6					
6.00 - 7.00	U7					
				Firm to stiff light and dark grey very silty CLAY. (London Clay) (1.00)	6.50	
7.00 - 7.45	S7	9				
7.00 - 7.45	D7					
7.00 - 8.00	U8					
				Stiff dark grey laminated silty CLAY with occasional fossil shell fragments. (London Clay) (4.50)	7.50	
8.00 - 8.45	S8	16				
8.00 - 8.45	D8					
8.00 - 9.00	U9					
9.00 - 9.45	S9	13				
9.00 - 9.45	D9					
9.00 -10.00	U10					
10.00-10.45	S10	20				

GROUNDWATER AND CASING INFORMATION

DEPTH STRUCK	DEPTH CASED	ELAPSED TIME	WATER LEVEL	DEPTH SEALED	REMARKS ON GROUNDWATER AND CASING
6.00	1.00	5 MINS	5.95	-	Groundwater sepages.

BORING METHOD AND REMARKS

Hole drilled by windowless sample rig, cased to 1.0m depth.
U Continuous Sample
D Disturbed Sample
S Standard Penetration Test
NR No Recovery

All dimensions are in metres unless otherwise stated

BOREHOLE LOG - MURRAY RIX GEOTECHNICAL

HOLE NO. WS2
Sheet 2 of 2

CLIENT	SITE
David Banks/Mr & Mrs Fafalios	1 Haversham Place, Highgate

DATE OF FIELDWORK	SCALE	LEVEL/POSITION	OPERATOR	LOGGED BY	JOB NO.
30/11/11	1:50	AS LOCATION PLAN	BC	RJ	VSJOB/11-2109

SAMPLE DEPTH	RECORD TYPE	SPT N (Cu-kN/m^2)	Standp/ Piezo	DESCRIPTION OF STRATUM (thickness)	DEPTH	LEGEND
10.00-10.45	D10			Stiff dark grey laminated silty CLAY with occasional fossil shell fragments. (London Clay)		
10.00-11.00	U11					
11.00-11.45	S11	21				
11.00-11.45	D11					
11.00-12.00	U12 NR					
					12.00	
				Borehole Complete		

GROUNDWATER AND CASING INFORMATION

DEPTH STRUCK	DEPTH CASED	ELAPSED TIME	WATER LEVEL	DEPTH SEALED	REMARKS ON GROUNDWATER AND CASING
6.00	1.00	5 MINS	5.95	-	Groundwater sepages.

BORING METHOD AND REMARKS

Hole drilled by windowless sample rig, cased to 1.0m depth.
U Continuous Sample
D Disturbed Sample
S Standard Penetration Test
NR No Recovery

All dimensions are in metres unless otherwise stated

Appendix (ii)
Laboratory Test Results – Material Properties

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : 19/12/11 PAGE 1 of 12 Pages

Contract: HIGHGATE

Serial No.: S25144

UKAS TESTING 0998

CLIENT:

MURRAY RIX LIMITED.
13 WILLOW PARK
UPTON LANE
STOKE GOLDING
NUNEATON
WARWICKSHIRE
CV13 6EU

Soil Property Testing

18 Halcyon Court, St Margarets Way,
Stukeley Meadows, Huntingdon,
Cambs. PE29 6DG.

Telephone (01480) 455579 Fax (01480) 453619
Email SPTownend@btclick.com

SAMPLES SUBMITTED BY:

MURRAY RIX LIMITED.

APPROVED SIGNATORIES:

☐ **S.P.TOWNEND FGS**
Technical Director

☐ **W.JOHNSTONE**
Deputy Technical/Quality Manager

☑ **J.C.GARNER B.Eng (Hons.) FGS**
Quality Manager

SAMPLES LABELLED:

HIGHGATE

DATE RECEIVED: 02/12/11

SAMPLES TESTED BETWEEN 02/12/11 **and** 19/12/11

REMARKS: For the attention of Mrs R Jones
Your ref 2109

NOTES:

1 All remaining samples or remnants from this contract will be disposed of after 21 days from today, unless we are notified to the contrary.

2 (a) UKAS - United Kingdom Accreditation Service.
(b) Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

3 Tests marked "NOT UKAS ACCREDITED" in this test report are not included in the UKAS Accreditation Schedule for this testing laboratory.

4 This test report may not be reproduced other than in full except with the prior written approval of the issuing laboratory.

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : As page 1 PAGE 2 of 12

Contract: HIGHGATE

Serial No.: S25144

SCHEDULE OF LABORATORY TESTS

Bh./ Tp No.	Sample Ref	Depth (from)	1:Moisture Content Determination	4:Liquid/Plastic limit 1 point	34:Sulphate Test (2:1 Water Soil)	36:ph value of Soil or Water	Remarks
WS1	L2	1.50	*	*	*	*	
	L3	2.50	*	*			
	L7	6.50	*	*	*	*	
	L12	11.50	*	*	*	*	
WS2	L2	1.50	*	*	*	*	
	L5	4.50	*	*			
	L9	8.50			*	*	
-	-	-	6	6	5	5	<— Total Number of Tests ——

Scheduled by: MURRAY RIX LIMITED.

Target Date: 16/12/11

SPTSCHED

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : As page 1

Contract: HIGHGATE

Serial No.: S25144

UKAS TESTING 0998

SUMMARY OF MOISTURE CONTENT, LIQUID LIMIT, PLASTIC LIMIT, PLASTICITY INDEX AND LIQUIDITY INDEX

Borehole/ Pit No.	Depth m.	Sample	Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)	SAMPLE PREPARATION				Description	CLASS
								Method S/N	Ret'd 0.425mm (%)	Corr'd M/C <0.425mm	Curing Time (hrs.)		
WS1	1.50 -1.80	L2	24	68	24	44	0.00	N	0(A)		26	Very stiff mottled light grey and orangey brown slightly sandy CLAY with occasional recently active and decayed roots	CH
WS1	2.50 -2.75	L3	25	50	21	29	0.14	N	0(A)		26	Stiff mottled orangey brown, light grey and yellowish brown slightly sandy CLAY with rare recently active and decayed roots	CI/ CH
WS1	6.50 -6.95	L7	28	50	22	28	0.21	N	0(A)		27	Stiff dark grey slightly sandy CLAY	CI/ CH
WS1	11.50	L12	32	70	28	42	0.10	N	0(A)		27	Firm dark grey CLAY	CH/ CV
WS2	1.50 -1.70	L2	19	58	23	35	-0.11	N	0(A)		27	Very stiff light grey and orangey brown slightly sandy CLAY with rare recently active and decayed roots	CH
WS2	4.50 -5.00	L5	25	41	21	20	0.20	N	0(A)		27	Stiff dark yellowish brown slightly sandy CLAY with rare orangey brown and light grey mottling and rare black speckling	CI

METHOD OF PREPARATION : BS 1377:PART 1:1990:7.4 & PART 2:1990:4.2 S = Wet Sieved Specimen N = prepared from Natural

METHOD OF TEST : BS 1377:PART 2:1990:3.2, 4.4, 5.3, 5.4

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter. A = Assumed, M = Measured

COMMENTS :

REMARKS TO INCLUDE : Sample disturbance, loss of moisture, variation from test procedure, location and origin of test specimen within original sample. Oven drying temperature if not 105-110 deg C.

TEST REPORT.

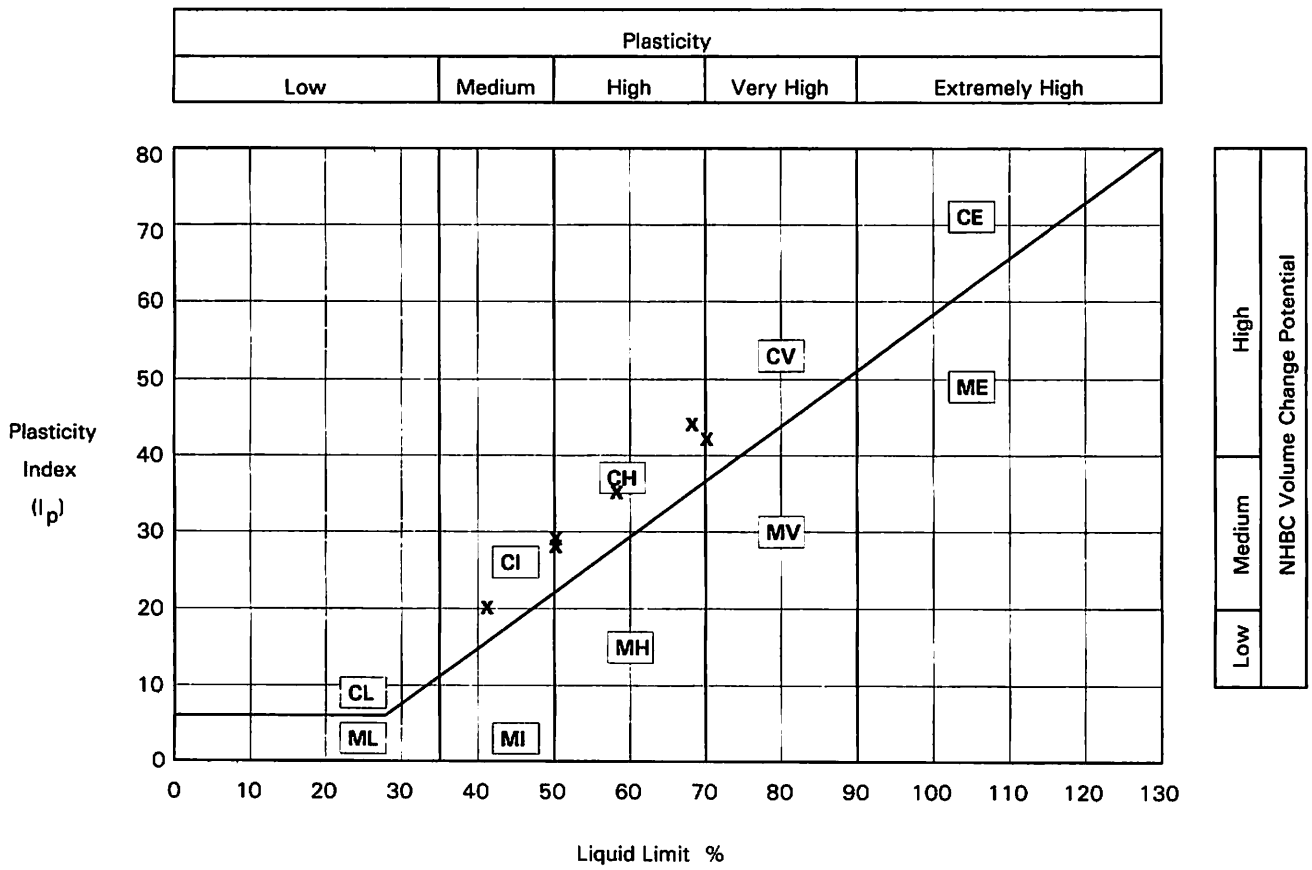
ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : As page 1 PAGE 4 of 12

Contract: HIGHGATE

Serial No.: S25144

PLOT OF PLASTICITY INDEX AGAINST LIQUID LIMIT USING CASAGRANDE CLASSIFICATION CHART



METHOD OF PREPARATION: BS 1377:PART 1:1990:7.4 & PART 2:1990:4.2

METHOD OF TEST : BS 1377:PART 2:1990:3.2, 4.4, 5.3, 5.4

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : VOLUME CHANGE POTENTIAL: NHBC Standards Chapter 4.2 Unmodified Plasticity Index PLASTICITY CHART BS5930:1999:Figure 18

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : As page 1 PAGE 5 of 12

Contract: HIGHGATE

Serial No.: S25144

UKAS TESTING 0998

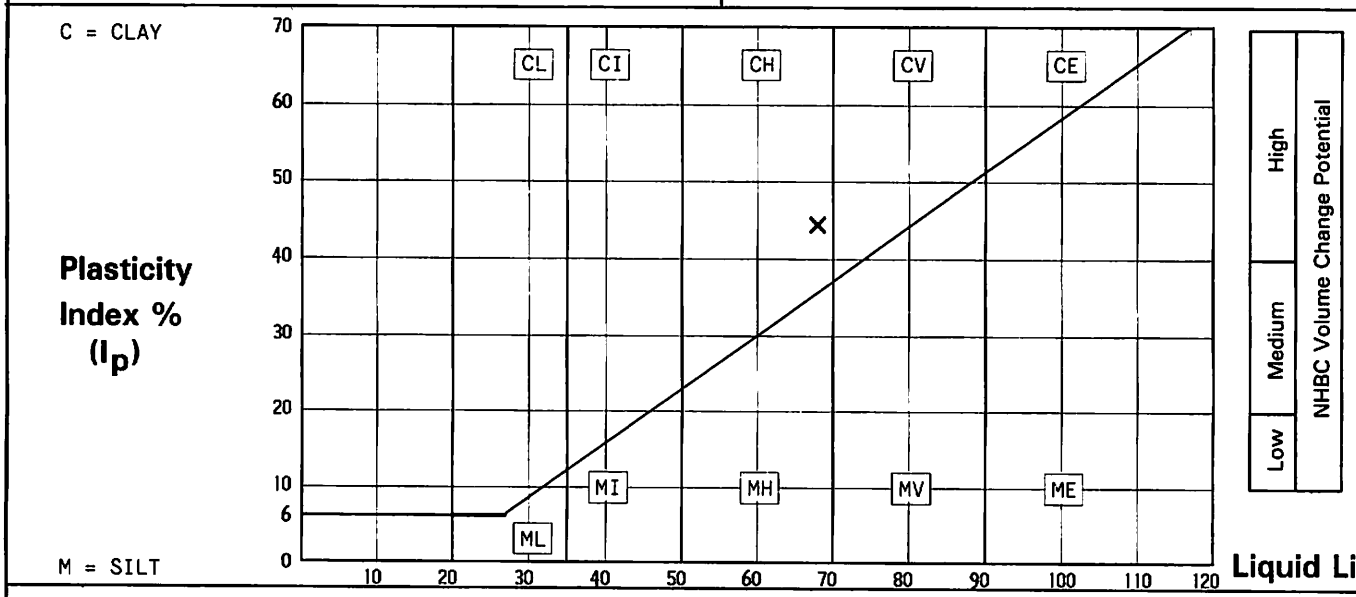
DETERMINATION OF MOISTURE CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX

Borehole/ Pit No.	Depth m.	Sample	Moisture Content %	Description	Remarks
WS1	1.50 -1.80	L2	24	Very stiff mottled light grey and orangey brown slightly sandy CLAY with occasional recently active and decayed roots	

PREPARATION

Method of Preparation	Specimen from Natural Soil
Sample retained 0.425 sieve (Assumed)	0 %
Corrected moisture content for material passing 0.425mm	%
Curing Time	26 Hours

Liquid Limit	68 %
Plastic Limit	24 %
Plasticity Index	44 %
Liquidity Index	0.00
Clay Content	Not analysed. %
Derived Activity (PI/CC)	Not analysed.



METHOD OF PREPARATION: BS 1377:PART 1:1990:7.4 & PART 2:1990:4.2

METHOD OF TEST : BS 1377:PART 2:1990:3.2, 4.4 , 5.3, 5.4

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : PLASTICITY CHART BS5930:1999:Figure 18
VOLUME CHANGE POTENTIAL: NHBC Standards Chapter 4.2 Unmodified Plasticity Index
NOTE: Modified Plasticity Index I'p = Ip x (% less than 425 microns/100)

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : As page 1 PAGE 6 of 12

Contract: HIGHGATE

Serial No.: S25144

UKAS TESTING 0998

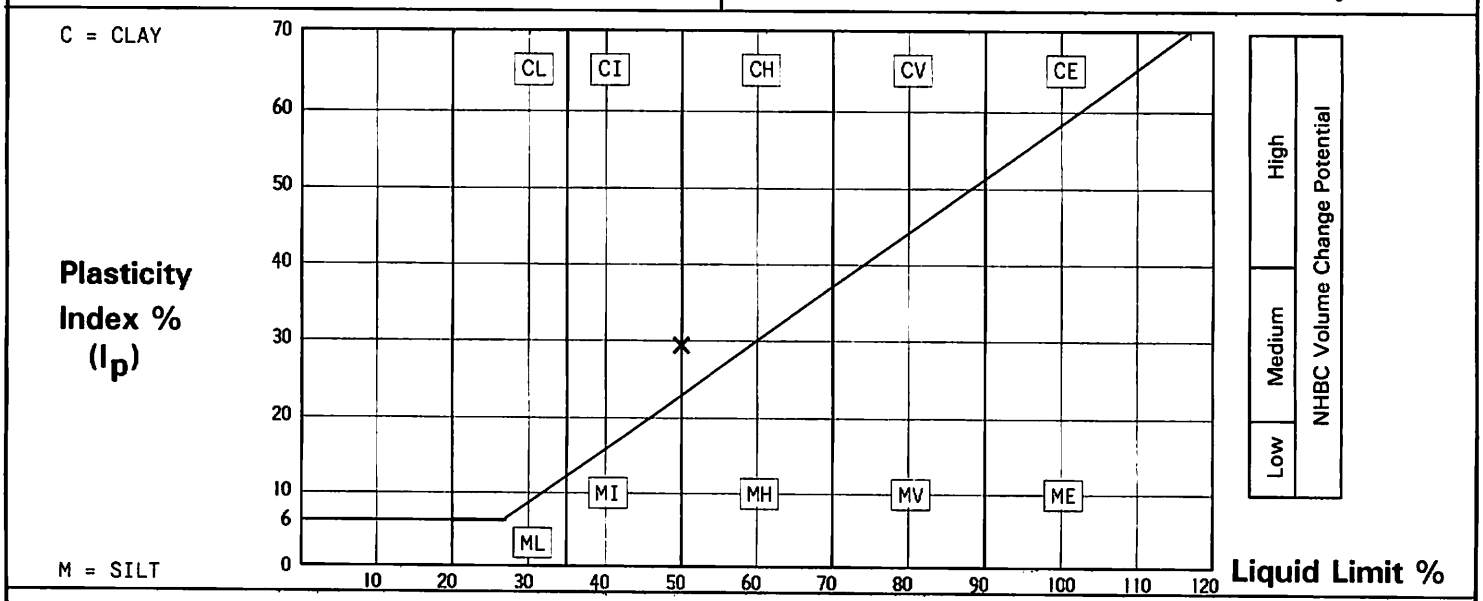
DETERMINATION OF MOISTURE CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX

Borehole/ Pit No.	Depth m.	Sample	Moisture Content %	Description	Remarks
WS1	2.50 -2.75	L3	25	Stiff mottled orangey brown, light grey and yellowish brown slightly sandy CLAY with rare recently active and decayed roots	

PREPARATION

Method of Preparation	Specimen from Natural Soil
Sample retained 0.425 sieve (Assumed)	0 %
Corrected moisture content for material passing 0.425mm	%
Curing Time	26 Hours

Liquid Limit	50 %
Plastic Limit	21 %
Plasticity Index	29 %
Liquidity Index	0.14
Clay Content	Not analysed. %
Derived Activity (PI/CC)	Not analysed.



METHOD OF PREPARATION: BS 1377:PART 1:1990:7.4 & PART 2:1990:4.2

METHOD OF TEST : BS 1377:PART 2:1990:3.2, 4.4, 5.3, 5.4

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : PLASTICITY CHART BS5930:1999:Figure 18
VOLUME CHANGE POTENTIAL: NHBC Standards Chapter 4.2 Unmodified Plasticity Index
NOTE: Modified Plasticity Index I'p = Ip x (% less than 425 microns/100)

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : As page 1 PAGE 7 of 12

Contract: HIGHGATE

Serial No.: S25144

UKAS TESTING 0998

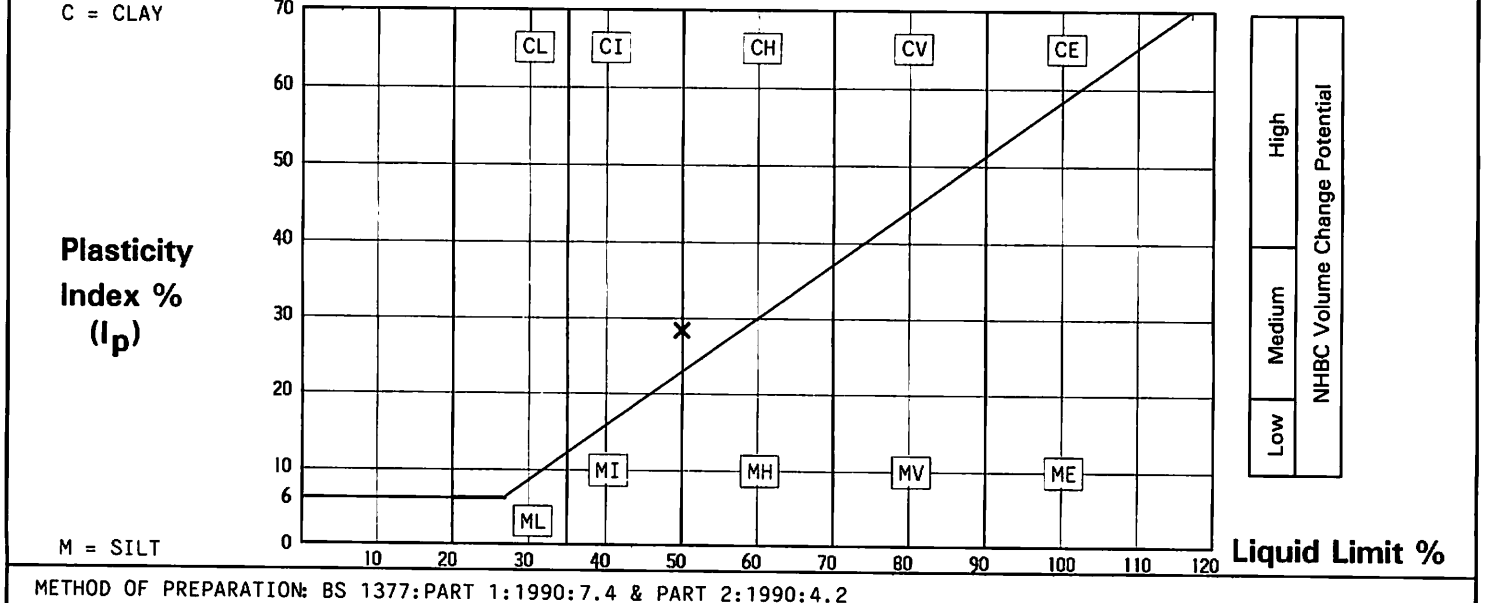
DETERMINATION OF MOISTURE CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX

Borehole/ Pit No.	Depth m.	Sample	Moisture Content %	Description	Remarks
WS1	6.50 -6.95	L7	28	Stiff dark grey slightly sandy CLAY	

PREPARATION

Method of Preparation	Specimen from Natural Soil
Sample retained 0.425 sieve (Assumed)	0 %
Corrected moisture content for material passing 0.425mm	%
Curing Time	27 Hours

Liquid Limit	50 %
Plastic Limit	22 %
Plasticity Index	28 %
Liquidity Index	0.21
Clay Content	Not analysed. %
Derived Activity (PI/CC)	Not analysed.



METHOD OF PREPARATION: BS 1377:PART 1:1990:7.4 & PART 2:1990:4.2

METHOD OF TEST : BS 1377:PART 2:1990:3.2, 4.4, 5.3, 5.4

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : PLASTICITY CHART BS5930:1999:Figure 18
VOLUME CHANGE POTENTIAL: NHBC Standards Chapter 4.2 Unmodified Plasticity Index
NOTE: Modified Plasticity Index I'p = Ip x (% less than 425 microns/100)

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : As page 1 PAGE 8 of 12

Contract: HIGHGATE

Serial No.: S25144

UKAS TESTING 0998

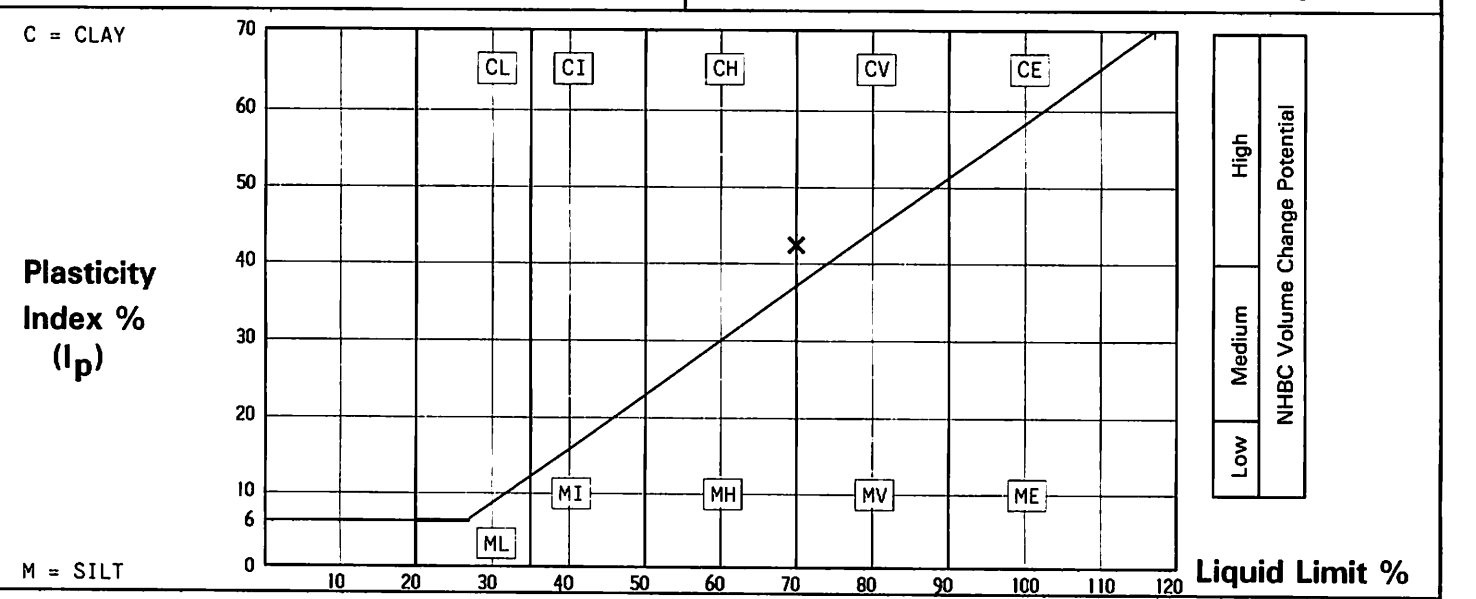
DETERMINATION OF MOISTURE CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX

Borehole/ Pit No.	Depth m.	Sample	Moisture Content %	Description	Remarks
WS1	11.50	L12	32	Firm dark grey CLAY	

PREPARATION

Method of Preparation	Specimen from Natural Soil
Sample retained 0.425 sieve (Assumed)	0 %
Corrected moisture content for material passing 0.425mm	%
Curing Time	27 Hours

Liquid Limit	70 %
Plastic Limit	28 %
Plasticity Index	42 %
Liquidity Index	0.10
Clay Content	Not analysed. %
Derived Activity (PI/CC)	Not analysed.



METHOD OF PREPARATION: BS 1377:PART 1:1990:7.4 & PART 2:1990:4.2

METHOD OF TEST : BS 1377:PART 2:1990:3.2, 4.4, 5.3, 5.4

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : PLASTICITY CHART BS5930:1999:Figure 18
VOLUME CHANGE POTENTIAL: NHBC Standards Chapter 4.2 Unmodified Plasticity Index
NOTE: Modified Plasticity Index I'p = Ip x (% less than 425 microns/100)

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : As page 1 PAGE 9 of 12

Contract: HIGHGATE

Serial No.: S25144

UKAS TESTING 0998

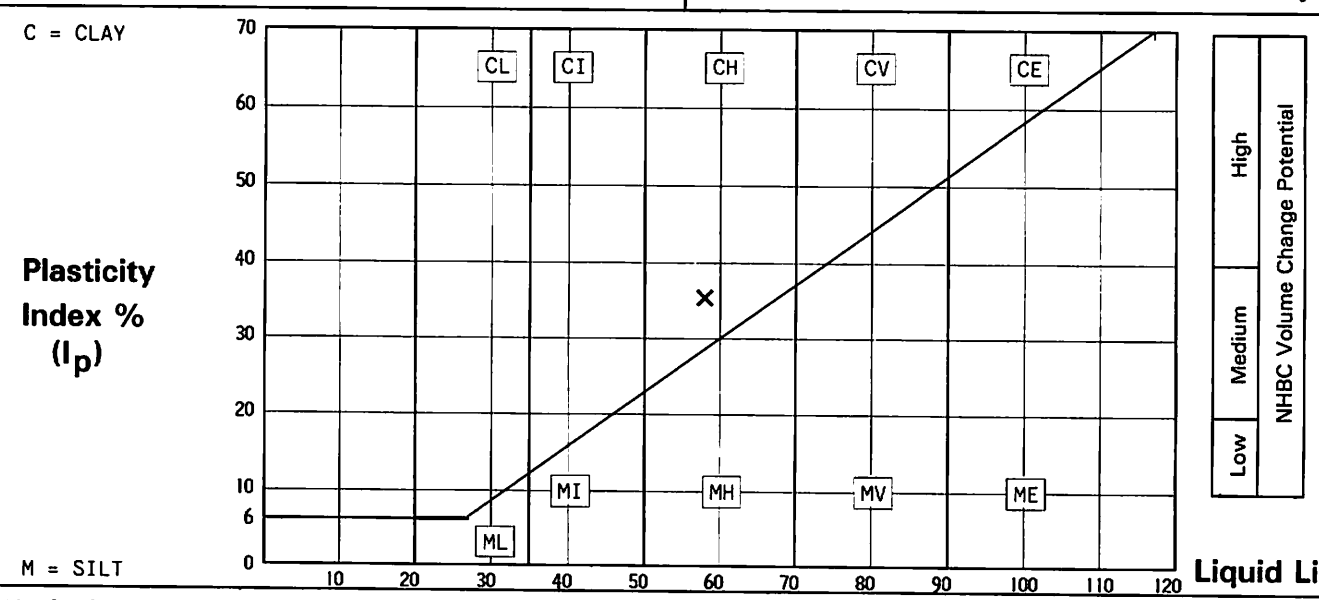
DETERMINATION OF MOISTURE CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX

Borehole/ Pit No.	Depth m.	Sample	Moisture Content %	Description	Remarks
WS2	1.50 -1.70	L2	19	Very stiff light grey and orangey brown slightly sandy CLAY with rare recently active and decayed roots	

PREPARATION

Method of Preparation	Specimen from Natural Soil
Sample retained 0.425 sieve (Assumed)	0 %
Corrected moisture content for material passing 0.425mm	%
Curing Time	27 Hours

Liquid Limit	58 %
Plastic Limit	23 %
Plasticity Index	35 %
Liquidity Index	-0.11
Clay Content	Not analysed. %
Derived Activity (PI/CC)	Not analysed.



METHOD OF PREPARATION: BS 1377:PART 1:1990:7.4 & PART 2:1990:4.2

METHOD OF TEST : BS 1377:PART 2:1990:3.2, 4.4, 5.3, 5.4

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : PLASTICITY CHART BS5930:1999:Figure 18
VOLUME CHANGE POTENTIAL: NHBC Standards Chapter 4.2 Unmodified Plasticity Index
NOTE: Modified Plasticity Index I'p = Ip x (% less than 425 microns/100)

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : As page 1

Contract: HIGHGATE

Serial No.: S25144

UKAS TESTING 0998

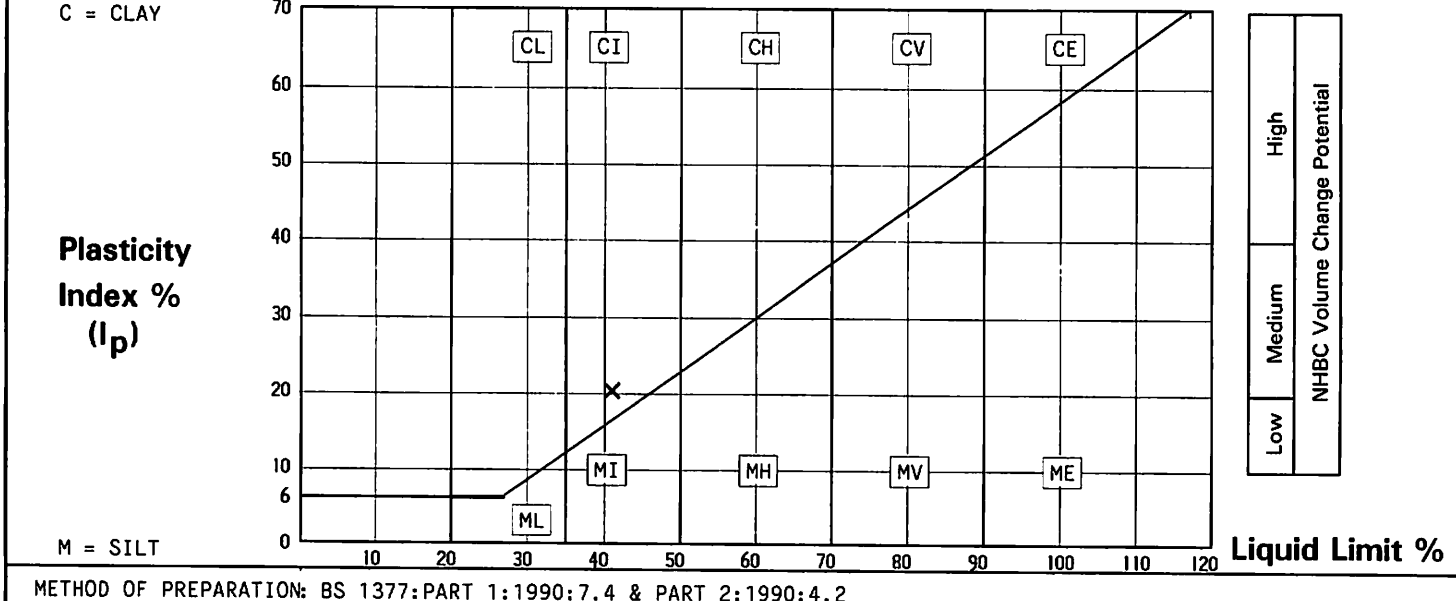
DETERMINATION OF MOISTURE CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX

Borehole/ Pit No.	Depth m.	Sample	Moisture Content %	Description	Remarks
WS2	4.50 -5.00	L5	25	Stiff dark yellowish brown slightly sandy CLAY with rare orangey brown and light grey mottling and rare black speckling	

PREPARATION

Method of Preparation	Specimen from Natural Soil
Sample retained 0.425 sieve (Assumed)	0 %
Corrected moisture content for material passing 0.425mm	%
Curing Time	27 Hours

Liquid Limit	41 %
Plastic Limit	21 %
Plasticity Index	20 %
Liquidity Index	0.20
Clay Content	Not analysed. %
Derived Activity (PI/CC)	Not analysed.



METHOD OF PREPARATION: BS 1377:PART 1:1990:7.4 & PART 2:1990:4.2

METHOD OF TEST : BS 1377:PART 2:1990:3.2, 4.4, 5.3, 5.4

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : PLASTICITY CHART BS5930:1999:Figure 18
VOLUME CHANGE POTENTIAL: NHBC Standards Chapter 4.2 Unmodified Plasticity Index
NOTE: Modified Plasticity Index I'p = Ip x (% less than 425 microns/100)

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : As page 1

Contract: HIGHGATE

Serial No.: S25144

DETERMINATION OF THE SULPHATE CONTENT OF SOIL AND GROUNDWATER

Borehole/ Pit No.	Depth m.	Sample	Concentration of Soluble Sulphate: Soil: Acid Soluble SO3 %	Soil: Water Soluble 2:1 SO3 g/l	Groundwater g/l	% of sample passing 2mm sieve	Description	Remarks
WS1	1.50 -1.80	L2		0.06		100	Very stiff mottled light grey and orangey brown slightly sandy CLAY with occasional recently active and decayed roots	
WS1	6.50 -6.95	L7		0.42		100	Stiff dark grey slightly sandy CLAY	
WS1	11.50	L12		0.22		100	Firm dark grey CLAY	
WS2	1.50 -1.70	L2		0.15		100	Very stiff light grey and orangey brown slightly sandy CLAY with rare recently active and decayed roots	
WS2	8.50 -9.00	L9		0.44		100	Very stiff dark grey slightly sandy CLAY with rare shell fragments	

METHOD OF PREPARATION: BS 1377:PART 1:1990:7.5 BS1377:PART 3:1990:5.2 Acid Soluble, 5.3 Soil/Water Extract :5.4 Groundwater

METHOD OF TEST : BS 1377:PART 3:1990:5.5

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : Test not UKAS accredited.

REMARKS TO INCLUDE : Sample disturbance, loss of moisture, variation from test procedure, location and origin of test specimen within original sample. Oven drying temperature if not 105-110 deg C.

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : As page 1 PAGE 12 of 12

Contract: HIGHGATE

Serial No.: S25144

DETERMINATION OF THE pH VALUE

Borehole/ Pit No.	Depth m.	Sample	pH Value	Description	Remarks
WS1	1.50 -1.80	L2	4.2	Very stiff mottled light grey and orangey brown slightly sandy CLAY with occasional recently active and decayed roots	pH value retested and result verified
WS1	6.50 -6.95	L7	6.9	Stiff dark grey slightly sandy CLAY	
WS1	11.50	L12	7.4	Firm dark grey CLAY	
WS2	1.50 -1.70	L2	3.9	Very stiff light grey and orangey brown slightly sandy CLAY with rare recently active and decayed roots	pH value retested and result verified
WS2	8.50 -9.00	L9	7.2	Very stiff dark grey slightly sandy CLAY with rare shell fragments	

METHOD OF PREPARATION: BS 1377:PART 1:1990:7 BS 1377:PART 3:1990:9.4

METHOD OF TEST : BS 1377:PART 3:1990:9.5

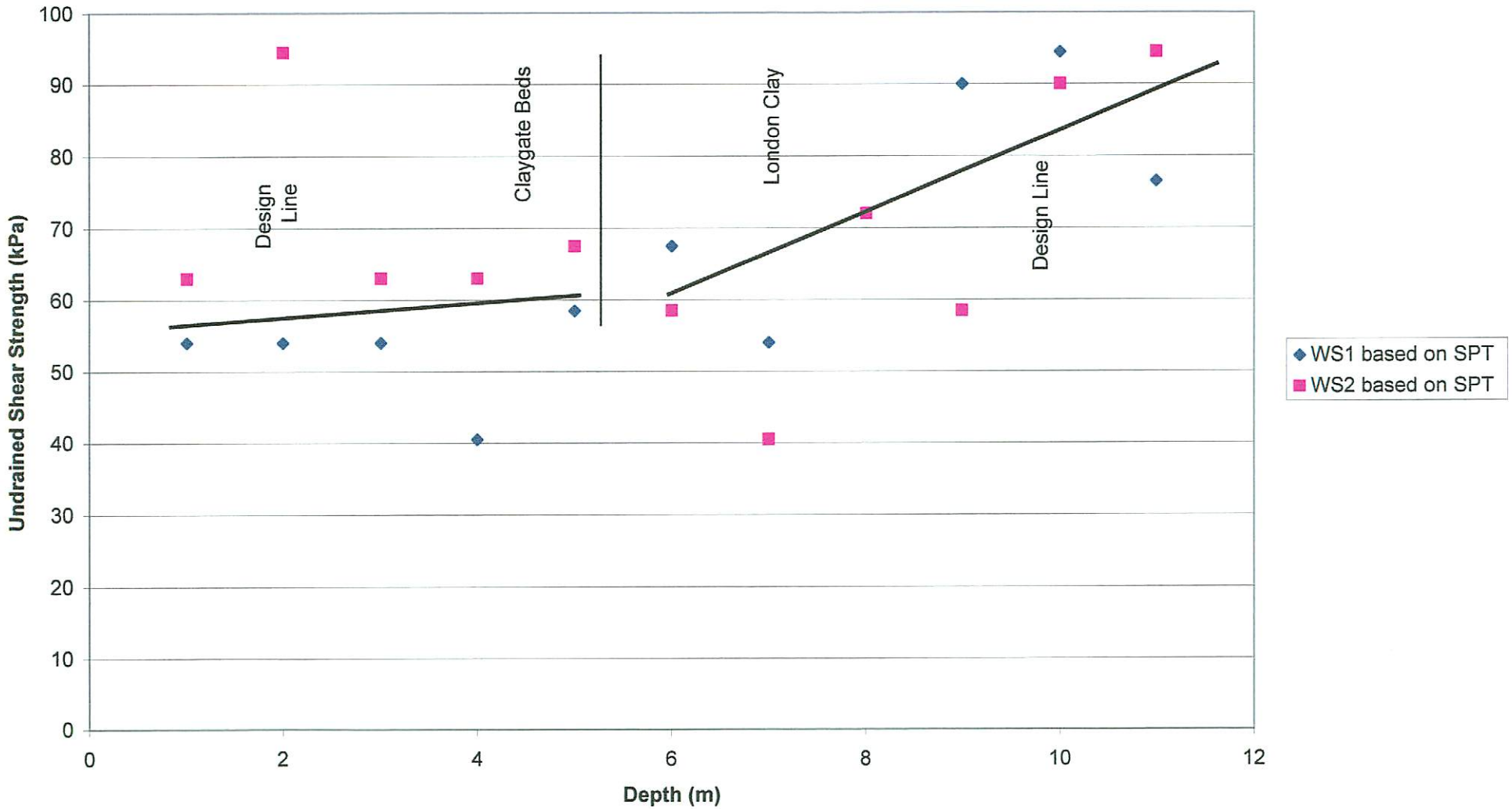
TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : Test not UKAS accredited.

REMARKS TO INCLUDE : Sample disturbance, loss of moisture, variation from test procedure, location and origin of test specimen within original sample. Oven drying temperature if not 105-110 deg C.

Appendix (iii)
Plots

Plot of Undrained Strength (kPa) against Depth (m), 1 Haversham Place, Highgate

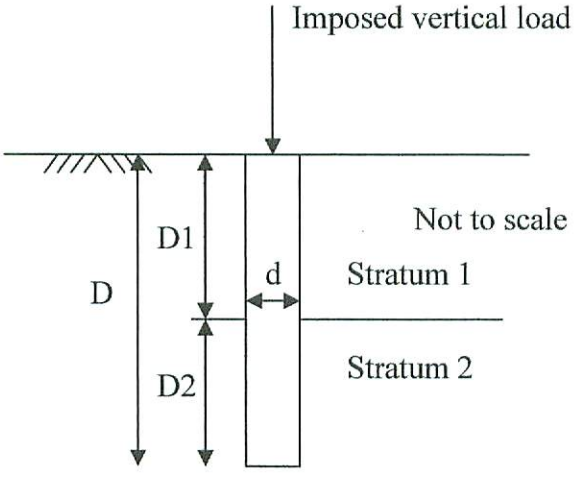


Appendix (iv)
ULS and SLS Calculations

Murray Rix Geotechnical		Sheet No: 1
Project Tile: 1 Haversham Place, Highgate		Calc.by:
Piled Foundation – CFA Pile	Date: 12.01.12	Check by:

Preliminary analysis for piled foundation, calculation for vertical load only

Notes: (clauses, Annexes etc)



$d = 0.60m$

$D = 12.0m$

$D1 = 5.0m$

$D2 = 7.0m$

$\gamma_{s;k}$ = characteristic weight density of soil $= 20kN/m^3$

$\gamma_{c;k}$ = characteristic weight density of concrete $= 24kN/m^3$

$c_{u;k}$ = characteristic value of undrained shear strength: Stratum 1 $= 55kPa$; Stratum 2 $= 75Pa$

2.4.7.3.4.2(2)

Design Approach 1 (axially loaded pile)(GEO Limit state)

The purpose to determine preliminary design value for imposed vertical load for 12.0m pile. The difference in weight of the pile and the displaced overburden load is ignored in this preliminary analysis.

(1)

Combination 1

$A1"+"M1"+"R1$

Design Action (Load) (A1)

To be determined

Murray Rix Geotechnical		Sheet No: 2
Project Tile: 1 Havesham Place, Highgate		Calc.by:
Piled Foundation – CFA Pile	Date: 12.01.12	Check by:

Material Factors (M1)

$\gamma_{cu} = 1.0$

Thus, $c_u = c_{u,k}$

Table A.4 undrained shear strength

Design Resistance (R1)

Basic Pile Resistance Factors using analytical method

Pile base: $9c_u$

Pile shaft: αc_u

For this case in Strata 1 and 2, take $\alpha = 0.5$

Pile shaft for Strata 1 and 2: $0.5c_u$

Skempton (19??) B/L=1,D/B>5

Base resistance: $R_b = 9c_u A_b$

Shaft resistance for Strata 1 and 2: $R_s = 0.5c_u A_s$

Compressive resistance: $R_{c,d} = R_{b,d} + R_{s,d}$

7.6.2.3(3)

Partial factors for CFA pile: $\gamma_b = 1.1$; $\gamma_s = 1.0$

Table A.8

Note: When deriving characteristic values for pile design from ground parameters, partial factors have to be corrected by a Model Factor. Presumed Model Factor = 1.4.

A.3.3.2

Partial factors for pile resistance for CFA piles:

$\gamma_{b,d} = 1.1x1.4 = 1.54$

$\gamma_{s,d} = 1.0x1.4 = 1.4$

Base resistance: $R_{b,d} = (9/1.54)c_u A_b = 5.84x75x\pi x0.6^2/4 = 123kN$

Shaft resistance:

$R_{s,d} = (0.5/1.4)\Sigma c_u A_s = 0.36x(55x5x\pi x0.6 + 75x7x\pi x0.6) = 543kN$

Compressive resistance: $R_{c,d} = R_{b,d} + R_{s,d} = 123 + 543 = 666kN$

Conclusion: Preliminary analysis indicates that a 12m long 0.60m diameter CFA pile can carry a pile design load of 666kN under Combination 1. The imposed loading should be factored for Design Approach 1. Accordingly the imposed loading should not exceed $666/1.35 = 493kN$.

Murray Rix Geotechnical		Sheet No: 3
Project Tile: 1 Haversham Place, Highgate		Calc.by:
Piled Foundation – CFA Pile	Date: 12.01.12	Check by:

Combination 2
$A2"+"M1 or M2"+"R4$

Design Action (Load) (A2)

To be determined

Material Factors (M1) (as for Combination M1)
$\gamma c_u = 1.0$
Thus, $c_u = c_{u,k}$

Design Resistance (R4)
Partial factors for CFA piles (without specific verification of SLS): 7.6.2.3(4) Table A8 (undrained strength

$\gamma_b = 2.0$

$\gamma_s = 1.6$

Note: When deriving characteristic values for pile design from ground parameters, partial factors have to be corrected by a Model Factor. Presumed Model Factor = 1.4. A.3.3.2

Partial factors for pile resistance for CFA piles:

$\gamma_{b,d} = 2.0x1.4 = 2.80$

$\gamma_{s,d} = 1.6x1.4 = 2.24$

Base resistance: $R_{b,d} = (9/2.80)c_u A_b = 3.21x75x\pi x0.6^2/4 = 68kN$

Shaft resistance:

$R_{s,d} = (0.5/2.24)\Sigma c_u A_s = 0.22(55x5x\pi x0.6 + 75x7x\pi x0.6) = 331kN$

Compressive resistance: $R_{c,d} = R_{b,d} + R_{s,d} = 68 + 331 = 399kN$

Conclusion: Preliminary analysis indicates that a 12m long 0.60m diameter CFA pile can carry a pile design load of 399kN under Combination 2.

1. Combination 1 is more critical than Combination 2.
2. It is necessary to check on the SLS Limit state.

Murray Rix Geotechnical		Sheet No: 4
Project Tile: 1 Haversham Place, Highgate		Calc.by:
Piled Foundation – CFA Pile	Date: 12.01.12	Check by:

Settlement (SLS Limit state)
Traditional pile analysis has been based broadly on verifying that the overall factor of safety depending on pile testing proposals.

Typically: F of S = 2.5 – 3.0 for no pile tests
F of S = 2.0 – 2.5 for tests on 1% of working piles
F of S = 2.0 – 2.25 when preliminary pile testing is undertaken

For no pile tests -

For Combination 1

F of S = $\gamma_G x$ Model Factor $x\gamma_t = 1.35x1.4x1.0 = 1.89$

For Combination 2

F of S = $\gamma_G x$ Model Factor $x\gamma_t = 1.0x1.4x2.0 = 2.80$

SLS Check
As no specific consolidation or similar tests have been carried out a check on the limit to settlements will be restricted using 'classical' bearing capacity theory (unfactored values) as in the following to give an overall factor of safety of 2.5:

Base resistance: $R_{b,d} = 9c_u A_b = 9x75x\pi x0.6^2/4 = 191kN$

Shaft resistance:

$R_{s,d} = 0.5\Sigma c_u A_s = 0.50x(55x5x\pi x0.6 + 75x7x\pi x0.6) = 753kN$

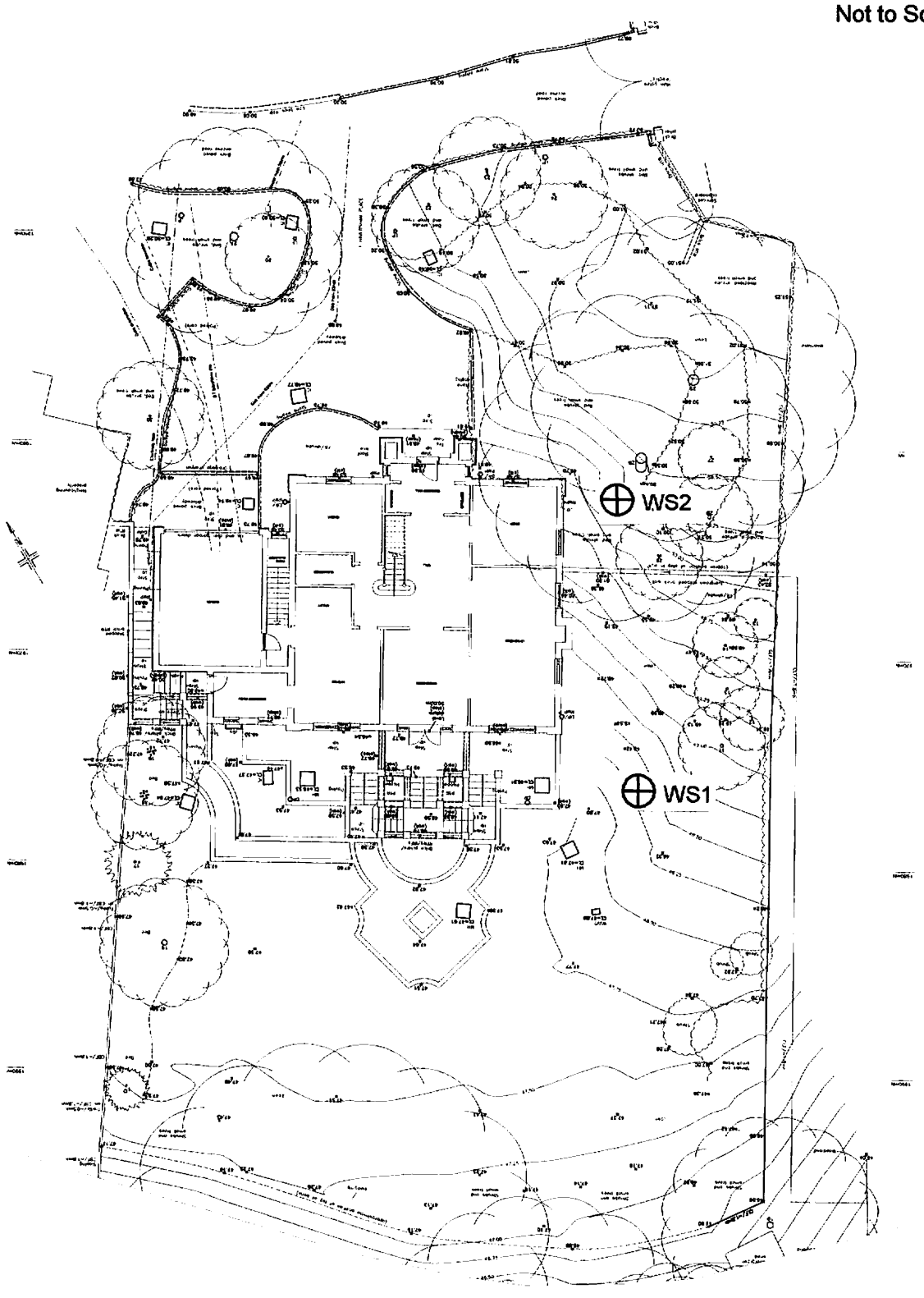
Compressive resistance: $R_{c,d} = R_{b,d} + R_{s,d} = 191 + 753 = 945kN$

Preliminary Design Load $= 945/2.5 = 378kN$

Conclusion: For a 0.60m diameter CFA pile of 12m length the analysis suggests a Preliminary Design Load of 378kN in the absence of pile testing.

Appendix (v)
Figures

Not to Scale



Location:	1 Haversham Place	**Murray Rix:**	
	Highgate	**Job No:**	VSJOB/11-2109
	London	**Date:**	30/11/2011
	N6 6NG	**Figure 1**	Site Plan