GROUND INVESTIGATION REPORT

for the site at

42 AVENUE ROAD, PRIMROSE HILL, LONDON NW8 6HS

on behalf of

GREENWAY ARCHITECTS C/O VINCENT RYMILL

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File Reference: Ground and Water/Project Files/ GWPR1330 42 Avenue Road, Primrose Hill		

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1.0 INTRODUCTION

1.1 General

Ground and Water Limited were instructed by Greenway Architects c/o Vincent Rymill, on the 29th June 2015 to undertake a Ground Investigation on 42 Avenue Road, Primrose Hill, London NW8 6HS. The scope of the investigation was detailed within the Ground and Water Limited fee proposal ref.: GWQ2510, dated 24th June 2015.

1.2 Aims of the Investigation

The aim of the investigation was understood to be to supply the client and their designers with information regarding the ground conditions underlying the site to assist them in preparing an appropriate scheme for development.

The investigation was to be undertaken to provide parameters for the design of foundations by means of in-situ and laboratory geotechnical testing undertaken on soil samples recovered from trial holes.

The requirements of the London Borough of Camden, Camden Geological, Hydrogeological and Hydrological Study, Guidance for Subterranean Development (November 2010) was reviewed with respect to this report.

A Desk Study and full scale contamination assessment were not part of the remit of this report.

The techniques adopted for the investigation were chosen considering the anticipated ground conditions and development proposals on-site, and bearing in mind the nature of the site, limitations to site access and other logistical limitations.

1.3 Conditions and Limitations

This report has been prepared based on the terms, conditions and limitations outlined within Appendix A.

2.0 SITE SETTING

2.1 Site Location

The site comprised an approximately 975m^2 (0.0975ha) rectangular shaped plot of land, orientated in a north-east to south-west direction, located on the north-eastern side of Avenue Road, ~20m north-east of its junction with Norfolk Road. The site was located in the Primrose Hill area of north-west London within the London Borough of Camden.

The national grid reference for the centre of the site was approximately TQ27076 83790. A site location plan is given within Figure 1. A plan showing the site area is given within Figure 2.

2.2 Site Description

At the time of reporting, January 2016, the site comprised a detached two storey property with roof accommodation and possible lower ground floor constructed as a semi-basement. A front tarmac surfaced parking area was accessed off Avenue Road via two sets of double gates. A rear garden was accessed via the existing building or via pathways adjacent to the property. A mature tree was noted close to the buildings on the boundary between No. 42 and No. 44. A further mature tree was noted on the pedestrian pathway adjacent to the site and Avenue Road.

An aerial view of the site is provided within Figure 3.

2.3 Proposed Development

At the time of reporting, January 2016, it is understood that the proposed development will comprise the installation of a car lift within the existing front forecourt and excavation of a sub-basement level to provide two car parking spaces. The sub-basement is anticipated to be formed at ~5.00m bgl.

2.4 Geology

The BGS Geological Map (Solid and Drift) for the North London area (Sheet No. 256), and Figure 3 and 4 of the Camden Geological, Hydrogeological and Hydrological Study, revealed that the site was underlain by the bedrock deposits of the London Clay Formation. An area of propensity for Head Deposits was noted beyond the eastern boundary of the site. No areas of Worked Ground or Made Ground were noted within a 250m radius of the site

Head Deposits

The majority of Head Deposits are clay-dominated, derived from the London Clay. Generally less than 2m thick, they probably accumulated in shallow mudslides of softened brecciated bedrock in the active layer. They consist of soft, ochreous brown silty clay with blue-grey mottling in places and angular, frost-shattered fragments of flint occur sporadically throughout. At the base of these deposits and interbedded in places, there is a bed of pebbly clay, generally less than 0.2m thick, with well-rounded flint pebbles derived from nearby outcrops of ‘high level’ gravel such as Stanmore Gravel.

London Clay Formation

The London Clay Formation comprises stiff grey fissured clay, weathering to brown near surface. Concretions of argillaceous limestone in nodular form (Claystones) occur throughout the formation. Crystals of Gypsum (Selenite) are often found within the weathered part of the London Clay Formation, and precautions against sulphate attack to concrete are sometimes required. The lowest part of the formation is a sandy bed with black rounded gravel and occasional layers of sandstone and is known as the Basement Bed.

A BGS borehole ~300m west of the site revealed 0.76m of Made Ground over a brown and grey mottled clay, becoming a dark brown clay with selenite crystals and claystones with depth.

2.5 Slope Stability and Subterranean Developments

The site was not situated within an area where a natural or man-made slope of greater than 7^{o} was present (Figure 16 Camden Geological, Hydrogeological and Hydrological Study).

Figure 17 of the Camden Geological, Hydrogeological and Hydrological Study indicated that the site was not situated within an area prone to landslides.

Figure 18 of the Camden Geological, Hydrogeological and Hydrological Study did not indicate any major subterranean infrastructure (including existing and proposed tunnels) within close proximity to the site.

2.6 Hydrogeology and Hydrology

A study of the aquifer maps on the Environment Agency website, and Figure 8 of the Camden Geological, Hydrogeological and Hydrological Study, revealed the site to be located on **Unproductive Strata** relating to the bedrock deposits of the London Clay Formation.

Superficial (Drift) deposits are permeable unconsolidated (loose) deposits, for example, sands and gravels. The bedrock is described as solid permeable formations e.g. sandstone, chalk and limestone.

Unproductive strata are rock layers with low permeability that have negligible significance for water supply or river base flow. These were formerly classified as non-aquifers.

Examination of the Environment Agency records, and Figure 8 of the Camden Geological, Hydrogeological and Hydrological Study, showed that the site **was** located within a Groundwater Source Protection Zone (SPZ – Outer Zone 2). An SPZ2 is defined by a 400 day travel time from a point below the water table. The previous methodology gave an option to define SPZ2 as the minimum recharge area required to support 25 per cent of the protected yield. This option is no longer available in defining new SPZs and instead this zone has a minimum radius of 250 or 500 metres around the source, depending on the size of the abstraction.

No surface water features were noted within a 250m radius of the site. The nearest surface water feature was a tributary of the River Thames located ~600m south-east of the site flowing in an overall easterly direction towards the River Thames.

Figure 11 of the Camden Geological, Hydrogeological and Hydrological Study indicated a former water course located ~200m west of the site, flowing in a southerly direction, suggesting it may have been culverted or backfilled.

From analysis of hydrogeological and topographical maps groundwater was anticipated to be encountered at moderate depth (>5m below existing ground level (bgl)) and it was considered that the groundwater was flowing in a southerly direction in alignment with the local topography, towards the River Thames.

Examination of the Environment Agency records showed that the site was **not** situated within flood zone or flood warning area.

2.7 Radon

BRE 211 (2015) Map 4 Hampshire, Berkshire and south Oxfordshire revealed the site **was not** located within an area where mandatory protection measures against the ingress of Radon were likely to be required. The site **was not** located within an area where a risk assessment was required.

3.0 FIELDWORK

3.1 Scope of Works

Fieldwork was undertaken on the 9th July 2015 and comprised the drilling of one Premier Window Sampler Borehole (BH1) to a depth of 15.45m bgl.

A groundwater monitoring standpipe was installed in BH1 to a depth of 7.00m bgl to enable the measurement of standing groundwater levels.

The construction of the well installed can be seen tabulated below.

Combined Bio-gas and Groundwater Monitoring Well Construction

Trial Hole	Depth of Installation (m bgl)	Thickness of slotted piping with gravel filter pack (m)	Depth of plain piping with bentonite seal (m bgl)	Piping external diameter (mm)
BH1	7.00	6.00	1.00	50

The approximate locations of the trial holes can be seen within Figure 4.

Prior to commencing the ground investigation, a walkover survey was carried out to identify the presence of underground services and drainage. Where underground services/drainage were suspected and/or positively identified, exploratory positions were relocated away from these areas.

Upon completion of the site works, the trial holes were backfilled and made good/reinstated in relation to the surrounding area.

3.2 Sampling Procedures

Small disturbed samples were recovered from the trial hole at the depths shown on the trial hole records. Soil samples were generally retrieved from each change of strata and/or at specific areas of concern. Samples were also taken at approximately 0.5m intervals during broad homogenous soil horizons.

A selection of samples were despatched for geotechnical testing purposes.

4.0 ENCOUNTERED GROUND CONDITIONS

4.1 Soil Conditions

All exploratory holes were logged by Philip Allvey of Ground and Water Limited generally in accordance with BS EN 14688 'Geotechnical Investigation and Testing – Identification and Classification of Soil'.

The ground conditions encountered within the trial hole constructed on the site generally conformed to that anticipated from examination of the geology map. Made Ground was noted to overlie Head Deposits, which was in turn were underlain by the bedrock deposits of the London Clay Formation.

The ground conditions encountered during the investigation are described in this section. For more complete information about the Made Ground, Head Deposits and the London Clay Formation at particular points, reference must be made to the individual trial hole logs within Appendix B.

The trial hole location plan can be viewed in Figure 4.

For the purposes of discussion the succession of conditions encountered in the trial holes in descending order can be summarised as follows:

Made Ground
Head Deposits
London Clay Formation

Made Ground

Made Ground was encountered from ground level underlying a 0.20m thick layer of Tarmac (over type 1 sub-base) to a depth of 0.60m bgl. These soils comprised a brown clayey gravelly sand to sandy gravelly clay. The gravel was occasional to abundant, fine to coarse, sub-angular to sub-rounded flint, brick and tile fragments.

Head Deposits

Soils described as representative of the Head Deposits were encountered underlying the Made Ground to a depth of 2.10m bgl. These soils comprised a brown to orange brown and grey mottled slightly gravelly silty clay. The gravel was rare to occasional, medium to coarse, sub-angular to sub-rounded flints.

London Clay Formation

Soils described as the London Clay Formation were encountered underlying the Head Deposits for the remaining depth of the borehole, a depth of 15.45m bgl. These soils were described as a brown, with some grey mottling, silty clay with shell fragments to 9.60m bgl. Orange sandy/silty pockets were noted at 5.50m bgl. From 9.60m bgl the deposits were described as a grey silty clay with light grey silty sand bands. Selenite crystals were noted throughout the deposits.

For details of the composition of the soils encountered at particular points, reference must be made to the individual trial hole logs within Appendix B.

4.2 Roots Encountered

Fine roots were noted to 1.80m bgl with traces of roots, most likely relic, noted at 3.50m and 5.70m bgl.

It must be noted that the chance of determining actual depth of root penetration through a narrow diameter borehole is low. Roots may be found to greater depths at other locations on the site, particularly close to trees and/or trees that have been removed both within the site and its close environs.

4.3 Groundwater Conditions

A groundwater seepage was encountered at 4.30m bgl.

Monitoring of the combined bio-gas and groundwater monitoring well installed in BH1 (installed to 7.00m bgl) by a Ground and Water Limited Engineer revealed a standing water level of 3.97m bgl on the 4th August 2015 and a standing water level of 1.60m bgl on 9th December 2015.

Changes in groundwater level occur for a number of reasons including seasonal effects and variations in drainage. Exact groundwater levels may only be determined through long term measurements from monitoring wells installed on-site. The investigation was undertaken between July and December 2015, when groundwater levels are likely to be rising towards their annual maximum (i.e. highest level).

Isolated pockets of groundwater may be perched within any Made Ground found at other locations around the site.

4.4 Obstructions

No artificial or natural sub-surface obstructions were noted during the drilling of the borehole.

5.0 INSITU AND LABORATORY GEOTECHNICAL TESTING

5.1 In-Situ Geotechnical Testing

Standard Penetration Testing (SPT's) was undertaken within BH1 at 1.0m intervals. The results of the SPT's have not been amended to take into account hammer efficiency, rod length and overburden pressure in accordance with Eurocode 7. The test results are presented on the borehole logs within Appendix B.

Windowless Sampler Boreholes provide samples of the ground for assessment but they do not give any engineering data. The standard penetration test (SPT) is an in-situ dynamic penetration test designed to provide information on the geotechnical engineering properties of soil. The test uses a thick-walled sample tube, with an outside diameter of 50 mm and an inside diameter of 35 mm, and a length of around 650mm. This is driven into the ground at the bottom of a borehole by blows from a slide hammer with a weight of 63.5 kg falling through a distance of 760 mm. The sample tube is driven 150 mm into the ground and then the number of blows needed for the tube to penetrate each 150 mm up to a depth of 450 mm is recorded. The sum of the number of blows is termed the "standard penetration resistance" or the "N-value".

The cohesive soils of the Head Deposits and London Clay Formation was classified based on the table below.

Undrained Shear Strength from Field Inspection/SPT "N" Blow Counts Cohesive Soils (EN ISO 14688-2:2004 & Stroud (1974))

Classification	Undrained Shear Strength (kPa)	Field Indications
Extremely High	>300	-
Very High	150 – 300	Brittle or very tough
High	75 – 150	Cannot be moulded in the fingers
Medium	40 – 75	Can be moulded in the fingers by strong pressure
Low	20 – 40	Easily moulded in the fingers
Very Low	10 – 20	Exudes between fingers when squeezed in the fist
Extremely Low	<10	-

An interpretation of the in-situ geotechnical testing results is given in the table below.

Interpretation of In-situ Geotechnical Testing Results

Strata	SPT "N" Blow Counts	Undrained Shear Strength kPa (based on Stroud, 1974)	Soil Type		Trial Hole/s
			Cohesive	Granular	
Head Deposits	11	55	Medium	-	BH1 (0.60 – 2.10m bgl)
London Clay Formation	11 – 33	55 – 165	Medium – Very High	-	BH1 (2.10 – 15.45m bgl)

It must be noted that field measurements of undrained shear strength are dependent on a number of variables including disturbance of sample, method of investigation and also the size of specimen or test zone etc.

The test results are presented on the trial hole logs within Appendix B.

5.2 Laboratory Geotechnical Testing

A programme of geotechnical laboratory testing, scheduled by Ground and Water Limited and carried out by K4 Soils Laboratory and QTS Environmental Limited, was undertaken on samples recovered from the Head Deposits and London Clay Formation. The results of the tests are presented in Appendix C.

The test procedures used were generally in accordance with the methods described in BS1377:1990.

Details of the specific tests used in each case are given below:

Standard Methodology for Laboratory Geotechnical Testing

Test	Standard	Number of Tests
Atterberg Limit Tests	BS1377:1990:Part 2:Clauses 3.2, 4.3 & 5	4
Swelling Test	BS1377:1990:Part 5:Clause 3 & 4	1
Water Soluble Sulphate & pH	BS1377:1990:Part 3:Clause 5	2
BRE Special Digest 1 (incl. Ph, Electrical Conductivity, Total Sulphate, W/S Sulphate, Total Chlorine, W/S Chlorine, Total Sulphur, Ammonium as NH4, W/S Nitrate, W/S Magnesium)	BRE Special Digest 1 “Concrete in Aggressive Ground (BRE, 2005).	2

5.2.1 Atterberg Limit Tests

A précis of Atterberg Limit Tests undertaken on one sample of the Head Deposits and three samples of the London Clay Formation can be seen tabulated below.

Atterberg Limit Tests Results Summary

Stratum/Depth	Moisture Content (%)	Passing 425 µm sieve (%)	Modified PI (%)	Soil Class	Consistency Index (Ic)	Volume Change Potential	
						NHBC	BRE
Head Deposits	16	90	25.20	CI	Very Stiff	Medium	Medium
London Clay Formation	23 – 30	90 – 100	44.00 – 48.00	CV	Stiff - Very Stiff	High	High

NB: NP – Non-plastic
BRE Volume Change Potential refers to BRE Digest 240 (based on Atterberg results)
Soil Classification based on British Soil Classification System.
Consistency Index (Ic) based on BS EN IS0 14688-2:2004.

5.2.2 Comparison of Soil’s Moisture Content with Index Properties

5.2.2.1 Liquidity Index Analyses

The results of the Atterberg Limit tests undertaken on one sample of the Head Deposits and three samples of the London Clay Formation were analysed to determine the Liquidity Index of the samples. This gives an indication as to whether the samples recovered showed a moisture deficit and their degree of consolidation. The results are tabulated below.

The test results are presented within Appendix C.

Liquidity Index Calculations Summary					
Stratum/Trial Hole/Depth	**Moisture Content (%)**	**Plastic Limit (%)**	**Modified Plasticity Index (%)**	**Liquidity Index**	**Result**
Head Deposits BH1/1.50m bgl Orangish brown mottled pale grey slightly sandy slightly gravelly silty CLAY. Gravel is fine to medium and angular to rounded.	16	16	25.20	0.00	Heavily Overconsolidated
London Clay Formation BH1/3.50m bgl Brown mottled bluish grey CLAY with traces of selenite.	30	27	48.00	0.06	Heavily Overconsolidated
London Clay Formation BH1/5.00m bgl Brown occasionally mottled bluish grey slightly silty CLAY.	28	26	44.00	0.05	Heavily Overconsolidated
London Clay Formation BH1/12.00m bgl Grey CLAY.	23	23	46.80	0.00	Heavily Overconsolidated

Liquidity Index testing revealed no evidence for moisture deficit within the heavily overconsolidated samples of the Head Deposits or London Clay Formation tested.

5.2.2.2 Liquid Limit

A comparison of the soil moisture content and the liquid limit can be seen tabulated below.

Moisture Content vs. Liquid Limit				
Strata/Trial Hole/Depth/Soil Description	**Moisture Content (MC) (%)**	**Liquid Limit (LL) (%)**	**40% Liquid Limit (LL)**	**Result**
Head Deposits BH1/1.50m bgl Orangish brown mottled pale grey slightly sandy slightly gravelly silty CLAY. Gravel is fine to medium and angular to rounded.	16	44	17.6	**MC < 0.4 x LL (Potentially significant moisture deficit)**
London Clay Formation BH1/3.50m bgl Brown mottled bluish grey CLAY with traces of selenite.	30	75	30.0	MC > 0.4 x LL (No significant moisture deficit)
London Clay Formation BH1/5.00m bgl Brown occasionally mottled bluish grey slightly silty CLAY.	28	70	28.0	MC > 0.4 x LL (No significant moisture deficit)
London Clay Formation BH1/12.00m bgl Grey CLAY.	23	75	30.0	**MC < 0.4 x LL (Potentially significant moisture deficit)**

The results in the table above indicated that a potential significant moisture deficit was present within one sample of the Head Deposits (BH1/1.50m bgl) and one sample of the London Clay Formation (BH1/12.00m bgl) tested. The moisture content values were below 40% of the liquid limit. The Head Deposits were described as an orangish brown mottled pale grey slightly sandy slightly gravelly silty clay. The sample of the London Clay Formation was described as a grey clay. Fine roots were noted to 1.80m bgl with traces of roots noted at 3.50m and 5.70m bgl. Consequently the apparent moisture deficit within the sample of the Head Deposit tested was likely to be related to a combination of the lithology of the soil (gravelly and heavily overconsolidated soils) and the water demand of roots from nearby trees. However the moisture deficit within the sample of the London Clay Formation is likely to be related to the lithology of the soil (heavily overconsolidated soils with selenite crystals) rather than the water demand of roots from nearby trees.

The remaining samples of the heavily overconsolidated London Clay Formation did not show a potential moisture deficit.

5.2.3 Swelling Test

A one dimensional Swelling Test was undertaken on a disturbed sample obtained from BH1 at a depth of 3.00m bgl.

The results of the test are tabulated below.

One Dimensional Consolidation Test - Swelling

Stratum/Depth		Height (mm)	Moisture Content (%)	Bulk Density (Mg/m^3)	Dry Density (Mg/m^3)	Void Ratio	Degree of Saturation (%)	Particle Density (Mg/m^3)	Swelling Pressure (kPa)
London Clay Formation BH1/3.00m bgl (Brown mottled bluish grey CLAY with traces of selenite and partings of orange silt)	Initial	15.80	11.2	1.76	1.58	0.691	43	2.68	45
	Final	16.32	34.7	2.07	1.53	0.747	125	-	-

It must be noted that the sample was remoulded and this must be taken into account in final design.

5.2.4 Sulphate and pH Tests

A sulphate and pH test was undertaken on one sample of the London Clay Formation (BH1/12.00m bgl). The sulphate concentration was 0.95g/l with a pH of 8.13.

5.2.5 BRE Special Digest 1

In accordance with BRE Special Digest 1 ‘Concrete in Aggressive Ground’ (BRE, 2005) one sample of the Head Deposits (BH1/2.00m bgl) and one sample of the London Clay Formation (BH1/6.00m bgl) were scheduled for laboratory analysis to determine parameters for concrete specification.

The results are given within Appendix C and a summary is tabulated overleaf.

Summary of Results of BRE Special Digest Testing			
Determinand	**Unit**	**Minimum**	**Maximum**
pH	-	7.8	8.2
Ammonium as NH_4	mg/kg	5.7	7.7
Sulphur	%	<0.02	0.47
Chloride (water soluble)	mg/kg	94	200
Magnesium (water soluble)	mg/l	11	160
Nitrate (water soluble)	mg/kg	<3	<3
Sulphate (water soluble)	mg/l	268	3190
Sulphate (total)	%	0.04	1.26

6.0 ENGINEERING CONSIDERATIONS

6.1 Soil Characteristics and Geotechnical Parameters

Based on the results of the intrusive investigation and geotechnical laboratory testing the following interpretations have been made with respect to engineering considerations.

- Made Ground was encountered from ground level underlying a 0.20m thick layer of Tarmac (over type 1 sub-base) to a depth of 0.60m bgl.

  As a result of the inherent variability of Made Ground 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 stratum of adequate bearing characteristics.

- Soils described as representative of the Head Deposits were encountered underlying the Made Ground to a depth of 2.10m bgl. These soils comprised a brown to orange brown and grey mottled slightly gravelly silty clay of medium undrained shear strength (55kPa).The gravel was rare to occasional, medium to coarse, sub-angular to sub-rounded flints.

  The soils of the Head Deposits were shown to have **medium volume change potential** in accordance with both BRE240 and NHBC Standards Chapter 4.2.

  Consistency Index calculations indicated the soils of Head Deposits to be very stiff. Liquidity Index testing revealed the soils to be heavily overconsolidated. Geotechnical analysis revealed a potential significant moisture deficit was present within one sample of the Head Deposits (BH1/1.50m bgl) tested, which was likely to be related to a combination of the lithology of the soil (gravelly and heavily overconsolidated soils) and the water demand of roots from nearby trees.

  The proposed development is understood to comprise the construction of a basement beneath the existing lower ground floor. It is therefore likely that the proposed construction will bypass the Head Deposits, which were noted to 2.10m bgl. Therefore these deposits have not been considered as a founding stratum for the site.

- Soils described as the London Clay Formation were encountered underlying the Head Deposits for the remaining depth of the borehole, a depth of 15.45m bgl. These soils were described as a brown, with some grey mottling, silty clay with shell fragments to 9.60m bgl. Orange sandy/silty pockets were noted at 5.50m bgl. From 9.60m bgl the deposits were described as a grey silty clay with light grey silty sand bands. Selenite crystals were noted throughout the deposits.

  In-situ testing indicated the soils to have medium to very high undrained shear strengths (55 – 165Kpa)

  The soils of the London Clay Formation were shown to have a **high** potential for volume change in accordance with both BRE240 and NHBC Standards Chapter 4.2. Consistency Index calculations indicated the soils of the London Clay Formation to be stiff to very stiff. Liquidity Index testing revealed the soils to be heavily overconsolidated. Geotechnical analysis revealed a potential moisture deficit present within one sample of the London Clay Formation (BH1/12.00m bgl) tested, resulting from the lithology of the soil (heavily overconsolidated soils with selenite crystals) rather than the water demand of roots from nearby trees. No potential significant moisture deficits were present within the remaining samples of London Clay Formation tested.

The soils of the London Clay Formation are heavily overconsolidated cohesive soils and are likely to be a suitable founding stratum for moderately loaded traditional strip/mat foundations. The settlements induced on loading are likely to be moderate.

The final design of foundations will need to take into account the volume change potential of the soil, the depth of root penetration and/or moisture deficit, depth to groundwater and the likely serviceability and settlement requirements of the proposed structure. These parameters for design are discussed in the next section of this report.

- Fine roots were noted to 1.80m bgl with traces of roots, most likely relic, noted at 3.50m and 5.70m bgl.

- A groundwater seepage was encountered at 4.30m bgl.

  Monitoring of the combined bio-gas and groundwater monitoring well installed in BH1 (installed to 7.00m bgl) by a Ground and Water Limited Engineer revealed a standing water level of 3.97m bgl on the 4th August 2015 and a standing water level of 1.60m bgl on 9th December 2015.

6.2 Basement Foundations

At the time of reporting, January 2016, it is understood that the proposed development will comprise the installation of a car lift with existing front forecourt and excavation of a sub-basement level to provide two car parking spaces. The sub-basement is anticipated to be formed at ~5.00m bgl.

The proposed development fell within Geotechnical Design Category 2 in accordance with Eurocode 7. The proposed foundation loads were not known to Ground and Water Limited at the time of reporting but are likely to range from 75 – 150kN/m^2.

The proposed development was understood not to involve any re-profiling of the site and its immediate environs. It is understood that no trees will be removed to facilitate the construction of the basement.

The soils of the Head Deposits were shown to have **medium volume change potential** in accordance with both BRE240 and NHBC Standards Chapter 4.2.

The soils of the London Clay Formation were shown to have a **high** potential for volume change in accordance with both BRE240 and NHBC Standards Chapter 4.2.

Foundations therefore must not be placed within cohesive root penetrated and/or desiccated soils and the influence of the trees surrounding the site must be taken into account. The base of foundation excavations must extend at least 300mm into non-root penetrated cohesive soils or soils showing no volume change potential (BRE240 and NHBC Standards Chapter 4.2). Foundations must also be designed in accordance with NHBC Standards Chapter 4.2 and the proximity of nearby trees or recently removed trees.

Where trees are mentioned in the text this means existing trees, recently removed trees (approximately 15 years to full recovery on cohesive soils) and those planned as part of the site landscaping. Should trees be removed from the footprint of the proposed building then an alternative foundation system, such as piles or isolated pads should be considered. Should trees be removed from the footprint of a proposed structure then consideration should be given to a piled foundation solution.

Fine roots were noted to 1.80m bgl. The root traces at 3.50m and 5.70m bgl were considered to be relic and therefore not likely to pose a risk to the serviceability of the proposed structure. Therefore the assumed minimum foundation depth of 5.00-5.50m bgl is considered suitable. Given the depth of the proposed foundation, the foundations will bypass both the Made Ground and Head Deposits to rest on the deposits of the London Clay Formation.

It is considered likely the proposed basement will be constructed with load bearing concrete retaining walls with semi-ground bearing concrete floors. The following bearing capacities could be adopted for 5.00m long by 0.75m and 1.00m wide retaining wall strip footings pads at a depth of 5.00m bgl and 5.50m bgl. The bearing capacities and settlements were determined based on BH1.

Limit State: Bearing Capacities Calculated (Based on BH1)		
Depth (m BGL)	**Foundation System**	**Limit Bearing Capacity (kN/m^2)**
5.00	5.00m by 0.75m Strip	1075.56
	5.00m by 1.00m Strip	1085.62
	1.50m by 1.50m Pad	1154.94
5.50	5.00m by 0.75m Strip	1079.65
	5.00m by 1.00m Strip	1089.70
	1.50m by 1.50m Pad	1159.03

Serviceability State: Settlement Parameters Calculated (Based on BH1)			
Depth (m BGL)	**Foundation System**	**Limit Bearing Capacity (kN/m^2)**	**Settlement (mm)**
5.00	5.00m by 0.75m Strip	300	<15
	5.00m by 1.00m Strip	300	<18
	1.50m by 1.50m Pad	300	<15
5.50	5.00m by 0.75m Strip	300	<14
	5.00m by 1.00m Strip	300	<17
	1.50m by 1.50m Pad	300	<14

It must be noted that a bearing capacity of less than 96kN/m^2 at 5.00m bgl and less than 105kN/m^2 at 5.50m bgl may result in heave of the underlying soils.

Excavations must be kept dry and either concreted or blinded as soon after excavation as possible. If water were allowed to accumulate on the formation for even a short time not only would an increase in heave occur resulting from the soil increasing in volume by taking up water, but also the shear strength and hence the bearing capacity would also be reduced.

General Recommendations for Spread Foundations:

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

- Inspection of foundation excavations, prior to concreting, must be made by a competent and suitably qualified person to check for any soft spots and to check for the presence of roots.

- Any groundwater or surface water ingress must be prevented from entering foundation trenches. Excavations must be kept dry and either concreted or blinded as soon after excavation as possible. If water were allowed to accumulate on the formation for even a short time not only would an increase in heave occur resulting from the soil increasing in volume by taking up water, but also the shear strength and hence the bearing capacity would also be reduced and this could result in increased settlements.

- Foundation excavations must be carefully bottomed out and any loose soil or soft spots removed prior to the foundation concrete or blinding being placed. Failure to ensure that foundation excavations are suitably bottomed out could result in additional settlements.

- Foundations must not be cast over foundations of former structures and/or other hard spots.

- Isolated Pad Foundations must be at least 1.5 times the width of the widest pad apart to keep to the anticipated settlements.

- Final designs for the foundations should be carried out by a suitably qualified Engineer based on the findings of this investigation and with reference to the anticipated loadings, serviceability requirements for the structure and the developments proximity to former, present and proposed trees.

A groundwater seepage was encountered at 4.30m bgl during site works. A standing groundwater level was noted in the standpipe installed in BH1 at 3.97m bgl on the 4th August 2015 and a standing water level of 1.60m bgl on 9th December 2015. The latter standing water reading may be due to the accumulation of water flowing through the Head Deposits into the borehole. From the readings taken it would suggest that groundwater water may accumulate within the Head Deposits and silty pockets within the London Clay Formation. **Dewatering therefore may be required during the excavation of the basement.** The advice of a reputable dewatering contractor, familiar with the type of ground and groundwater conditions encountered on this site, should be sought prior to finalising the design of the excavation for the basement.

If the construction works take place during the winter months, when the groundwater level is expected to be at its higher elevation, perched water could accumulate thus dewatering could be required to facilitate the construction and prevent the base of the excavation blowing before the slab was cast.

It is recommended that the well installed is dipped prior to commencement of construction to confirm the anticipated groundwater level.

The basement must be suitably tanked to prevent ingress of groundwater and also surface water run-off. The basement must also be designed to take into account pressure exerted by the presence of groundwater in and around the basement.

6.3 Piled Foundations

Based on the results of the investigation it was considered unlikely that a piled foundations scheme would be required at this site.

6.4 Basement Excavations and Stability

Shallow excavations in the Made Ground are likely to be marginally stable at best. Long, deep excavations, through these strata are likely to become unstable.

The excavation of the basement must not affect the integrity of the adjacent structures beyond the boundaries. The excavation must be supported by suitably designed retaining walls. It is considered unlikely that battering the sides of the excavation, casting the retaining walls and then backfilling to the rear of the walls would be suitable given the close proximity of the party walls.

The retaining walls for the basement will need to be constructed based on cohesive soils with an appropriate angle of shear resistance (*Φ'*) for the ground conditions encountered.

Based on the ground conditions encountered the following parameters could be used in the design of retaining walls. These have been designed based the results of geotechnical classification tests and reference to literature.

Retaining Wall/Basement Design Parameters

Strata	Unit Volume Weight (kN/m^3)	Cohesion Intercept (c') (kPa)	Angle of Shearing Resistance (Ø)	Ka	Kp
Made Ground	~15	0	15	0.59	1.70
Head Deposits	~20	0	20	0.49	2.04
London Clay Formation	~24	0	24	0.42	2.37

Unsupported earth faces formed during excavation may be liable to collapse without warning and suitable safety precautions should therefore be taken to ensure that such earth faces are adequately supported before excavations are entered by personnel.

A groundwater seepage was encountered at 4.30m bgl during site works. A standing groundwater level was noted in the standpipe installed in BH1 at 3.97m bgl on the 4th August 2015 and a standing water level of 1.60m bgl on 9th December 2015. The latter standing water reading may be due to the accumulation of water flowing through the Head Deposits into the borehole. From the readings taken it would suggest that groundwater may accumulate within the Head Deposits and silty pockets within the London Clay Formation.

Perched water may be encountered within the Made Ground, Head Deposits and silty pockets of the London Clay Formation especially after period of prolonged rainfall. This will need to be taken into account in final design.

6.5 Hydrogeological Effects

A study of the aquifer maps on the Environment Agency website, and Figure 8 of the Camden Geological, Hydrogeological and Hydrological Study, revealed the site to be located on **Unproductive Strata** relating to the bedrock deposits of the London Clay Formation.

The ground conditions encountered generally comprised a capping of Made Ground over Head Deposits, which was in turn underlain by the bedrock deposits of the London Clay Formation. Based on a visual appraisal of the soils encountered the permeability of the Made Ground, Head Deposits and London Clay Formation is likely to be low.

A groundwater seepage was encountered at 4.30m bgl during site works. A standing groundwater level was noted in the standpipe installed in BH1 at 3.97m bgl on the 4th August 2015 and a standing water level of 1.60m bgl on 9th December 2015. The latter standing water reading may be due to the accumulation of water flowing through the Head Deposits into the borehole. From the readings taken it would suggest that groundwater may accumulate within the Head Deposits and silty pockets within the London Clay Formation.

The advice of a reputable dewatering contractor, familiar with the type of ground and groundwater conditions encountered on this site, should be sought prior to finalising the design of the excavation for the basement.

Perched water may be encountered within the Made Ground, Head Deposits and silty pockets of the London Clay Formation especially after period of prolonged rainfall. This will need to be taken into account in final design.

If the construction works take place during the winter months, when the groundwater level is expected to be at its higher elevation, perched water could accumulate thus dewatering could be required to facilitate the construction and prevent the base of the excavation blowing before the slab was cast.

In relation to the basement, once constructed, the Made Ground, Head Deposits and London Clay Formation are unlikely to act as a porous medium for water to migrate, therefore additional drainage should be considered.

The basement must be suitably tanked to prevent ingress of groundwater and also surface water run-off. The basement must also be designed to take into account pressure exerted by the presence of groundwater in and around the basement.

6.6 Sub-Surface Concrete

Sulphate concentrations were measured in 2:1 water/soil extracts taken from the Head Deposits and London Clay Formation fell into class DS-1 – DS-4 of the BRE Special Digest 1, 2005, *'Concrete in Aggressive Ground'.*

Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of AC-3. For the classification given, the "mobile" and "natural" case was adopted given the geology, Head Deposits underlain by the London Clay Formation. The sulphate concentration in the samples ranged from 268 - 3190mg/l with a pH range of 7.8 – 8.2. The total potential sulphate concentrations ranged from 0.04 – 1.26%.

Concrete to be placed in contact with soil or groundwater must be designed in accordance with the recommendations of Building Research Establishment Special Digest 1, 2005, *'Concrete in Aggressive Ground'* taking into account the pH of the soils.

6.7 Surface Water Disposal

Infiltration tests were beyond the scope of the investigation.

Soakaway construction within the Head Deposits or London Clay Formation are unlikely to prove satisfactory due to negligible anticipated infiltration rates.

Consultation with the Environment Agency must be sought regarding any use that may have an impact on groundwater resources.

The principles of sustainable urban drainage system (SUDS) should be applied to reduce the risk of flooding from surface water ponding and collection associated with the construction of the basement.

6.8 Discovery Strategy

There may be areas of contamination that have not been identified during the course of the intrusive investigation. For example, there may have been underground storage tanks (UST's) not identified during the Ground Investigation for which there is no historical or contemporary evidence.

Such occurrences may be discovered during the demolition and construction phases for the redevelopment of the site.

Groundworkers should be instructed to report to the Site Manager any evidence for such contamination; this may comprise visual indicators, such as fibrous materials within the soil, discolouration, or odours and emission. Upon discovery advice must be taken from a suitably qualified person before proceeding, such that appropriate remedial measures and health and safety protection may be applied.

Should a new source of contamination be suspected or identified then the Local Authority will need to be informed.

6.9 Waste Disposal

The excavation of foundations is likely to produce waste which will require classification and then recycling or removal from site.

Under the Landfill (England and Wales) Regulations 2002 (as amended), prior to disposal all waste must be classified as;

- Inert;
- Non-hazardous, or;
- Hazardous.

The Environment Agency’s Hazardous Waste Technical Guidance (WM2) document outlines the methodology for classifying wastes.

Once classified the waste can be removed to the appropriately licensed facilities, with some waste requiring pre-treatments prior to disposal.

6.10 Imported Material

Any soil which is to be imported onto the site must undergo chemical analysis to prove that it is suitable for the purpose for which it is intended.

The Topsoil must be fit for purpose and must either be supplied with traceable chemical laboratory test certificates or be tested, either prior to placing (ideally) or after placing, to ensure that the human receptor cannot come into contact with compounds that could be detrimental to human health.

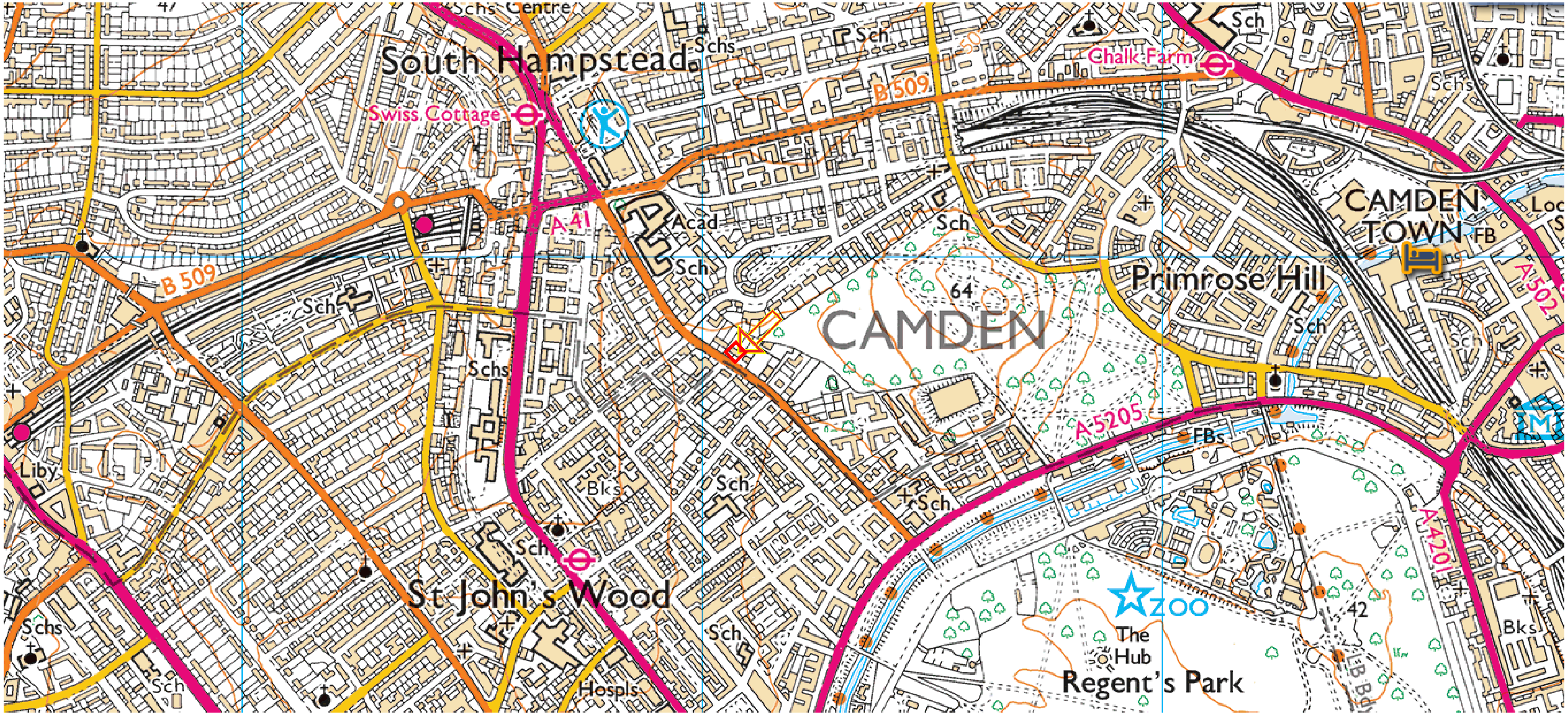
6.11 Duty of Care

Groundworkers must maintain a good standard of personal hygiene including the wearing of overalls, boots, gloves and eye protectors and the use of dust masks during periods of dry weather.

To prevent exposure to airborne dust by both the general public and construction personnel the site should be kept damp during dry weather and at other times when dust were generated as a result of construction activities.

The site should be securely fenced at all times to prevent unauthorised access. Washing facilities should be provided and eating restricted to mess huts.

N



NOT TO SCALE

APPROXIMATE SITE BOUNDARY

Project:

42 Avenue Road, Primrose Hill, London NW8 6HS

Client: Greenway Architects c/o Vincent Rymill	**Date:** January 2016
Site Location Plan	**Ref:** GWPR1330

Figure 1

ground&water

N

NOT TO SCALE

APPROXIMATE SITE BOUNDARY

Project:
42 Avenue Road, Primrose Hill, London NW8 6HS

Client:
Greenway Architects c/o Vincent Rymill

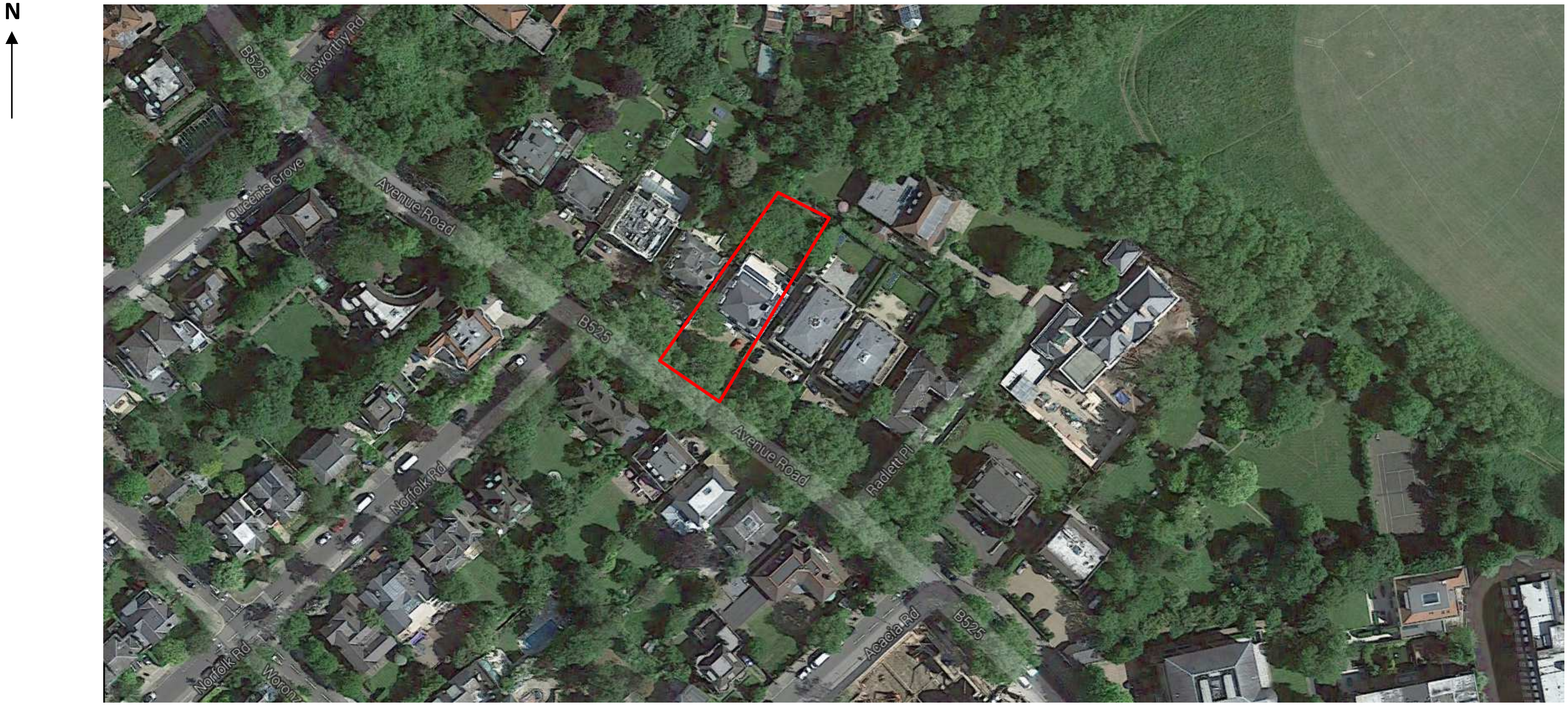
Date:
January 2016

Proposed Development Area

Ref:
GWPR1330

Figure 2

ground&water



NOT TO SCALE

APPROXIMATE SITE BOUNDARY

Project: 42 Avenue Road, Primrose Hill, London NW8 6HS	
Client: Greenway Architects c/o Vincent Rymill	**Date:** January 2016
Aerial View of the Site	**Ref:** GWPR1330

Figure 3

ground&water

🟥 **BORHOLE LOCATION (BH1)**

NOT TO SCALE

Project:
42 Avenue Road, Primrose Hill, London NW8 6HS

Client:
Greenway Architects c/o Vincent Rymill

Date:
January 2016

Trial Hole Location Plan

Ref:
GWPR1330

Figure 4

ground&water

APPENDIX A
Conditions and Limitations

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

The report has been prepared on the basis of information, data and materials which were available at the time of writing. Accordingly any conclusions, opinions or judgements made in the report should not be regarded as definitive or relied upon to the exclusion of other information, opinions and judgements.

The investigation, interpretations, and recommendations given in this report were prepared for the sole benefit of the client in accordance with their brief; as such these do not necessarily address all aspects of ground behaviour at the site. No liability is accepted for any reliance placed on it by others unless specifically agreed in writing.

Any decisions made by you, or by any organisation, agency or person who has read, received or been provided with information contained in the report (“you” or “the Recipient”) are decisions of the Recipient and we will not make, or be deemed to make, any decisions on behalf of any Recipient. We will not be liable for the consequences of any such decisions.

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

Any Recipient must take into account any other factors apart from the Report of which they and their experts and advisers are or should be aware. The information, data, conclusions, opinions and judgements set out in the report may relate to certain contexts and may not be suitable in other contexts. It is your responsibility to ensure that you do not use the information we provide in the wrong context.

This report is based on readily available geological records, the recorded physical investigation, the strata observed in the works, together with the results of completed site and laboratory tests. Whilst skill and care has been taken to interpret these conditions likely between or below investigation points, the possibility of other characteristics not revealed cannot be discounted, for which no liability can be accepted. The impact of our assessment on other aspects of the development required evaluation by other involved parties.

The opinions expressed cannot be absolute due to the limitations of time and resources within the context of the agreed brief and the possibility of unrecorded previous in ground activities. The ground conditions have been sampled or monitored in recorded locations and tests for some of the more common chemicals generally expected. Other concentrations of types of chemicals may exist. It was not part of the scope of this report to comment on environment/contaminated land considerations.

The conclusions and recommendations relate to 42 Avenue Road, Primrose Hill, London NW8 6HS.

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

The depth to roots and/or of desiccation may vary from that found during the investigation. The client is responsible for establishing the depth to roots and/or of desiccation on a plot-by-plot basis prior to the construction of foundations. Where trees are mentioned in the text this means existing trees, recently removed trees (approximately 15 years to full recovery on cohesive soils) and those planned as part of the site landscaping.

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

Recipients are not permitted to publish this report outside of their organisation without our express written consent.

APPENDIX B
Fieldwork Logs

Ground and Water Ltd
Tel: 0333 600 1221
email: enquiries@groundandwater.co.uk
www.groundandwater.co.uk

Project Name 42 Avenue Road	Project No. GWPR1330	Co-ords: -	Borehole No **BH1** Sheet 1 of 2
Location: Primrose Hill, London NW8 6HS		Level: -	Hole Type WLS
			Scale 1:50
Client: Greenway Architects c/o Vincent & Rymill		Dates: 09/07/2015	Logged By PA

Samples & In Situ Testing

Depth (m)	Type	Results
0.30	D	
0.50	D	
0.80	D	
1.00	SPT	N=11 (2,3/ 2,3,3,3)
1.00	D	
1.50	D	
2.00	SPT	N=14 (2,2/ 3,3,4,4)
2.00	D	
2.50	D	
3.00	SPT	N=11 (2,2/ 2,3,3,3)
3.00	D	
3.50	D	
4.00	SPT	N=15 (3,3/ 4,4,3,4)
4.00	D	
4.50	D	
5.00	SPT	N=20 (4,4/ 5,5,5,5)
5.00	D	
5.50	D	
6.00	SPT	N=20 (5,5/ 5,5,5,5)
6.00	D	
6.50	D	
7.00	SPT	N=23 (5,5/ 5,6,6,6)
7.00	D	
7.50	D	
8.00	SPT	N=21 (4,5/ 5,5,6,5)
8.00	D	
8.50	D	
9.00	SPT	N=18 (4,5/ 4,4,5,5)
9.00	D	
9.50	D	

Water Strikes: ▽ (4.30)

Depth (m)	Level (m AOD)	Stratum Description
0.20		MADE GROUND: TARMAC/TYPE ONE
0.60		MADE GROUND: Brown clayey gravelly sand to sandy gravelly clay. Sand is fine to medium grained. Gravel is occasional to abundant, fine to coarse, sub-angular to sub-rounded flint, brick and tile fragments.
2.10		HEAD DEPOSITS: Brown/brown orange and grey mottled slightly gravelly silty CLAY. Gravel is rare to occasional, medium to coarse grained, sub-angular to sub-rounded flint.
9.60		LONDON CLAY FORMATION: Brown, with some grey mottling, silty CLAY. Shell fragments and selenite crystals noted. Orange sandy silty pockets noted at 5.50m bgl.
		LONDON CLAY FORMATION: Grey CLAY with light grey silty pockets

Continued next sheet

Remarks: Fine roots noted to 1.80m bgl. Traces of roots noted at 3.50m and 5.70m bgl.
Water seepage noted at 4.30m bgl.

ground &water
geotechnical and environmental consultants

Ground and Water Ltd
Tel: 0333 600 1221
email: enquiries@groundandwater.co.uk
www.groundandwater.co.uk

Project Name 42 Avenue Road	Project No. GWPR1330	Co-ords: -	Borehole No **BH1** Sheet 2 of 2
			Hole Type WLS
Location: Primrose Hill, London NW8 6HS		Level: -	Scale 1:50
Client: Greenway Architects c/o Vincent & Rymill		Dates: 09/07/2015	Logged By PA

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description
		Depth (m)	Type	Results				
		10.00	SPT	N=22				and occasional selenite crystals.
		10.00	D	(5,5/ 5,6,5,6)				
		10.50	D					
		11.00	SPT	N=25				
		11.00	D	(5,6/ 6,6,6,7)				
		11.50	D					
		12.00	SPT	N=30				
		12.00	D	(5,5/ 6,7,8,9)				
		12.50	D					
		13.00	SPT	N=28				
		13.00	D	(5,6/ 6,7,7,8)				
		13.50	D					
		14.00	SPT	N=33				
		14.00	D	(5,5/ 7,8,9,9)				
		14.50	D					
		15.00	SPT	N=31				
		15.00	D	(6,6/ 6,7,8,10)				
					15.45			End of Borehole at 15.45 m
			Type	Results				

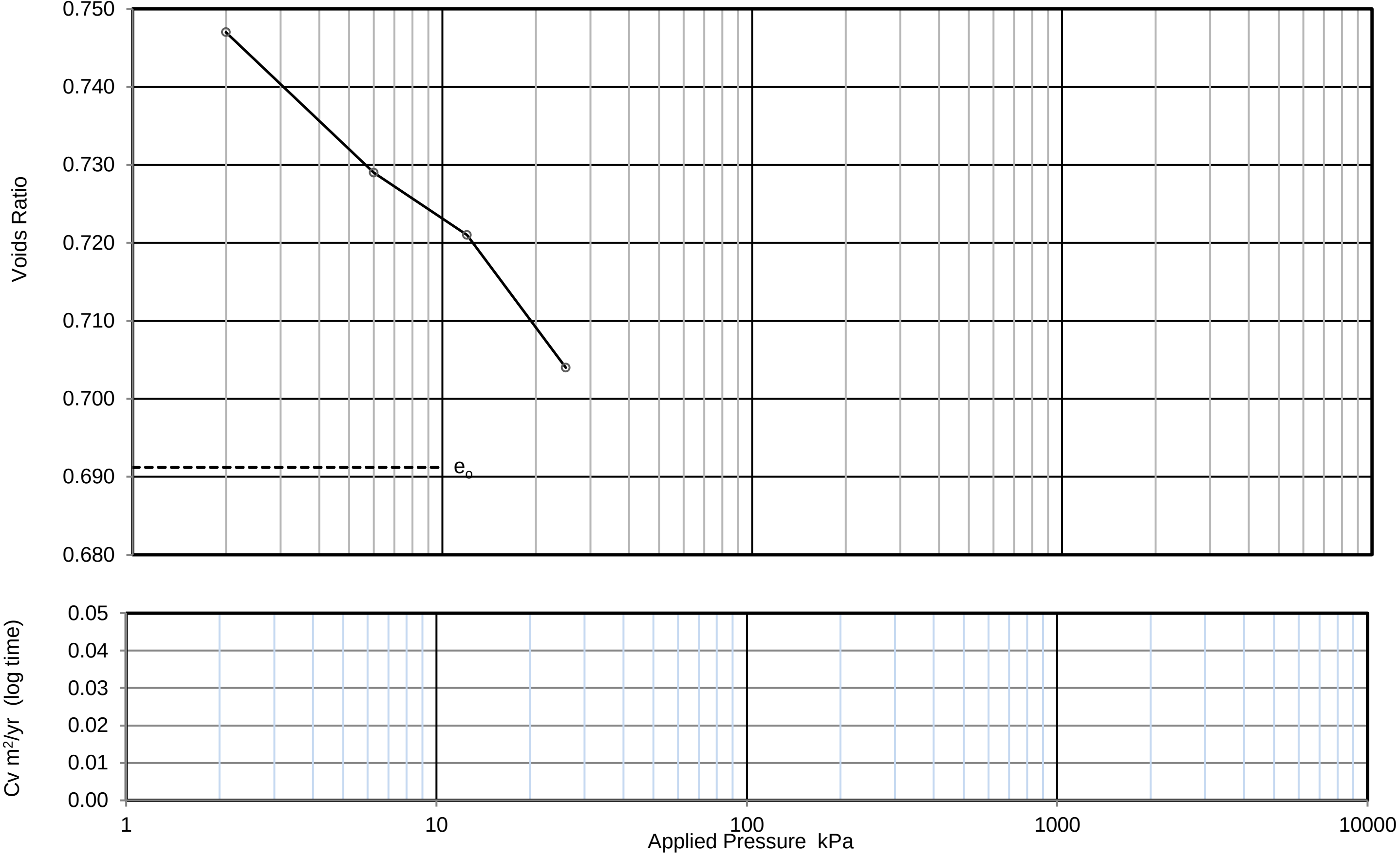
Remarks: Fine roots noted to 1.80m bgl. Traces of roots noted at 3.50m and 5.70m bgl.
Water seepage noted at 4.30m bgl.

AGS

APPENDIX C
Geotechnical Laboratory Test Results

ONE DIMENSIONAL CONSOLIDATION TEST

				Job Ref	19298
				Borehole/Pit No.	BH1
Site Name	42 Avenue Road, Primrose Hill, NW8 6HS			Sample No.	
Project ID	1330	Client	Ground and Water Ltd	Depth	3.00
Soil Description	Brown mottled bluish grey CLAY with traces of selenite and partings of orange silt			Sample Type	D
				Sample Received	30/07/2015
				Schedule received	31/07/2015
				Project Started	07/08/2015
Test Method	BS1377:Part 5:1990, clause 3			Date Test started	10/08/2015



Applied Pressure kPa	Voids ratio	Mv m2/MN	Cv (t50, log) m2/yr	Cv (t90, root) m2/yr	Csec
45.0	0.691	-	-	-	-
25	0.704	0.37			
12	0.721	0.79			
6	0.729	0.73			
2	0.747	2.6			

Preparation

Orientation wthin sample Vertical

Particle density assumed 2.68 Mg/m3

Specimen details	Initial	Final	
Diameter	74.86	-	mm
Height	15.80	16.32	mm
Moisture Content	11.2	34.7	%
Bulk density	1.76	2.07	Mg/m3
Dry density	1.58	1.53	Mg/m3
Voids Ratio	0.691	0.747	
Saturation	43	125	%
Average temperature for test			oC
Swelling Pressure	45		kPa
Settlement on saturation			%

Remarks

Test Report by K4 SOILS LABORATORY
Unit 8 Olds Close Olds Approach
Watford Herts WD18 9RU
Tel: 01923 711 288
Email: James@k4soils.com

Checked and Approved

Initials K.P

Date: 25/08/2015

UKAS TESTING 2519

Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)

Summary of Classification Test Results

Job No.	Project Name	Programme	
19298	42 Avenue Road, Primrose Hill, NW8 6HS	Samples received	30/07/2015
		Schedule received	30/07/2015
Project No.	**Client**	Project started	31/07/2015
1330	Ground and Water Ltd	Testing Started	17/08/2015

Hole No.	Sample				Soil Description	NMC	Passing 425µm	LL	PL	PI	Remarks
	Ref	Top	Base	Type		%	%	%	%	%	
BH1		1.50		D	Orangish brown mottled pale grey slightly sandy slightly gravelly silty CLAY (gravel is fm angular to rounded)	16	90	44	16	28	
BH1		3.50		D	Brown mottled bluish grey CLAY with traces of selenite	30	100	75	27	48	
BH1		5.00		D	Brown occsaionally mottled bluish grey slightly silty CLAY	28	100	70	26	44	
BH1		12.00		D	Grey CLAY	23	90	75	23	52	

Test Methods: BS1377: Part 2: 1990:
Natural Moisture Content : clause 3.2
Atterberg Limits: clause 4.3 and 5.0

Test Report by K4 SOILS LABORATORY
Unit 8 Olds Close Olds Approach
Watford Herts WD18 9RU

Tel: 01923 711 288
Email: James@k4soils.com

Checked and Approved

Initials **J.P**

Date: 19/08/2015

UKAS TESTING
2519

Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)

Sulphate Content (Gravimetric Method) for 2:1 Soil: Water Extract and pH Value - Summary of Results
Tested in accordance with BS1377 : Part 3 : 1990, clause 5.3 and clause 9

Job No.	Project Name	Programme	
19298	42 Avenue Road, Primrose Hill, NW8 6HS	Samples received	30/07/2015
		Schedule received	30/07/2015
Project No.	Client	Project started	31/07/2015
1330	Ground and Water Ltd	Testing Started	18/08/2015

Hole No.	Sample				Soil description	Dry Mass passing 2mm %	SO3 Content g/l	SO4 Content g/l	pH	Remarks
	Ref	Top	Base	Type						
BH1		12.00		D	Grey CLAY	100	0.79	0.95	8.13	

UKAS TESTING
2519

Test Report by K4 SOILS LABORATORY
Unit 8 Olds Close Olds Approach
Watford Herts WD18 9RU
Tel: 01923 711 288
Email: James@k4soils.com

Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)

Checked and Approved
Initials J.p
Date: 19/08/2015

Phil Allvey
Ground & Water Ltd
2 The Long Barn
Norton Farm
Selborne Road
Alton
Hampshire
GU34 3NB

QTS Environmental Ltd
Unit 1
Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Kent
ME17 2JN
t: 01622 850410
russell.jarvis@qtsenvironmental.com

QTS Environmental Report No: 15-33993

Site Reference:	42 Avenue Road, Primrose Hill, NW8 6HS
Project / Job Ref:	GWPR1330
Order No:	None Supplied
Sample Receipt Date:	29/07/2015
Sample Scheduled Date:	29/07/2015
Report Issue Number:	1
Reporting Date:	04/08/2015

Authorised by:

Russell Jarvis
Director
On behalf of QTS Environmental Ltd

Authorised by:

Kevin Old
Director
On behalf of QTS Environmental Ltd

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

Soil Analysis Certificate						
QTS Environmental Report No: 15-33993	**Date Sampled**	09/07/15	09/07/15			
Ground & Water Ltd	**Time Sampled**	None Supplied	None Supplied			
Site Reference: 42 Avenue Road, Primrose Hill, NW8 6HS	**TP / BH No**	BH1	BH2			
Project / Job Ref: GWPR1330	**Additional Refs**	None Supplied	None Supplied			
Order No: None Supplied	**Depth (m)**	2.00	6.00			
Reporting Date: 04/08/2015	**QTSE Sample No**	159892	159893			

Determinand	**Unit**	**RL**	**Accreditation**					
pH	pH Units	N/a	**MCERTS**	8.2	7.8			
Total Sulphate as SO_4	mg/kg	< 200	NONE	431	12570			
Total Sulphate as SO_4	%	< 0.02	NONE	0.04	1.26			
W/S Sulphate as SO_4 (2:1)	mg/l	< 10	**MCERTS**	268	3190			
Total Sulphur	%	< 0.02	NONE	< 0.02	0.47			
Ammonium as NH_4	mg/kg	< 0.5	NONE	5.7	7.7			
W/S Chloride (2:1)	mg/kg	< 1	**MCERTS**	94	200			
Water Soluble Nitrate (2:1) as NO_3	mg/kg	< 3	**MCERTS**	< 3	< 3			
W/S Magnesium	mg/l	< 0.1	NONE	11	160			

Analytical results are expressed on a dry weight basis where samples are dried at less than 30^{O}C
Analysis carried out on the dried sample is corrected for the stone content
Subcontracted analysis $^{(S)}$

Soil Analysis Certificate - Sample Descriptions

QTS Environmental Report No: 15-33993
Ground & Water Ltd
Site Reference: 42 Avenue Road, Primrose Hill, NW8 6HS
Project / Job Ref: GWPR1330
Order No: None Supplied
Reporting Date: 04/08/2015

QTSE Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
$ 159892	BH1	None Supplied	2.00	14.6	Light brown clay
$ 159893	BH2	None Supplied	6.00	19.1	Brown clay

Moisture content is part of procedure E003 & is not an accredited test
Insufficient Sample $^{I/S}$
Unsuitable Sample $^{U/S}$

$ samples exceeded recommended holding times

Soil Analysis Certificate - Methodology & Miscellaneous Information

QTS Environmental Report No: 15-33993
Ground & Water Ltd
Site Reference: 42 Avenue Road, Primrose Hill, NW8 6HS
Project / Job Ref: GWPR1330
Order No: None Supplied
Reporting Date: 04/08/2015

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

D	**Dried**
AR	**As Received**