AP GEOTECHNICS
a ground investigation and consultancy service

Devonshire House
60 Station Road
Addlestone
Surrey KT15 2AF

t 01932 848460
f 01932 851255
e mail@apgeotechnics.co.uk
w www.apgeotechnics.co.uk

239 HAVERSTOCK HILL LONDON NW3 4PR

Geotechnical Investigation

Client
Mr M Spalter

Architect
Davies Architecture Limited

Report No. 3770

15 May 2012

CONTENTS

239 HAVERSTOCK HILL
LONDON NW3 4PR

Geotechnical Investigation

Synopsis

An investigation has been carried out at 239 Haverstock Hill on the instructions of owner Mr. M Spalter. Technical direction to the investigation has been provided by the client's architect, Davies Architecture Limited.

An Hydrological Assessment[1] has previously been carried out and should be read in conjunction with this report.

The purpose of the investigation was to determine the ground conditions and to provide recommendations in respect of foundation design and other geotechnical matters for the proposed basement construction.

This report describes the work carried out in the field and laboratory for structural aspects of the proposals, presents the results and discusses their implications.

A rigid concrete box construction is recommended for the basement and appropriate design data is provided.

---

[1] *Report No. 3731: Hydrological Assessment, 239 Haverstock Hill, AP Geotechnics Ltd., 12 March 2012*

1

Site description

The property lies at the end of a row of established two storey semi - detached houses on the south western side of Haverstock Hill at the National Grid reference $^{5}271\ ^{1}852$ as shown at Figure 1 of Appendix A.

It is set in a plot about 10 m wide by 37 m deep as shown at Figure 2 with the front garden laid to lawn and the rear garden leading to a terrace used for car parking. There is a mature horse chestnut tree in the front garden near the road frontage and other trees in adjoining land as shown at Figure 2.

Haverstock Hill falls gently to the south east. In order to maintain a level roof line for the row of houses, the ground floor of No. 239 is about 1 - 1½m above road level, the front garden sloping towards the road and retained by a small wall at the back of footway. The rear garden is essentially level.

2

Development proposals

The proposal is to construct a single level of basement some 13 m long and 9 m wide, thus beneath the full width of the property and extending about 3 m beyond the rear elevation as shown at Figures 3 & 4. Light wells will be provided on the front and left flank elevations.

3

Geology

Published records of the British Geological Survey indicate the site to lie on London Clay.

4

Field work

Four bores were sunk by dynamic "window" sampler and hand auger to a maximum of 3.8 m depth at the locations shown on Figure 5.

Representative samples were recovered for subsequent laboratory examination and testing; whilst in situ hand shear vane tests were carried out as appropriate. Details of the strata encountered are provided on the Borehole Records at Appendix B; together with particulars of the samples recovered, groundwater observations and in situ test results.

A standpipe was installed in WS 1 as part of the Hydrological Assessment to monitor the groundwater level and to permit an in situ permeability test to be carried out. The data is presented in the Hydrological Assessment and at Appendix C herein.

5

Laboratory testing

The following laboratory tests were conducted on samples recovered during the field work:-

- Natural moisture content: to assess the in situ condition of the soil.

- Liquid and Plastic Limits: to classify cohesive soil into behavioural groups.
- Soluble sulphate concentration and pH value: for the specification of buried concrete.

Results of these tests are presented at Appendix D.

6
Ground conditions

6.1
Stratigraphy

The stratigraphy of the site as revealed by the investigation is shown in detail at Appendix B and is described in general terms hereafter.

6.1.1
Made Ground

All bores encountered Made Ground, to between 1.07 and 1.9 m depth.

The composition of the Made Ground varied from bore to bore but was primarily a clay with pieces of brick and charcoal. Subordinate silt and sand were often present within the clay together with a flint gravel fraction. WS 1 encountered glass, earthenware and concrete fragments within the parent clay below 0.83 m depth whilst the base of the Made Ground in HA 3 was marked by a layer of brick hardcore.

6.1.2
London Clay

This Formation was represented by the predominantly brown clay that is typical of the weathered part of London Clay, frequently with small pockets or lenses of silt.

The clay was assessed to be in a stiff condition and this was confirmed by in situ vane testing yielding shear strengths of 75 to 88 kPa.

Laboratory testing confirmed the very high plasticity of London Clay with Modified Plasticity Indices of 49 - 59 %. These are illustrated on the Soil Classification Chart at Appendix D.

6.2
Groundwater

No groundwater was encountered during drilling. However, a standing level of 2.89 m depth was measured prior to the permeability test, as noted with the test results at Appendix C.

7
Discussion

7.1
General

The investigation has revealed some Made Ground to be present. It is possible that other deposits of Made Ground may be present; perhaps of different character, deeper or associated with underground construction; which have not been detected by the investigation.

All remains of underground obstructions should be removed prior to redevelopment to enable the new foundations to be constructed without hindrance and to perform satisfactorily.

The horse chestnut in the front garden is some 7.5 m from the front of the house. According to the NHBC guidelines[2], this species has a moderate water demand and reaches a mature height of 20 m. The basement construction will therefore be below the depth of root action from the tree. Construction will be well outside the canopy but advice should be sought from an arboriculturalist to confirm the extent of the root protection zone.

7.2 Foundations

The Hydrological Assessment found groundwater to be at about 2.9 m depth in March 2012 and discussed the potential for long term groundwater seepage within the depth of the proposed basement. In view of the potential for a rise in groundwater level, the basement should be fully tanked to ensure waterproof construction. It is therefore expected that the basement will be constructed as a concrete box with effectively a rigid base exerting a uniform low bearing pressure on the soil.

The basement will have a storey height of about 2.5 m and thus the excavation will be approximately 2.7 m deep. This will reduce the vertical stress by some 50 kPa which is expected to be more than the imposed foundation load and swelling will result. To avoid the need to resist the swelling forces and any hydrostatic uplift, the mass of the basement construction should be increased by adopting thicker structural sections. Post construction swelling will theoretically be zero when the imposed load equates to the reduction in stress

[2] *NHBC Standards, Chapter 4.2, Building near trees, National House Building Council, 2011*

due to the excavation. However, in practice, small movements either as settlement or heave usually occur.

London Clay will deteriorate rapidly on exposure, especially in the presence of water. The basement slab should therefore be cast immediately the formation is complete to reduce the risk of unacceptable movement.

Should alternative construction be chosen, a net allowable bearing capacity of 150 kPa is recommended for strip foundations up to 1.2 m width at the new basement level. Total settlement of such foundations is expected to be in the order of 25 mm. However, settlement of the adjoining house will be long since complete and distress will occur at the junction between the two. Foundations should therefore be designed to reduce the differential settlement between No. 239 and its neighbour.

In any event, basement construction will create variations in the soil / structure stiffness between the two parts of this semi - detached property and thus give rise to the potential for distress at the party wall.

7.3
Excavations

7.3.1
Stability

All material encountered during the investigation should be regarded as unstable. Any apparent stability that may be present immediately on excavation must not be relied upon and all excavations should therefore be supported at all times.

Although London Clay is generally able to support vertical excavations of moderate depth in the short term, the scale of basement excavation is such that support should be provided at all times. This is especially important for the safety of personnel when required to work in or close to excavations.

It should be ensured that no loss of support is suffered by any nearby structure. In particular, the existing property, the adjoining house, other neighbouring property and underground services in the vicinity must be protected. Both temporary and permanent works must be able to resist lateral earth pressures arising from both the ground conditions and any superimposed loading without significant deformation.

7.3.2
Groundwater

Groundwater observations during the investigation have indicated water at approximately the same depth as the basement excavation. However, both the Hydrological Assessment and Section 7.2 herein have discussed the potential for long term groundwater movement. It is therefore possible that more onerous groundwater conditions might occur during construction.

The coefficient of permeability of 10^{-7} to 10^{-10} m/s suggested in the Hydrological Assessment confirms the low permeability of London Clay and inflows to excavations are therefore expected to be slow, probably emanating from the thin silt lenses or partings in the clay. It is expected they may be controllable by conventional pumping from a shallow sump.

As stated previously, the basement construction should be waterproof and designed to resist hydrostatic uplift.

7.3.3

Retaining structures

Lateral earth pressures will act upon both the temporary and permanent works and may be assessed from the parameters of Table 1. It should be ensured these can be resisted by both temporary and permanent works without significant deformation.

Table 1: Estimated design parameters for lateral earth pressure assessment

Stratum	Bulk density Mg/m^3	Effective cohesion kPa	Effective angle of internal shearing resistance degrees
Made Ground	1.8	0	20
London Clay	2.1	0	22

7.4

Buried concrete

Laboratory tests yielded a maximum soluble sulphate concentration of 0.36 g/l which results in a Design Sulphate Class[3] of DS-1 for the site. Groundwater conditions must be considered mobile in view of the potential for seepage. The soil was found to be alkaline and the aggressive chemical environment for concrete, ACEC, is therefore class AC-1.

A W Parr
AP GEOTECHNICS LTD. 15 May 2012

[3] *Concrete in aggressive ground, BRE Special Digest 1, Building Research Establishment, 2005*

PROCEDURAL NOTES for GROUND INVESTIGATIONS

General

This report is based upon data obtained from field descriptions of the strata and examination of the samples by an engineer, together with the results of in situ and laboratory tests as appropriate. Responsibility cannot be accepted for variations in ground conditions between and around any of the exploratory points that is not revealed by the data. Whilst the report may offer an opinion on the ground conditions between exploratory points and below the depth of investigation, this is for guidance only and no liability is accepted for its accuracy. Unless specifically included in the report, it should be assumed that no testing has been carried out in respect of asbestos or Japanese Knotweed and no liability is inferred or will be accepted.

Drilling procedure

Boring by light cable percussion drilling allows the ground conditions to be reasonably well established. However, a certain amount of disturbance is inevitable and some mixing of soils can occur.

Sampling procedure

"Undisturbed" samples of predominantly cohesive soils are taken with a 100mm diameter open tube sampler, generally in accordance with BS 5930: 1999.

Where appropriate, or where an undisturbed sample is unsuccessful, disturbed samples are recovered and sealed into polythene bags.

Groundwater samples are taken when water is encountered in sufficient quantity.

Standard penetration tests

The test is conducted generally in accordance with BS 1377: Part 9: 1990. The sampler tube is subject to a seating drive of 150mm into the soil at the base of the borehole. Results are given on the Borehole Records as the number of blows required to drive the sampler tube a further 300mm and this is known as the "N" value. Where the driving resistance is such that full penetration is not achieved, the test is generally terminated after 50 blows and the actual distance penetrated is recorded.

Groundwater

Groundwater observations necessarily reflect the conditions encountered at the time of the exploratory work. Long term monitoring of standpipes is usually required to establish an equilibrium water level since the normal rate of boring is too fast to permit steady state conditions to be achieved.

Groundwater levels are subject to variations caused by changes in drainage conditions and seasonal climatic changes.

Water may necessarily be added to advance the bore whilst casing may be required to maintain an open hole. These can both mask subsequent groundwater observations and are therefore noted on the individual Borehole Record.

APPENDICES

A Figures

B Borehole Records

C In Situ Permeability Test

D Laboratory Test Results

APPENDIX A

FIGURES

239 Haverstock Hill,
London NW3

Site location plan

Scale unknown

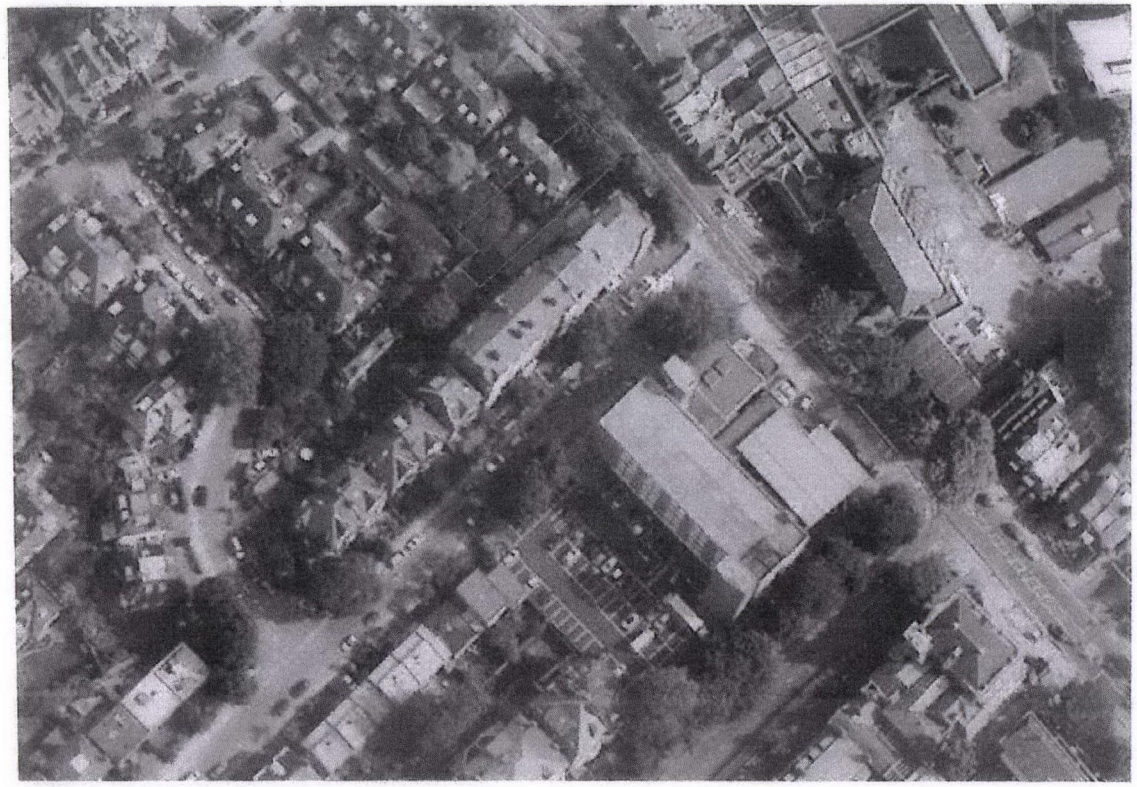


Figure 1

239 Haverstock Hill

Tree survey

Scale 1:100 @ A3

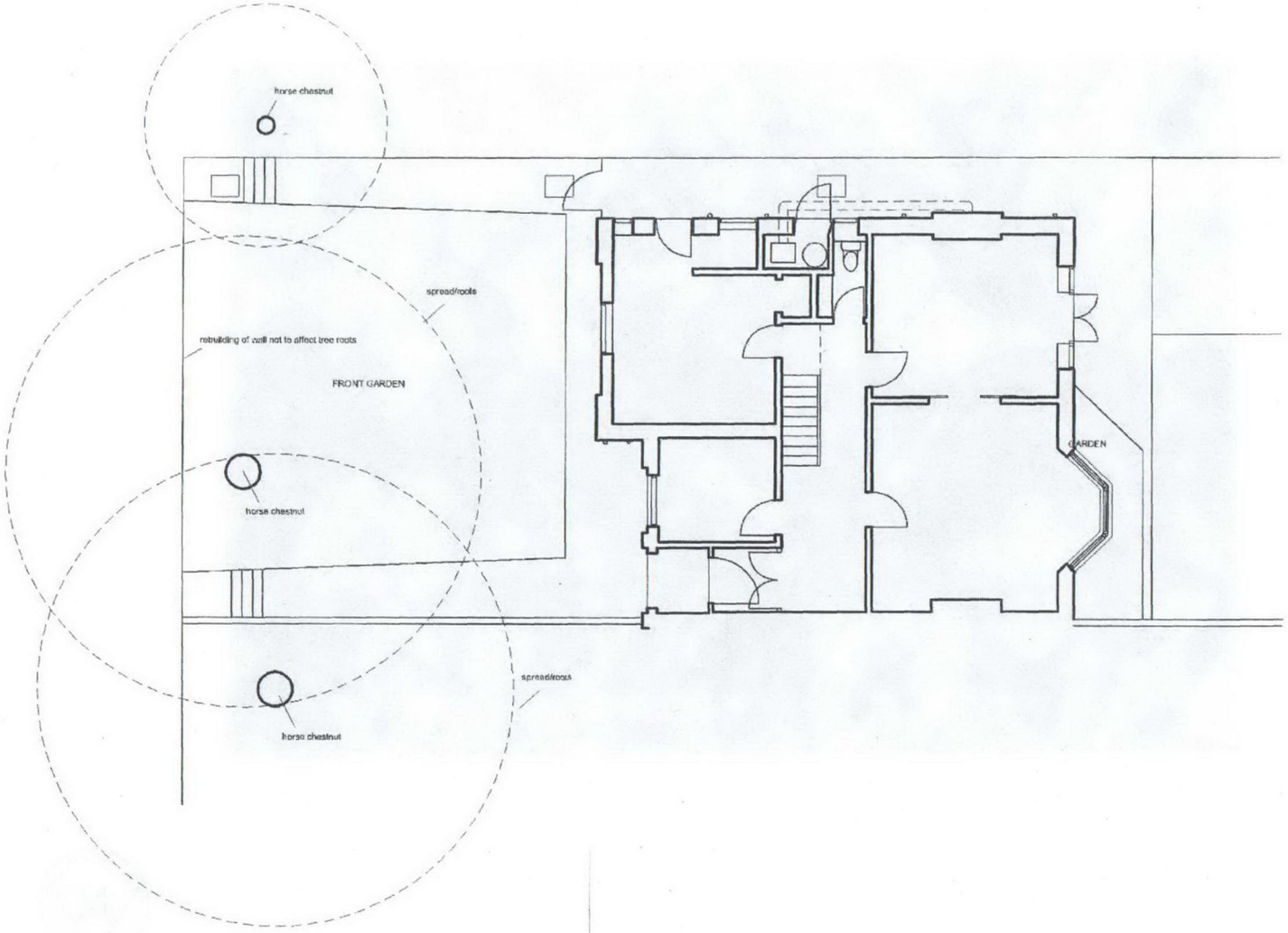


Figure 2

239 Haverstock Hill

Existing ground floor plan showing outline of proposed basement

Scale 1:100 @ A3

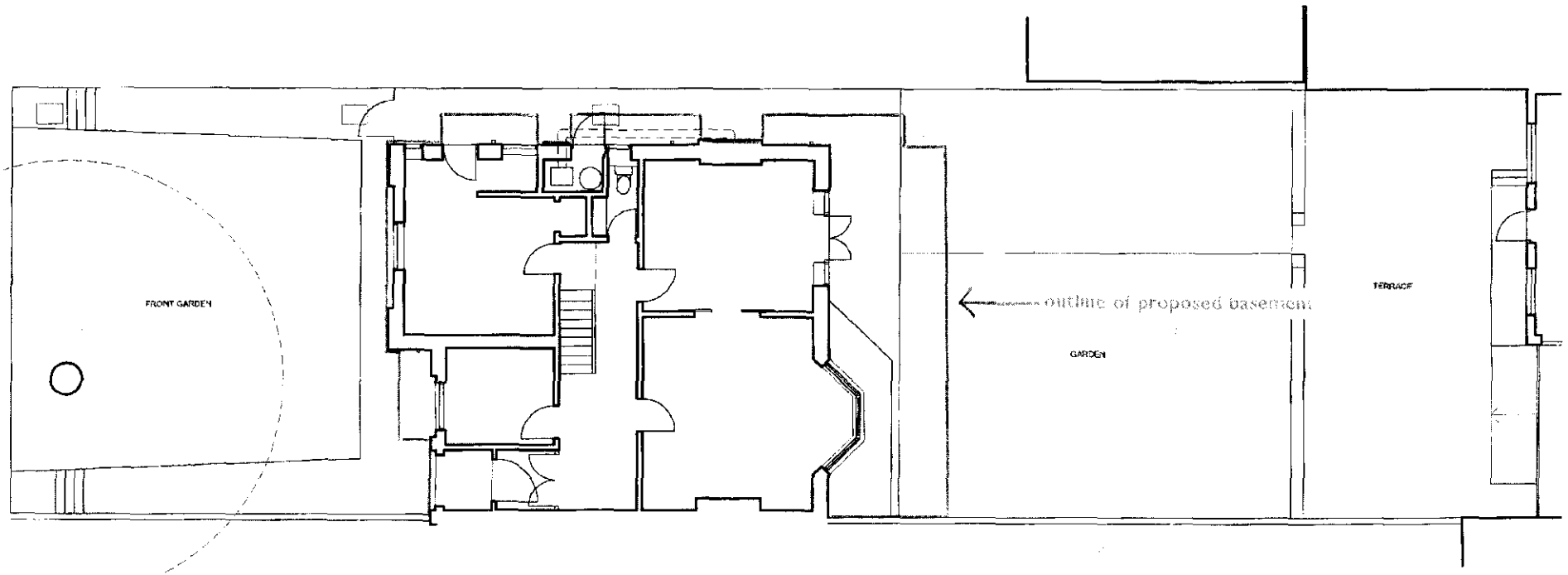


Figure 3

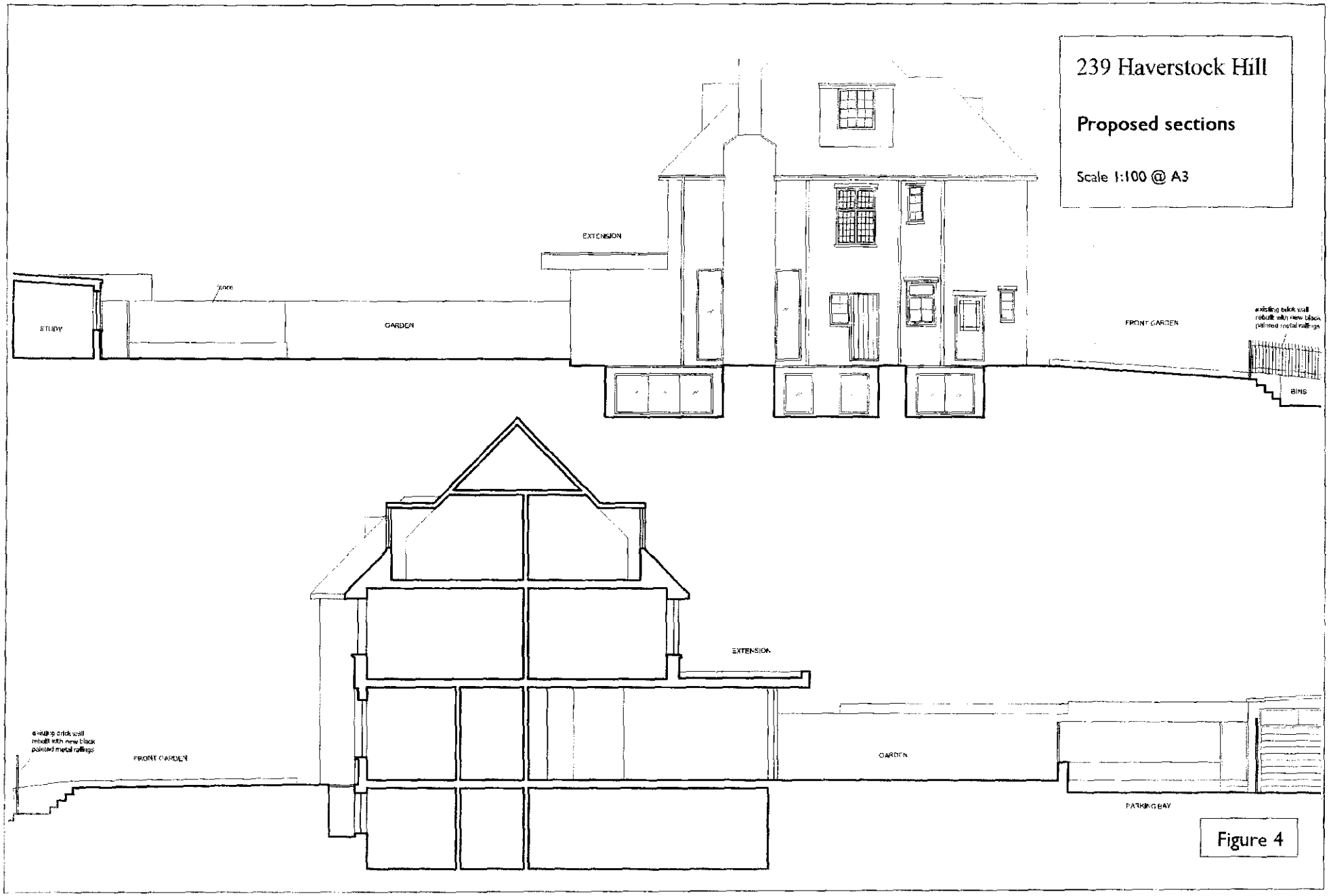

239 Haverstock Hill
Proposed sections
Scale 1:100 @ A3
EXTENSION
STUDY
GARDEN
FRONT GARDEN
existing brick wall rebuilt with new black painted metal railings
BINS
EXTENSION
existing brick wall rebuilt with new black painted metal railings
FRONT GARDEN
GARDEN
PARKING BAY

Figure 4

239 Haverstock Hill

Borehole location plan

Scale unknown

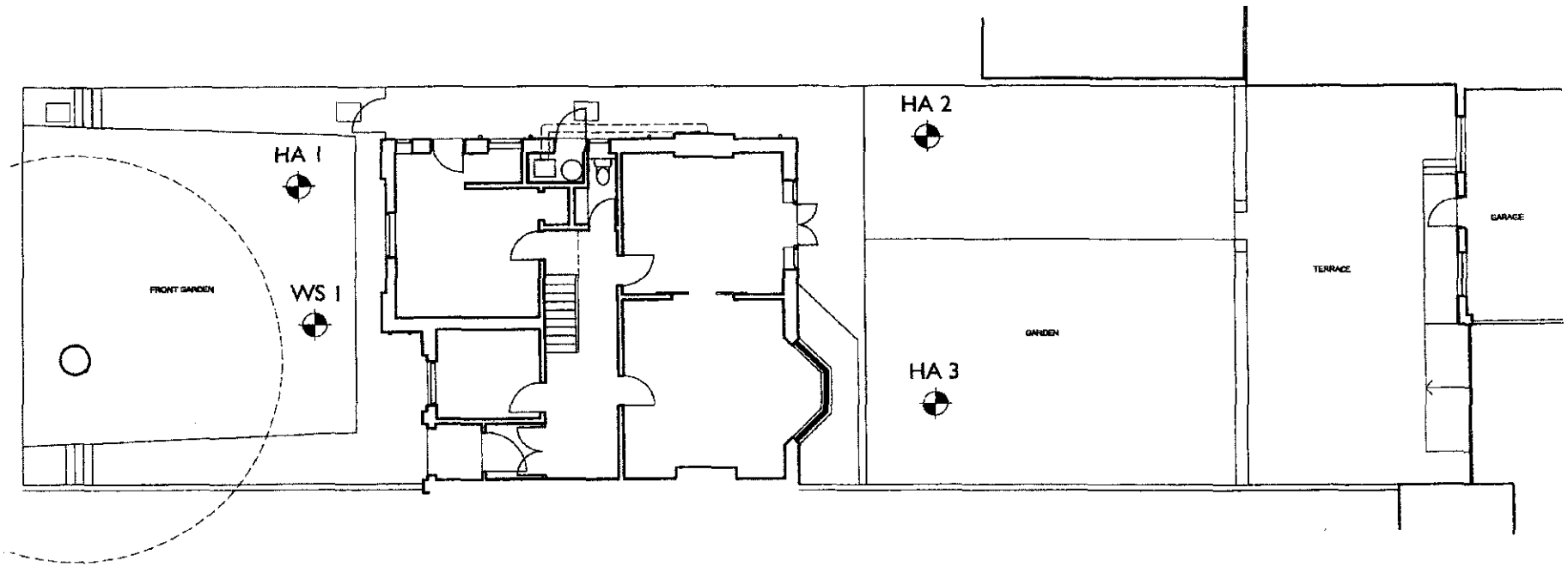


Figure 5

APPENDIX B

BOREHOLE RECORDS

SYMBOLS and ABBREVIATIONS

Samples

Undisturbed

U	Standard open drive "undisturbed" 102mm dia. in boreholes 38mm dia. in trial pits, window sampler and hand auger
T	Thin wall open drive
P	Piston
C	CBR mould

Disturbed

D	Small
B	Bulk
C	Contaminants: plastic tub
J	brown glass jar
W	Water

In situ tests

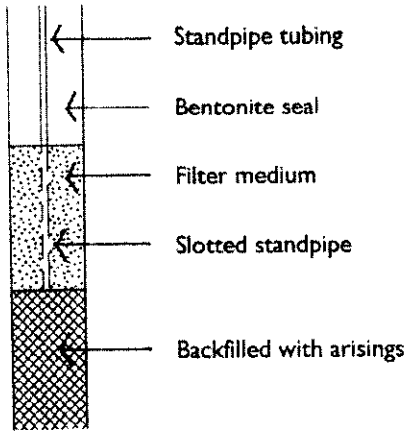
SPT	Standard Penetration Test, open shoe
CPT	solid cone
	N value is number of blows for 300mm penetration. Blow count also given as seating drive followed by four increments of 75mm.
V ( )	Vane test (c_u kPa)
P ( )	Hand penetrometer (c_u kg/cm^2)
M ( )	Mexe probe (CBR %)

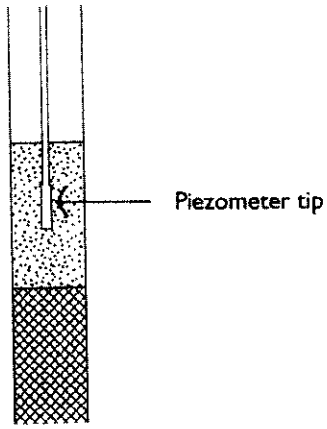
Water records

$\blacktriangledown_1$	Standing level
$\triangledown_1$	Depth encountered

suffix identifies separate strikes

Standpipes





AP GEOTECHNICS
T 01932 848460
F 01932 851255
E mail@apgeotechnics.co.uk

Site	Number
239 HAVERSTOCK HILL, CAMDEN	HA1

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Hand excavated pit followed by hand auger			Mr Michael Spalter	3731
	Location	**Dates**	**Engineer**	**Sheet**
	See site plan	03/04/2012	Davies Architecture Ltd	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.11)	TOPSOIL		
					0.11	MADE GROUND: Firm dark brown and brown clay with brick and charcoal fragments with occasional rounded flint gravel		
0.35	D1							
					(1.19)			
0.90	D2							
					1.30	MADE GROUND: Firm brown sandy clay with fine brick and charcoal fragments		
1.50	V1 88.33kPa		92, 90, 83 /Av. 88.33		(0.50)			
1.50	D3							
					1.80	Stiff orange brown and brown CLAY		
2.00	D4							
2.50	D5							
					(2.00)			
3.00	D6							
					3.80			
3.80	D7					Complete at 3.80m		

Remarks
Bore stable and dry
Backfilled with arisings

Scale (approx)	Logged By
1:25	MM

Figure No.
3731.HA2

AP GEOTECHNICS
T 01932 848460
F 01932 851255
E mail@apgeotechnics.co.uk

Site 239 HAVERSTOCK HILL, CAMDEN

Number HA2

Excavation Method Hand excavated pit followed by hand auger

Dimensions

Ground Level (mOD)

Client Mr Michael Spalter

Job Number 3731

Location See site plan

Dates 03/04/2012

Engineer Davies Architecture Ltd

Sheet 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.02) 0.02	Concrete slab		
					(0.04) 0.06	CONCRETE		
0.20	D1				(0.04) 0.10	MADE GROUND: Light brown gravelly sand. Gravel of concrete fragments		
					(1.10)	MADE GROUND: Soft to firm dark brown and brown clay with occasional brick and charcoal fragments		
0.90	D2							
					1.20	MADE GROUND: Stiff dark brown silty clay with charcoal fragments		
1.50	D3				(0.60)			
					1.80	Stiff brown and orange brown CLAY with pockets of silt		
2.00	D4							
2.50	D5				(2.00)			
3.00	D6							
3.80	D7				3.80	Complete at 3.80m		

Remarks
Bore stable and dry
Backfilled with arisings

Scale (approx) 1:25

Logged By MM

Figure No. 3731.HA3

AP GEOTECHNICS
T 01932 848460
F 01932 851255
E mail@apgeotechnics.co.uk

Site	Number
239 HAVERSTOCK HILL, CAMDEN	HA3

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Hand excavated pit followed by hand auger			Mr Michael Spalter	3731

Location	Dates	Engineer	Sheet
See site plan	03/04/2012	Davies Architecture Ltd	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.10)	TOPSOIL		
					0.10	MADE GROUND: Firm dark brown clay with brick and charcoal fragments with occasional flint gravel		
0.25	D1							
					(0.80)			
0.60	D2							
0.80	D3							
					0.90			
					(0.17)	MADE GROUND: Red brick fragments		
					1.07			
1.10	V1 75kPa		76, 77, 72/Av. 75.00			Stiff brown and orange brown CLAY with occasional pockets of silt		
1.50	D4							
2.00	D5							
					(2.73)			
2.50	D6							
3.00	D7							
3.80	D8				3.80			
						Complete at 3.80m		

Remarks
Bore stable and dry
Backfilled with arisings

Scale (approx)	Logged By
1:25	MM

Figure No.
3731.HA4

AP GEOTECHNICS
T 01932 848460
F 01932 851255
E mail@apgeotechnics.co.uk

Site 239 HAVERSTOCK HILL, CAMDEN

Number WS1

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler			Mr Michael Spalter	3731

Location	Dates	Engineer	Sheet
See site plan	27/02/2012	Davies Architecture Ltd	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
					(0.30)	TOPSOIL			
					0.30	MADE GROUND: Stiff dark brown sandy clay with brick fragments			
0.50	D1				(0.53)				
					0.83	*MADE GROUND: Stiff brown clay with flint gravel and fragments of brick, glass, earthernware, charcoal and concrete*			
1.00	D2								
					(1.07)				
1.50	D3								
					1.90	Stiff brown CLAY			
2.00	D4								
2.50	D5					...silt lens at 2.50 to 2.60 m			
					(1.40)				
3.00	D6								
3.30	D7				3.30	*Terminated at 3.30m*			

Remarks
Hand excavated service pit to 1.00 m
Bore dry
Refusal at 3.30 m

Scale (approx)	Logged By
1:25	MM

Figure No. 3731.WS1

APPENDIX C

IN SITU PERMEABILITY TEST

IN SITU PERMEABILITY TEST

HVORSLEV'S TIME LAG

Project: 239 HAVERSTOCK HILL, CAMDEN
Client: Mr Michael Spalter
Agent: Davies Architecture Ltd

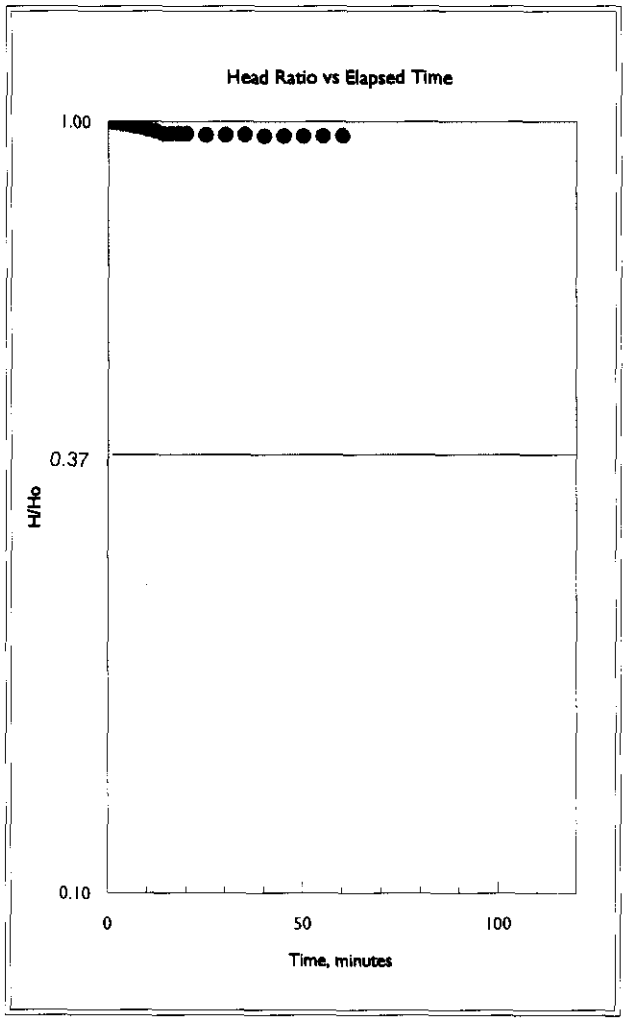
Project No: 3731
Sheet No: 1/1

Location: WS 1
Test depth from 0.00 m
to 3.30 m in borehole

Height of casing above g.l., m	0.00
Depth of casing below g.l., m	1.00
Diameter of casing, m	0.031
Depth to water at start of test, m b.g.l.	2.89

Description of stratum under test
London Clay

Elapsed Time min	Depth to Water, m from Casing	Depth to Water, m from GL	H	H/Ho
0.00	0.00	0.00	2.89	1.000
1.00	0.00	0.00	2.89	1.000
2.00	0.01	0.01	2.88	0.997
3.00	0.01	0.01	2.88	0.997
4.00	0.02	0.02	2.87	0.993
5.00	0.02	0.02	2.87	0.993
6.00	0.03	0.03	2.86	0.990
7.00	0.04	0.04	2.85	0.986
8.00	0.04	0.04	2.85	0.986
9.00	0.05	0.05	2.84	0.983
10.00	0.06	0.06	2.83	0.979
12.00	0.08	0.08	2.81	0.972
14.00	0.10	0.10	2.79	0.965
16.00	0.10	0.10	2.79	0.965
18.00	0.10	0.10	2.79	0.965
20.00	0.10	0.10	2.79	0.965
25.00	0.11	0.11	2.78	0.962
30.00	0.11	0.11	2.78	0.962
35.00	0.11	0.11	2.78	0.962
40.00	0.12	0.12	2.77	0.958
45.00	0.12	0.12	2.77	0.958
50.00	0.12	0.12	2.77	0.958
55.00	0.12	0.12	2.77	0.958
60.00	0.12	0.12	2.77	0.958



k = A/FT

A = 0.001 m^2
F = 3.868 m
T = Indeterminate min
k = Indeterminate m/s

APPENDIX D

LABORATORY TEST RESULTS

SUMMARY OF GEOTECHNICAL TESTS

Project: 239 HAVERSTOCK HILL
Client: Mr M Spalter
Agent: Davies Architecture Limited

Project No: 3770
Sheet No: 1/1

Location	Sample No	Depth m	Description	CLASSIFICATION							TRIAXIAL COMPRESSION - TOTAL STRESS							CHEMICAL		
				Natural Moisture Content %	Liquid Limit %	Plastic Limit %	Plast. Index %	Passing 425µm %	Mod. Plast. Index %	Class	Type	Moisture Content %	Bulk Density Mg/m³	Radial Stress kPa	Deviator Stress kPa	Cohesion cu, kPa assuming Øu = 0	Cohesion cu, kPa Øu, deg	Sulphate (SO4) Water g/l	Sulphate (SO4) Soil (Sol) g/l	pH
HA1	D2	0.90	Made Ground: firm clay with brick, charcoal and occasional flint gravel																0.36	8.43
	D3	1.50	Made Ground: firm sandy clay with brick and charcoal																0.27	8.08
	D6	3.00	Stiff orange brown and brown CLAY	27	74	25	49	100	49	CV									0.17	8.13
	D7	3.80	Stiff orange brown and brown CLAY	28	82	23	59	100	59	CV										
HA2	D6	3.00	Stiff brown and orange brown CLAY with pockets of silt	28	76	23	53	100	53	CV									0.36	8.01
	D7	3.80	Stiff brown and orange brown CLAY with pockets of silt	29	76	24	52	100	52	CV									0.27	8.43

Note: Soil Classification based upon unmodified Plasticity Index

SOIL CLASSIFICATION CHART
239 Haverstock Hill