Site Analytical Services Ltd.

SAS

Site Investigations, Analytical & Environmental Chemists, Laboratory Testing Services.

Units 14 + 15, River Road Business Park,
33 River Road, Barking, Essex IG11 0EA

Directors: J. S. Warren, M.R.S.C., P. C. Warren, J. I. Pattinson, BSc (Hons). MSc
Consultants: G. Evans, BSc., M.Sc., P.G. Dip., FGS., MIEnvSc. A. J. Kingston, BSc C.Eng. MIMM
F. J. Gibbs, F.I.B.M.S. F.I.F.S.T., F.R.S.H. K. J. Blanchette

Tel: 020 8594 8134
Fax: 020 8594 8072
E-Mail: services@siteanalytical.co.uk

Your Ref:

Our Ref: **14/22499**
September 2014

88 – 90 CAMDEN ROAD,

LONDON, NW1 9EA

REPORT ON A GROUND INVESTIGATION

Prepared for

Mr Pearse Molloy

CONTENTS

1.0 INTRODUCTION

1.1 Outline and Limitations of Report

At the request of Mr Pearse Molloy a ground investigation was carried out in connection with a proposed basement development at the above site.

The information was required for the design and construction of foundations and infrastructure for the proposed development which includes the installation of a lightwell at the front of the shop units Nos. 88 and 90 to provide daylighting to the basements which provide shared storage for the shop units above. A study to assess whether any remediation was required for protection of the end-user from the presence of potential contamination within the soils encountered was outside the scope of the present report.

The recommendations and comments given in this report are based on the ground conditions encountered in the exploratory holes made during the investigation and the results of the tests made in the field and the laboratory. It must be noted that there may be special conditions prevailing at the site remote from the exploratory hole locations which have not been disclosed by the investigation and which have not been taken into account in the report. No liability can be accepted for any such conditions.

2.0 SITE DETAILS

(National Grid Reference: TQ 291 841)

2.1 Site Location

The site is situated to the east of Camden Road in London at approximate postcode NW1 9EA. The site is currently occupied by shop units Nos. 88 and 90.

2.2 Geology

The 1:50000 Geological Survey of Great Britain (England and Wales) covering the area (Sheet 256, 'North London', Solid and Drift Edition) indicates the site to be underlain by the London Clay Formation.

2.3 Previous Investigations

A Basement Impact Assessment presented in a Site Analytical Services Limited report (Project No. 14/22499-1) dated September 2014.

2.4 Details of intended future uses of the site

It is proposed to install a lightwell at the front of the shop units Nos. 88 and 90 to provide daylighting to the basements which provide shared storage for the shop units above.

The maximum depth of the proposed basement is expected to be approximately 2.80m below existing ground level.

3.0 SCOPE OF WORK

3.1 Site Works

The proposed scope of works was agreed by the client prior to the commencement of the investigations. To achieve this, the following works were undertaken:-

- The drilling of one continuous flight auger borehole to a depth of 8.00m below ground level (Borehole 1).
- Sampling and in-situ testing as appropriate to the ground conditions encountered in the borehole.
- The placement of groundwater monitoring standpipes to a depth of approximately 8.0m below ground level in the borehole.
- Laboratory testing to determine the engineering properties of the soils encountered in the exploratory hole.
- Interpretative reporting on foundation options for the proposed building and infrastructure.
- A study into the possibility of the presence of toxic substances in the soil together with comments on any remediation required was outside the scope of the present investigation.

3.2 Ground Conditions

The location of the exploratory hole is shown on the site sketch plan, Figure 1.

The exploratory hole revealed ground conditions that were generally consistent with the geological records and known history of the area and comprised up to 3.80m thickness of Made Ground followed by the London Clay Formation at depth.

For detailed information on the ground conditions encountered in the exploratory hole, reference should be made to the exploratory hole record presented in Appendix A.

3.3 Groundwater

Groundwater was encountered as a seepage at a depth of 2.30m below ground level and was recorded at 7.10m depth of completion of drilling operations.

It must be noted that the speed of excavation and boring is such that there may well be insufficient time for further light seepages of groundwater to enter the borehole and hence be detected, particularly within more cohesive soils of low permeability. Due to these inaccuracies a groundwater monitoring standpipe was installed in the borehole to approximately 8.00m below ground level

Groundwater was subsequently recorded at a depth of depth of 3.53m below ground level in the monitoring standpipe installed in Borehole 1 after a period of approximately two to three weeks. This is below the depth of the proposed excavation.

It should be noted that the comments on groundwater conditions are based on observations made at the time of the investigation (August and September 2014) and that changes in the groundwater level could occur due to seasonal effects and also changes in drainage conditions.

Groundwater is by its nature, hidden from view and unforeseen ground conditions can occur. It is therefore recommended that the water levels in the monitoring borehole be periodically measured immediately prior to, and during construction. Should groundwater levels rise to within the excavation volume, or should significant groundwater inflow be observed during excavation, professional advice should be sought.

4.0 IN-SITU AND LABORATORY TESTS

4.1 In Situ Vane Tests

In the essentially cohesive natural soils encountered at the site, in-situ shear vane tests were made at regular depth increments in order to assess the undrained shear strength of the materials. The results indicate that the natural soils are of a generally stiff and then very stiff consistency with increasing depth below ground level.

The results of the in-situ tests are shown on the appropriate exploratory hole records contained in Appendix A.

4.2 Classification Tests

Atterberg Limit tests were conducted on two selected samples taken from the upper cohesive portion of the natural soils in Borehole 1 and showed the samples tested to fall into Classes CH and CH/CV according to the British Soil Classification System.

These are fine grained silty clay soils of high and very high plasticity and as such generally have a low permeability and a high susceptibility to shrinkage and swelling movements with changes in moisture content, as defined by the NHBC Standards, Chapter 4.2. The results indicated Plasticity Index values between 45% and 51%, with both of the samples being above the 40% boundary between soils assessed as being of medium swelling and shrinkage potential and those assessed as being of high swelling and shrinkage potential.

The test results are given in Table 1, contained in Appendix B.

4.3 Sulphate and pH Analyses

The results of the sulphate and pH analyses made on two soil samples are presented on Table 2. The results show the soil samples to have water soluble sulphate contents of up to 2.01g/litre associated with slightly acidic to near neutral pH values.

5.0 FOUNDATION DESIGN

5.1 General

It is proposed to install a lightwell at the front of the shop units Nos. 88 and 90 to provide daylighting to the basements which provide shared storage for the shop units above. The final level of the basement is expected to be around 2.80m below existing ground level, although further details of the development including the exact structure, layout and loadings were not available at the time of preparation of this report.

5.2 Site Preparation Works

The CDM Co-ordinator should be informed of the site conditions and risk assessment undertaken to comply with the Construction Design Management (CDM) regulations. Site personnel are to be made aware of the site conditions. It is recommended that extensive searches of existing man made services are undertaken over the site prior to final design works.

5.3 Conventional Spread Foundations

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

Based on the ground and groundwater conditions encountered in the borehole, it should be possible to support the proposed new development on conventional spread or basement raft foundations taken down below the Made Ground and any weak superficial soils and placed in the natural stiff becoming very stiff sandy silty clay deposits encountered at depths of 4.00m below ground level in the borehole.

Using theory from Terzaghi (1943), strip foundations placed within natural soils may be designed to allowable net bearing pressures of approximately 280kN/m^2 at 4.00m below ground level in order to allow for a factor of safety of 2.5 against general shear failure and should be sufficiently low to ensure that overstressing of the underlying soils does not occur. The actual allowable bearing pressure applicable will depend on the form of foundation, its geometry and depth in accordance with classical analytical methods, details of which can be obtained from "Foundation Design and Construction", Seventh Edition, 2001 by M J Tomlinson (see references) or similar texts.

Any soft or loose pockets encountered within otherwise competent formations should be removed and replaced with well compacted granular fill.

In addition, foundations may need to be taken deeper should they be within the zones of influence of both existing or recently felled trees and any proposed tree planting. The depth of foundation required to avoid the zone likely to be affected by the root systems of trees is shown in the recommendations given in NHBC Standards, Chapter 4.2, April 2010, "Building near Trees" and it is considered that this document is relevant in this situation.

5.4 Piled Foundations

In the event that the use of conventional spread foundations proves either impracticable or uneconomical due to the size and depth of foundation required, then a piled foundation will be required. In these ground conditions, it is considered that some form of bored and in-situ cast concrete piled foundation with reinforced concrete ground beams should prove satisfactory.

The construction of a piled foundation is a specialist activity and the advice of a reputable contractor, familiar with the type of soil and groundwater conditions encountered at this site should be sought prior to finalising the foundation design. The actual pile working load will depend on the particular type of pile chosen and method of installation adopted.

To achieve the full bearing value a pile should penetrate the bearing stratum by at least five times the pile diameter.

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.

Driven piles could also be used and would develop much higher working loads approximately 2.5 to 3 times higher than bored piles of a similar diameter at the same depth. However, the close proximity of adjacent buildings will in all probability preclude their use due to noise and vibration.

5.5 Retaining Walls

Several methods of retaining wall construction could be considered. These may include retaining structures cast in an underpinning sequence, or the use of temporary or sacrificial works to facilitate the retaining structure's construction. The excavation of the basement must not compromise the integrity of adjacent structures.

Retaining walls should generally be designed as self-supporting cantilevered retaining walls. The excavations for a basement must not affect the integrity of adjacent structures and therefore will need to be supported. Two forms of support could be considered, these being temporary works i.e. sheet piling which could be removed after the earth retaining walls have been constructed or as permanent works incorporated into the final design.

Generally, cantilevered piled walls have an open face to embedded ratio of about one to two, i.e. a supported face three metres in height would require a penetration into the ground of about six metres below the base of the excavation. Should the piled retaining wall be purely an unsupported cantilever, then it is likely that quite deep section sheet piles or large diameter bored piles would be required.

The section of the sheet or the diameter of the piles could be reduced by installing a braced waling to the wall. Piles placed as part of the permanent works would be propped by the roof to the basement and would not be acting purely as a cantilevered support in the long term.

To reduce the likelihood of loss of ground if a sheet piled wall was adopted when removing the sheets, it is considered that the sheet piles should be incorporated into the final wall design. Assuming that the earth retaining wall will be propped, i.e. have its base slab and first floor slab cast in place soon after excavation, it is unlikely that full if any earth pressures will act on the wall while it is not propped. The greatest force acting on the wall, in the short term, is likely to be from the hydrostatic head should water percolate and be retained to the rear of the earth retaining structure.

The design parameters for each element of soil recorded in the relevant exploratory holes are provided in Table A below. The depth of pile penetration can be calculated once structural details of the proposed basement are known.

Founding Material	Depth to top (m)	Description	Critical Angle of Shearing Resistance (°) (Φ'_{crit})[1]	Coefficient active pressure (Ka)	Coefficient passive resistance (Kp)
London Clay	3.80	Stiff and then very stiff silty CLAY	21	0.47	2.12

Table A. Summary of design parameters for proposed basement foundation

Notes:

1. Calculated using guidance from BS8002 (1994)

2. As the depth and structural details of the proposed basement are unknown these values should be used as guidance only and should be seen as 'very cautious values' using guidance from Eurocode 7.

The site lies above the London Clay Formation determined from laboratory testing as having a high susceptibility to shrinkage and swelling movements with changes in moisture content, as defined by the NHBC Standards, Chapter 4.2 (2010).

The amount of movement will depend upon a number of factors including the construction timetable, ultimate loads and critically, the depth of the final excavation. Consideration should therefore be given to providing heave protection measures to the floor slab and foundations to mitigate this.

Heave can be reduced by proceeding with the excavation in stages and observing and recording any movement that occurs over a set period of time using strain gauges or similar following the guidance from Boscardin and Cording (1989).

It may be advantageous to delay the construction until an adequate proportion of the uplift has occurred. Once this monitoring period has elapsed and a suitably qualified engineer is confident that the majority of uplift has occurred, basement construction can commence.

These processes and other ways of dealing with ground movements are described at length in BS8004 (British Standard Code of Practice for Foundations).

5.6 Floor Slabs

Due to the presence of soils assessed to be of high swelling and shrinkage potential below, it is recommended that ground slabs should be fully suspended.

5.7 Excavations

Shallow excavations for foundations and services are likely to require nominal side support in the short term and groundwater is unlikely to be encountered in significant quantities once any accumulated surface water has been removed. Deeper and longer excavations below approximately 1.50m below existing ground level will require close side support and some seepages of groundwater could be encountered.

No particular difficulties are envisaged in removing such water by conventional internal pumping methods from open sumps.

Normal safety precautions should be taken if excavations are to be entered.

5.8 Chemical Attack on Buried Concrete

The results show the natural soil samples to have water soluble sulphate contents of up to 2.01g/litre associated with slightly acidic to near neutral pH values.

In these conditions, it is considered that deterioration of buried concrete due to sulphate attack is likely to occur unless precautions are taken. The final design of buried concrete according to Tables C1 and C2 of BRE Special Digest 1:2005 should be in accordance with Class DS-3 conditions.

In addition, segregations of gypsum were noted within the London Clay and scattered small gypsum crystals were also noted at depth. Consequently, it is considered that any buried concrete at depth may be attacked by such sulphates in solution and that it would be prudent to design any such deep buried concrete in accordance with full Class DS-3 conditions.

p.p. SITE ANALYTICAL SERVICES LIMITED

A P Smith BSc (Hons) FGS
Senior Geologist

6.0 REFERENCES

1. Beckett M.J. and Sims D.L. (1984). "The Development of Contaminated Land", Symposium on Hazardous Waste Disposal and the Re-use of Contaminated Land. Society of Chemical Industry.

2. Boscardin and Cording (1989). Building Response to Excavation-Induced Settlement. Journal of Geotechnical Engineering, ASCE.

3. British Standards Institution, 1986. Code of practice for foundations, BS 8004, BSI, London.

4. British Standards Institution, 1990. Methods for test for soils for civil engineering purposes, BS1377, BSI, London

5. British Standards Institution, 1994. Code of practice for earth retaining structures, BS8002, BSI, London

6. British Standards Institution, 2001. Investigation of Potentially Contaminated Sites - Code of Practice, BS 10175, BSI, London

7. British Standards Institution, 2007. Code of Practice for Site Investigations, BS5930, BSI, London

8. British Standards Institution, 2009. Code of practice for protection of below ground structures against water from the ground, BS 8102, BSI, London

9. Building Research Establishment Special Digest 1, 2005, "Concrete in Aggressive Ground – Third Edition."

10. Driscoll, R (1983) "The influence of vegetation on the shrinking and swelling of clay soils in Great Britain", Geo-technique 33, 93-107

11. Eurocode 1: Actions on structures – BS EN 1991-1-1:2002: General actions – Densities, self weight and imposed loads, BSI, London

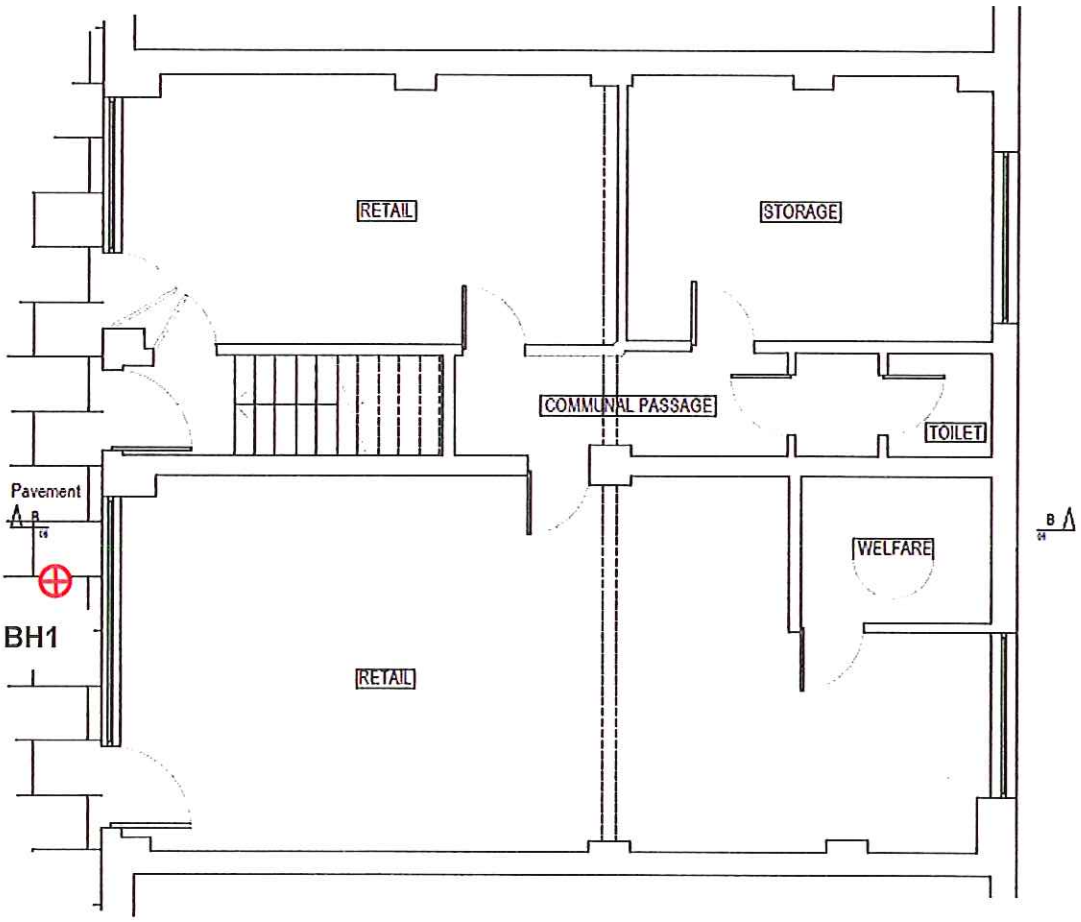
12. NHBC Standards, Chapter 4.1, "Land Quality - managing ground conditions", September 1999.

13. NHBC Standards, Chapter 4.2, "Building near Trees", April 2010.

14. Stroud M.A. and Butler F.G. (1975) Symposium on the Engineering Behaviour of Glacial Materials; the Midland Soil Mechanics and Foundation Engineering Society; pgs 124 et seq.

15. Tomlinson, M J, 2001. "Foundation Design and Construction", Seventh Edition, Prentice Hall (ISBN 0-13-031180-4).

Site Analytical Services Ltd.				REF: 14/22499
LOCATION:	88-90 Camden Road, London, NW1 9EA			FIG: 1
TITLE:	Site Sketch Plan	DATE:	Sept 2014	SCALE: NTS



Existing Ground Floor

APPENDIX `A'

Borehole Logs

Site Analytical Services Ltd.

Site	Borehole Number
88-90 CAMDEN ROAD, LONDON, NW1 9EA	BH1

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
CONTINUOUS FLIGHT AUGER	100mm cased to 0.00m		MR PEARSE MOLLOY	1422499
	Location	**Dates**	**Engineer**	**Sheet**
	TQ 291 841	18/08/2014		1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
						(0.17)	MADE GROUND : Concrete slab over sand and concrete		
						0.17	MADE GROUND : Loose dark brown silty clayey fine to coarse SAND with brick, concrete, clinker and metal fragments		
0.25	D1								
0.50	D2								
0.50-0.80	M1 47/300								
0.75	D3								
1.00	D4								
1.00-1.30	M2 57/300								
1.50	D5								
1.50-1.80	M3 74/300								
						(3.63)			
2.00	D6								
2.00-2.30	M4 58/300			SEEPAGE(1) at 2.30m.					∇1
2.50	D7								
2.50-2.80	M5 52/300								
3.00	D8								
3.00-3.30	M6 65/300								
3.50	D9								
3.50-3.80	M7 78/300								
						3.80	Stiff becoming very stiff brown and mottled orange brown, veined blue grey silty CLAY with occasional partings of light brown silty fine sand and occasional small gypsum crystals		
4.00	D10								
4.00	V1 140+								
4.50	D11								
4.50	V2 140+								
5.00	D12					(2.70)			
5.00	V3 140+								
6.00	D13								
6.00	V4 140+								
						6.50	Very stiff dark grey brown fissured silty CLAY with occasional partings of light brown silty fine sand and scattered small gypsum crystals		
7.00	D14								
7.00	V5 140+					(1.50)			
8.00	D15					8.00			
8.00	V6 140+			18/08/2014:7.10m			Complete at 8.00m		

Remarks
V = In Situ Vane Test - Result in kPa
M = Mackintosh Probe - Blows/Penetration (mm)
D = Disturbed Sample

Scale (approx)	Logged By
1:50	APS

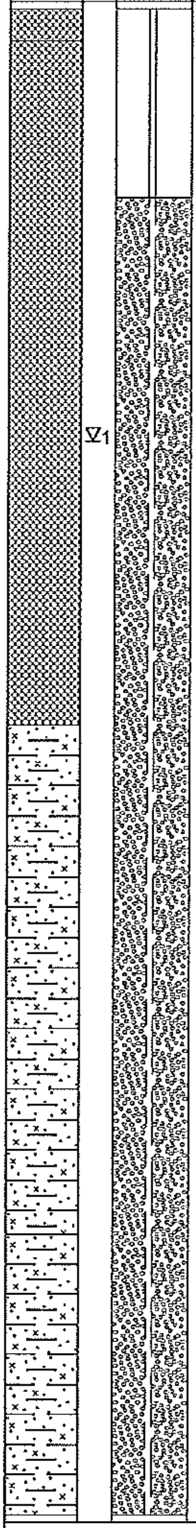
Figure No.
1422499.BH1

Site Analytical Services Ltd.

Site	Borehole Number
88-90 CAMDEN ROAD, LONDON, NW1 9EA	BH1

Installation Type	Dimensions	Client	Job Number
MONITORING STANDPIPE	Internal Diameter of Tube [A] = 50 mm Diameter of Filter Zone = 100 mm	MR PEARSE MOLLOY	1422499

Location	Ground Level (mOD)	Engineer	Sheet
TQ 291 841			1/1



Legend	Water	Instr (A)	Level (mOD)	Depth (m)	Description
	∇1			1.00	Bentonite Seal
				8.00	Slotted Standpipe

Groundwater Strikes During Drilling

Date	Time	Depth Struck (m)	Casing Depth (m)	Inflow Rate	Readings 5 min	10 min	15 min	20 min	Depth Sealed (m)
18/08/14		2.30	0.00	SEEPAGE					

Groundwater Observations During Drilling

Date	Start of Shift					End of Shift				
	Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)	Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)
18/08/14				DRY			8.00		7.10	

Instrument Groundwater Observations

Inst. [A] Type : SINGLE STANDPIPE

Date	Instrument [A]			Remarks
	Time	Depth (m)	Level (mOD)	

Remarks

Lockable cover set in concrete

APPENDIX `B'

Laboratory Test and Groundwater Monitoring Data

Ref: 14/22499

PLASTICITY INDEX & MOISTURE CONTENT DETERMINATIONS

LOCATION 88-90 Camden Road, London NW1 9EA

BH/TP No.	Depth m	Natural Moisture %	Liquid Limit %	Plastic Limit %	Plasticity Index %	Passing 425 µm %	Class
BH1	4.00	31	70	19	51	99	CH/CV
	4.50	34	65	20	45	99	CH

Ref: 14/22499

SULPHATE & pH DETERMINATIONS

LOCATION 88-90 Camden Road, London NW1 9EA

BH/TP No.	DEPTH BELOW GL m	SOIL SULPHATES AS SO_4 TOTAL %	SOIL SULPHATES AS SO_4 WATER SOL g/l	WATER SULPHATES AS SO_4 g/l	pH	CLASS	SOIL - 2mm %
BH1	5.00		0.30		6.6	DS-1	100
	8.00		2.01		5.6	DS-3	100

Classification – Tables C1 and C2 : BRE Special Digest 1 : 2005

Ref: 14/22499

GROUNDWATER MONITORING

LOCATION 88-90 Camden Road, London NW1 9EA

GROUNDWATER MONITORING RECORD			
Date	**Weather Conditions**	**Ground Conditions**	**Temperature (°C)**
27/08/2014	Overcast	Dry	21
Monitoring Point Location	**Depth to water (mBGL)**		**Depth to Base of well (mBGL)**
BH1	3.54		7.76

Ref: 14/22499

GROUNDWATER MONITORING

LOCATION 88-90 Camden Road, London NW1 9EA

GROUNDWATER MONITORING RECORD			
Date	**Weather Conditions**	**Ground Conditions**	**Temperature (°C)**
03/09/2014	Cloudy	Dry	22
Monitoring Point Location	**Depth to water (mBGL)**		**Depth to Base of well (mBGL)**
BH1	3.53		7.76