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Your Ref:

Our Ref: **11/18665**
December 2011

6 & 7 WARREN MEWS

LONDON, W1T 6AS

REPORT ON A GROUND INVESTIGATION

Prepared for

Drawing and Planning Limited

Acting on behalf of

Mr Timothy Tan Yit Ching

Reg Office: Units 14 + 15, River Road Business Park,
33 River Road, Barking, Essex IG11 0EA
Business Reg. No. 2255616

constructionline
Registration No: 79455

ISO 9002
REGISTERED FIRM

Ref: 11/18665
December 2011

Report on a Ground Investigation

At

6 and 7 Warren Mews, London, W1T 6AS

For

Mr Timothy Tan Yit Ching

1.0 INTRODUCTION

At the request of Drawing and Planning Limited, Structural Engineers, acting on behalf of Mr Timothy Tan Yit Ching, 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 an extension of the existing basement below building No. 6 and the creation of a new basement below building No. 7 to create three new mews houses. A study to assess whether any remediation was required for the protection of the end-user from the presence of potential contamination within the soils encountered was outside the scope of the present investigation.

The recommendations and comments given in this report are based on the ground conditions encountered in the single exploratory hole 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 location 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 THE SITE AND LOCAL GEOLOGY

(National Grid Reference: TQ 290 820)

2.1 Site Description

The site is situated on the east side of Warren Mews located just to the south of the A501 Marylebone Road in Central London, W1T 6AS. The site is currently occupied by a three-storey terraced mews building with existing basement space below building No. 6.

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 superficial deposits comprising Lynch Hill River Terrace Deposits underlain by the London Clay Formation.

3.0 SCOPE OF WORK

3.1 General

The scope of the investigation was agreed with the Client and comprised:

- The drilling of one continuous flight auger borehole to a depth of 15m below ground level (Borehole 1).
- The placement of a groundwater monitoring standpipe to a depth of 6.10m below ground level in the borehole.
- A single in-situ rising head test in the monitoring standpipe to assess the effective permeability of the near surface soils.
- Sampling and in-situ testing as appropriate to the ground conditions encountered in the borehole.
- Interpretative reporting on foundation options for the proposed building works and infrastructure.

3.2 Ground Conditions

The location of the borehole 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 about 2.80m thickness of made ground resting on deposits typical of Lynch Hill River Terrace Deposits with the London Clay Formation at depth.

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

The made ground extended down to a depth of 2.80m below ground level and comprised of a surface layer of cobbled pavement overlying a mixture of very loose becoming loose silty sand, fine to coarse flint gravel and brick fragments.

The underlying natural materials comprised of a thin development of medium dense silty sand with occasional fine to coarse gravel in varying proportions which extended down to a depth of 3.00m below ground level in Borehole 1. These essentially granular soils are typical of Lynch Hill River Terrace Deposits.

The River Terrace Deposits were underlain by stiff becoming very stiff mottled silty clay with occasional partings of silty fine sand and occasional small gypsum crystals. These deposits represent weathered London Clay and extended to a depth of 4.40m below ground level.

The underlying material comprised of very stiff fissured silty clay with occasional partings of silty fine sand, occasional weak claystone nodules and scattered small gypsum crystals. These materials are typical of the more competent unweathered London Clay Formation and extended down to the full depth of investigation of 15.0m below ground level in the borehole.

3.3 Groundwater

Groundwater strikes were encountered in Borehole 1 and are detailed below:

Exploratory Hole	Depth (m)	Notes	Stratum
BH1	2.80	Seepage	River Terrace deposits
	6.10	Seepage	London Clay

Table 1. Groundwater Strike Summary

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.

Groundwater was subsequently recorded to have stabilised at a depth of 3.58m below ground level in the monitoring standpipe installed in Borehole 1 after a period of approximately three weeks.

Isolated pockets of groundwater may be present perched within any less permeable material found at shallower depth on other parts of the site especially within any made ground.

It should be noted that the comments on groundwater conditions are based on observations made at the time of the investigation (November and December 2011) and that changes in the groundwater level could occur due to seasonal effects and also changes in drainage conditions.

4.0 IN-SITU AND LABORATORY TESTS

4.1 In-Situ Mackintosh Probe and Shear Vane Tests

In essentially granular soils and cohesive soils with a granular content, Mackintosh Probe tests were made in the borehole in order to assess the relative density or undrained shear strength of the materials. The results indicate that the made ground is in a generally very loose becoming loose state of compaction, all results being based on the generally accepted correlation as follows:

Mackintosh N75 X 0.38 = SPT 'N' Value

or

Mackintosh N300 X 0.1 = SPT 'N' Value

In essentially cohesive soils, 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 cohesive soils are of a stiff becoming very stiff consistency with increasing depth below ground level.

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

4.2 Classification Tests

Atterberg Limit tests were conducted on six selected samples taken from the essentially cohesive natural soils encountered in the borehole and showed the samples tested to fall into Class CH according to the British Soil Classification System.

These are fine grained sometimes sandy silty clay soils of high plasticity and as such generally have moderate bearing and settlement characteristics, have a low permeability and a medium to 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 36% and 46% with three of the samples being at or 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 and the other three samples falling below this boundary.

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 natural soil samples are presented on Table 2 and show the natural soil samples tested to have water soluble sulphate contents of up to 0.14g/litre associated with near neutral pH values.

4.4 Groundwater Monitoring Results

The standpipe installed in Borehole 1 was monitored for groundwater levels on 22nd and 28th November 2011 and 4th December 2011 and the results are presented in Tables 3, 3a and 3b contained in Appendix B.

Groundwater was found to have stabilised at a depth of 3.58m below ground level in the monitoring standpipe installed in Borehole 1 after a period of approximately three weeks.

4.5 In-situ Rising Head Permeability Tests

In order to assess the soil infiltration characteristics of the natural superficial soils at the site, an in-situ rising head permeability test was carried out in Borehole 1, using the procedure recommended in BS 5930 (2007).

5.0 FOUNDATION DESIGN

5.1 General

It is proposed to carry out an extension of the existing basement below building No. 6 and the creation of a new basement below building No. 7 to create three new mews houses. It is envisaged that the excavation for the new basements will be a mixture of secant piled retaining walls and underpinning to the existing walls. Exact details of the finalised structures, layout and loadings were not available at the time of preparation of this report.

5.2 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 exploratory hole, it could, in theory, 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 stiff becoming very stiff London Clay deposits encountered at a depth of about 3.00m below ground level. Foundations should be placed in the natural deposits at a minimum depth of 1.00m below final ground level in order to avoid the zone affected by seasonal moisture content changes.

In-situ testing indicates allowable net bearing pressures within the natural cohesive deposits at 3.00m depth of approximately 200kN/m^2 increasing to about 250kN/m^2 at 4.00m depth in order to allow for a factor of safety of about three against general shear failure. 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 either 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 2003, "Building near Trees" and it is considered that this document is relevant in this situation.

5.3 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.

5.4 Retaining Walls

It is proposed to carry out an extension of the existing basement below building No. 6 and the creation of a new basement below building No. 7 to create three new mews houses. Exact details of the structure, layout and loadings were not available at the time of preparation of this report.

The results of the investigation indicated that made ground occurs to a depth of about 2.80m below existing ground level and is underlain by a thin layer of River Terrace Deposits extending down to a depth of 3.00m below ground level with the London Clay Formation at depth proven to at least 15.00m below ground level. The general groundwater level beneath the site lies at an approximate depth of 3.58m below existing ground level.

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.

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 the London Clay (i.e. the suitable bearing stratum at the site) 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	2.80	Stiff becoming very stiff silty CLAY	21.0	0.49	2.04

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.

5.5 Basement Floor Slab

The basement slab may be cast on the natural silty clay deposits provided that the exposed formation is adequately compacted and protected from the elements.

5.6 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 within the made ground has been removed. Deeper and longer excavations below approximately 1.0m below existing ground level will require close side support and some inflows of groundwater are likely to 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.

5.7 Soil Permeability

The results of the in-situ permeability test indicate an apparent permeability or soil infiltration rate of 4.2×10^{-6} m/sec.

It may be concluded that the average soil infiltration rate and apparent permeability of the natural materials at the site is of the order of 4.2×10^{-6} m/sec. The average soil infiltration rate given above lies within the range of published data for very fine or silty sands and fissured and weathered clays and is classed as low permeability material at the boundary between good and poor drainage characteristics.

5.8 Chemical Attack on Buried Concrete

The results of the chemical analyses show the natural soil samples to have water soluble sulphate contents of up to 0.14g/litre associated with near neutral pH values

In these conditions, it is considered that deterioration of buried concrete due to sulphate attack is unlikely to occur and the final design of buried concrete according to table C1 and C2 of BRE Special Digest 1:2005 should be in accordance with Class DS-1 conditions.

However, 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-2 conditions.

p.p. SITE ANALYTICAL SERVICES LIMITED

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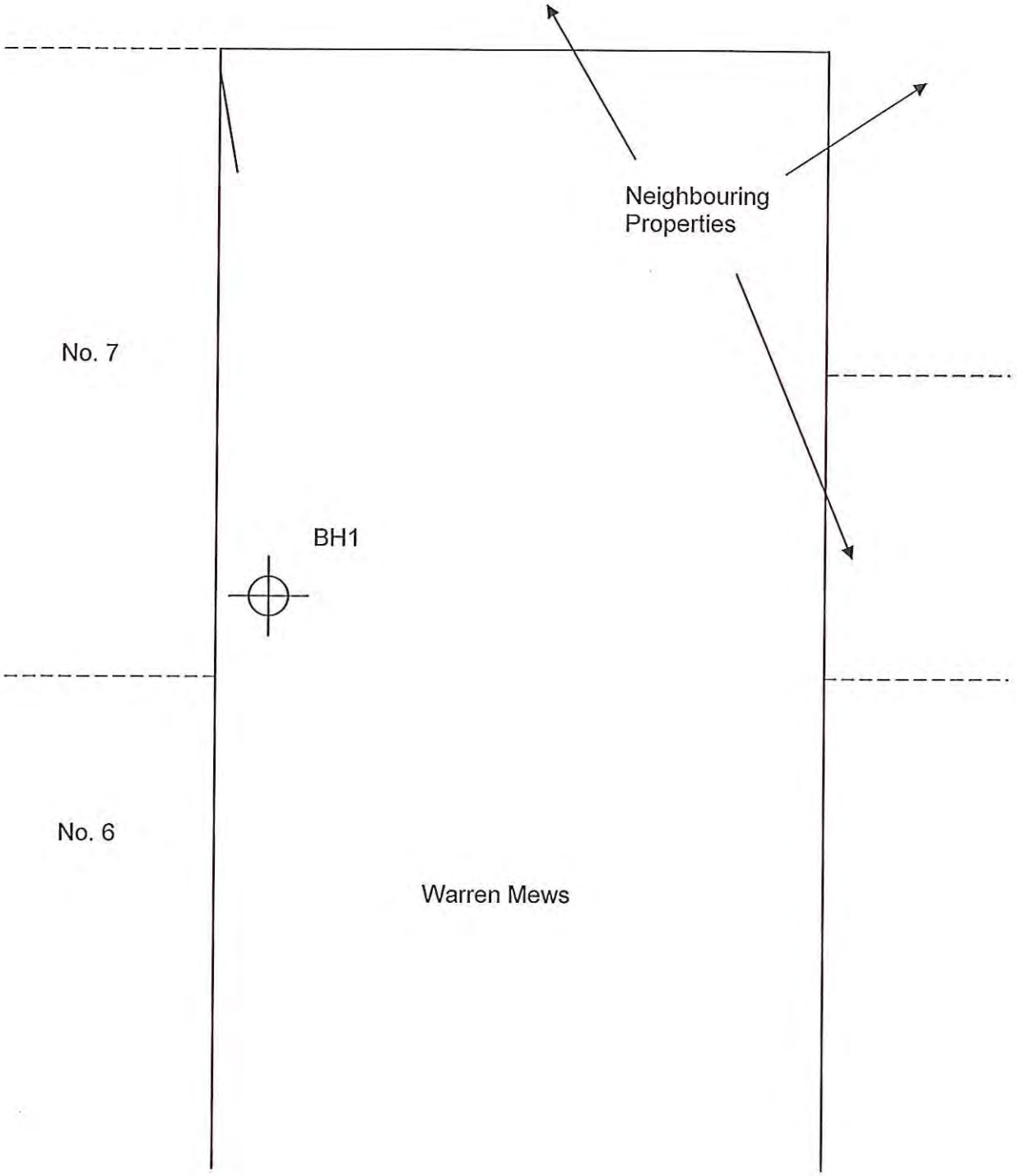
Site Analytical Services Ltd.				REF: 11/18665
LOCATION:	6-7 Warren Mews, London, W1			FIG: 1
TITLE:	Sketch Site Plan	DATE:	Dec 2011	SCALE: NTS



APPENDIX `A'

Borehole / Trial Pit Logs

Site Analytical Services Ltd.

Site	Borehole Number
6-7 WARREN MEWS, LONDON, W1T 6AS	BH1

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
CONTINUOUS FLIGHT AUGER	100mm cased to 0.00m		MR TIMOTHY TAN YIT CHING	1118665
	Location	**Dates**	**Engineer**	**Sheet**
	TQ 290 820	15/11/2011	DRAWING AND PLANNING	1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
						(0.25)	MADE GROUND : cobbled pavement overlying fine sand		
0.25	D1					0.25	MADE GROUND : very loose becoming loose dark brown silty sand with fine to coarse flint gravel and brick fragments		
0.50	D2								
0.50-0.80	M1 34/300								
0.75	D3								
1.00	D4								
1.00-1.30	M2 56/300								
						(2.55)			
1.50	D5								
1.50-1.80	M3 47/300								
2.00	D6								
2.00-2.30	M4 68/300								
2.50	D7								
2.50-2.80	M5 56/300								
				SEEPAGE(1) at 2.80m.		2.80			▽1
						(0.20)	Medium dense brown to light orange brown silty fine to coarse SAND with occasional fine to coarse sub rounded to sub angular flint gravel		
3.00	D8					3.00			
3.00	V1 140+								
3.50	D9						Stiff becoming very stiff brown and mottled orange brown, veined blue grey silty CLAY with occasional partings of light brown silty fine sand and occasionsal small gypsum crystals		
3.50	V2 140+					(1.40)			
4.00	D10								
4.00	V3 140+								
						4.40			
4.50	D11						Very stiff dark grey brown fissured silty CLAY with occasional partings of light brown silty fine sand and scattered small gypsum crystals		
4.50	V4 140+								
5.00	V5 140+								
5.00	D12								
6.00	D13								▽2
6.00	V6 140+			MEDIUM(2) at 6.10m.					
7.00	D14								
7.00	V7 140+					(5.60)			
8.00	D15								
8.00	V8 140+								
9.00	D16								
9.00	V9 140+								
						10.00			

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

Scale (approx)	Logged By
1:50	APS

Figure No. 1118665.BH1

Site Analytical Services Ltd.

Site	Borehole Number
6-7 WARREN MEWS, LONDON, W1T 6AS	BH1

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
CONTINUOUS FLIGHT AUGER	100mm cased to 0.00m		MR TIMOTHY TAN YIT CHING	1118665
	Location	**Dates**	**Engineer**	**Sheet**
	TQ 290 820	15/11/2011	DRAWING AND PLANNING	2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
10.00 10.00	D17 V10 140+						Very stiff dark grey brown fissured silty CLAY with occasional partings of light brown silty fine sand and scattered small gypsum crystals		
11.00 11.00	V11 140+ D18								
12.00 12.00	D19 V12 140+					(5.00)			
13.00 13.00	D20 V13 140+								
14.00 14.00	D21 V14 140+								
15.00 15.00	D22 V15 140+			15/11/2011:11.00m		15.00	Complete at 15.00m		

Remarks

Scale (approx)	Logged By
1:50	APS

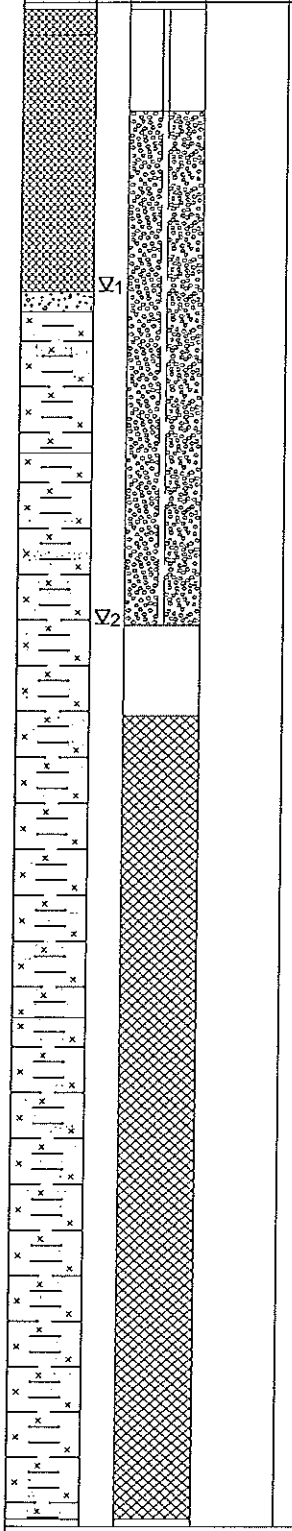
Figure No. 1118665.BH1

Site Analytical Services Ltd.

Site	Borehole Number
6-7 WARREN MEWS, LONDON, W1T 6AS	BH1

Installation Type	Dimensions	Client	Job Number
MONITORING STANDPIPE	Internal Diameter of Tube [A] = 50 mm Diameter of Filter Zone = 100 mm	MR TIMOTHY TAN YIT CHING	1118665

Location	Ground Level (mOD)	Engineer	Sheet
TQ 290 820		DRAWING AND PLANNING	1/1



Groundwater Strikes During Drilling

Date	Time	Depth Struck (m)	Casing Depth (m)	Inflow Rate	Readings 5 min	Readings 10 min	Readings 15 min	Readings 20 min	Depth Sealed (m)
15/11/11		2.80	0.00	SEEPAGE					
15/11/11		6.10	0.00	MEDIUM					

Groundwater Observations During Drilling

Date	Start of Shift Time	Start of Shift Depth Hole (m)	Start of Shift Casing Depth (m)	Start of Shift Water Depth (m)	Start of Shift Water Level (mOD)	End of Shift Time	End of Shift Depth Hole (m)	End of Shift Casing Depth (m)	End of Shift Water Depth (m)	End of Shift Water Level (mOD)
15/11/11				DRY			15.00		11.00	

Instrument Groundwater Observations

Inst. [A] Type : SINGLE STANDPIPE

Date	Instrument [A] Time	Instrument [A] Depth (m)	Instrument [A] Level (mOD)	Remarks
22/11/11		3.56		Gas readings taken
28/11/11		3.58		Gas readings taken
05/12/11		3.58		Gas readings taken

Remarks

Lockable cover set in concrete
Gas valve fitted

APPENDIX `B'

Laboratory Test and Gas Monitoring Data

Site Analytical Services Ltd.

Ref: 11/18665

PLASTICITY INDEX & MOISTURE CONTENT DETERMINATIONS

LOCATION 6 & 7 Warren Mews, London, W1T 6AS

BH/TP No.	Depth m	Natural Moisture %	Liquid Limit %	Plastic Limit %	Plasticity Index %	Passing 425 μm %	Class
BH1	3.50	29	59	23	36	100	CH
	4.00	24	62	23	39	100	CH
	4.50	27	67	22	45	99	CH
	5.00	28	61	23	38	100	CH
	6.00	32	69	23	46	100	CH
	7.00	32	63	23	40	100	CH

Table 1

Site Analytical Services Ltd.

Ref: 11/18665

SULPHATE & pH DETERMINATIONS

LOCATION 6 & 7 Warren Mews, London, W1T 6AS

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	3.00		0.08		7.0	DS-1	100
	12.00		0.14		6.7	DS-1	100

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

Table 2

Site Analytical Services Ltd.

Ref: 11/18665

GAS MONITORING

LOCATION	6 and 7 Warren Mews, London, W1T 6AS
MONITORING DATE	22nd November 2011

BOREHOLE REF:		**BH1**
Methane	(%)	0.0
Carbon Dioxide	(%)	0.3
Oxygen	(%)	18.8
Hydrogen Sulphide	(p.p.m.)	0
Carbon Monoxide	(p.p.m.)	0
Atmospheric Pressure	(mb)	1005
Water Level	(m.bgl)	3.56
Oxygen in Air	(%)	21.3
Flow	(l/hour)	0.0

N.B. Methane Lower Explosive Limit - 5% Gas in Air

Table 3

Site Analytical Services Ltd.

Ref: 11/18665

GAS MONITORING

LOCATION	6 and 7 Warren Mews, London, W1T 6AS
MONITORING DATE	28th November 2011

BOREHOLE REF:		**BH1**
Methane	(%)	0.0
Carbon Dioxide	(%)	0.5
Oxygen	(%)	18.4
Hydrogen Sulphide	(p.p.m.)	0
Carbon Monoxide	(p.p.m.)	0
Atmospheric Pressure	(mb)	1012
Water Level	(m.bgl)	3.58
Oxygen in Air	(%)	21.2
Flow	(l/hour)	0.0

N.B. Methane Lower Explosive Limit - 5% Gas in Air

Table 3a

Site Analytical Services Ltd.

Ref: 11/18665

GAS MONITORING

LOCATION	6 and 7 Warren Mews, London, W1T 6AS
MONITORING DATE	5th December 2011

BOREHOLE REF:		**BH1**
Methane	(%)	0.0
Carbon Dioxide	(%)	0.3
Oxygen	(%)	19.8
Hydrogen Sulphide	(p.p.m.)	0
Carbon Monoxide	(p.p.m.)	0
Atmospheric Pressure	(mb)	1005
Water Level	(m.bgl)	3.58
Oxygen in Air	(%)	21.3
Flow	(l/hour)	0.0

N.B. Methane Lower Explosive Limit - 5% Gas in Air

Table 3b