GROUND INVESTIGATION REPORT

for the site at

14 ROSECROFT AVENUE, HAMPSTEAD, LONDON NW3 7QB

on behalf of

VINCENT AND RYMILL

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File Reference: Ground and Water/Project Files/ GWPR1540 14 Rosecroft Avenue, Hampstead, London		

CONTENTS

FIGURES

APPENDICES

1.0 INTRODUCTION

1.1 General

Ground and Water Limited were instructed by Vincent and Rymill on the 15th January 2016 to undertake a Ground Investigation at 14 Rosecroft Avenue, Hampstead, London NW3 7QB. The scope of the investigation was detailed within the Ground and Water Limited fee proposal ref: GWQ2734 dated 14th January 2016.

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.

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 a ~520m^2 rectangular shape plot of land, orientated in a west to east direction, located on the eastern side of Rosecroft Avenue, ~70m north of its junction with Hollycroft Avenue. The site was located in the Childs Hill/Hampstead area of north-west London.

The national grid reference for the centre of the site was approximately TQ 25517 86160. A site location plan is given within Figure 1. A plan showing the boundary of the site is provided in Figure 2.

2.2 Site Description

The site comprised a semi-detached two storey brick built structure, with roof accommodation, set into a southerly slope. A lower ground floor garage structure was noted beneath the front of the southern portion of the site with a concrete driveway onto Rosecroft Avenue. A paved front garden, with steps, was noted to front the property, with the ground floor level of the property ~2.0 – 2.5m higher than Rosecroft Avenue. The rear garden of the property was accessed via the existing building only. An aerial view of the site is provided within Figure 3.

2.3 Proposed Development

At the time of reporting, March 2016, the proposed development is understood to comprise the construction of a lower ground floor beneath the remaining footprint of the structure. The basement will be formed at ~3.00 – 3.50m below ground floor level, a similar level to the existing garage. A plan showing the proposed development can be seen in Figure 4.

2.4 Geology

The BGS Geological Map (Solid and Drift) for the North London area (Sheet No. 256) revealed that the site was underlain by the Bagshot Formation overlying the Claygate Member of the London Clay Formation.

Bagshot Formation

Bagshot Beds comprise mainly fine to medium grained yellow, pink and brown sand with ferruginous concretions. Beds of grey clay "pipe clay" occur frequently as do beds of black flint gravel.

Claygate Member of the London Clay Formation

The Claygate Member of the London Clay Formation comprises alternating layers of clayey sand and sandy clays. The sands usually overlie the clays. The clays are typically brown to mauve mottled and are overconsolidated. The bed is transitional and overlays the undivided London Clay Formation. It has been used extensively for brick making.

A BGS borehole in similar geology ~1.2km south-east of the site revealed 0.60 – 0.90m of Topsoil/Made Ground to overlie a yellow/brown fine sand with clay pockets to 5.10 – 5.30m bgl and then laminated grey sandy clays and orange brown silty sands.

No areas of Made Ground or Worked Ground were noted within a 250m radius of the site.

2.6 Hydrogeology and Hydrology

A study of the aquifer maps on the Environment Agency website revealed the site to be located on **Secondary (A) Aquifer** relating to the bedrock deposits of the Bagshot Formation and the Claygate Member of the London Clay Formation. No designation was given for any superficial deposits due to their likely absence.

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.

Secondary aquifers include a wide range of drift deposits with an equally wide range of water permeability and storage capacities. Secondary (A) Aquifers consist of deposits with permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as Minor Aquifers.

Examination of the Environment Agency records showed that the site did not fall within a Groundwater Source Protection (SPZ) as classified in the Policy and Practice for the Protection of Groundwater.

No surface water features were noted within a 250m radius of the site.

From analysis of hydrogeological and topographical maps groundwater was anticipated to be encountered at moderate depth (3 – 6m below existing ground level (bgl)) and it was considered that the groundwater was flowing in a south-westerly direction in alignment with local topography.

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 5 of the London, Sussex and west Kent area revealed the site was located within an area where mandatory protection measures against the ingress of Radon were **unlikely 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 22nd January 2016 and the 1st February 2016 and comprised the drilling of one Terrier Windowless Sampler Borehole (WS1) to a depth of 6.00m below lower ground level (blgl), the drilling of one Hand Held Window Sampler Borehole (WS2) to a depth of 6.00m below ground level (bgl) and the hand excavation of two trial pit foundation exposures (TP/FE1 and TP/FE2) to a depth of 0.70m – 1.20m bgl. Standard Penetration Testing was undertaken in WS1 at 1.00m intervals. A Super Heavy Dynamic Probe (SHDP) (DP1) was undertaken through the base of WS1 to a depth of 10.00m blgl.

WS1 was drilled from the level of the driveway located to the front of the property, ~2.40m below the ground floor of the existing property. WS2 was drilled to the rear of the property at ground level.

A small diameter combined bio-gas and groundwater monitoring well was installed within WS1 to 5.00m blgl. 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 blgl)**	**Thickness of slotted piping with gravel filter pack (m)**	**Depth of plain piping with bentonite seal (m blgl)**	**Piping external diameter (mm)**
WS1	5.00	4.00	1.00	63

The approximate location of the trial holes can be seen within Figure 5.

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 holes 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 Megan James 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 holes constructed on the site generally conformed to that anticipated from examination of the geology map. Made Ground was noted to overlie Head Deposits over the Bagshot Formation and the Claygate Member 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, Bagshot Formation and the Claygate Member of 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 5.

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

Made Ground
Head Deposits (WS1, WS2 and TP/FE2)
Bagshot Formation (WS1 and WS2)
Claygate Member of the London Clay Formation (WS1 and WS2)

Made Ground

Made Ground was encountered from ground level within all trial holes to a proved depth of 0.20m blgl within WS1, to 0.70m bgl within WS2 and TP/FE2 and for the full depth of TP/FE1, a maximum of 1.20m bgl.

The Made Ground generally comprised paving/concrete from ground level to 0.14 – 0.20m bgl/blgl within all trial holes with crushed brick and concrete noted to extend to 0.40m bgl within TP/FE1. Within WS1, TP/FE1 and TP/FE2 the underlying Made Ground generally comprised a brown gravelly sandy silty clay to clayey sand and gravel. The sand was fine to coarse grained. The gravel was occasional to abundant, fine to medium, sub-angular to sub-rounded concrete, brick and flint. From 0.75m, and for the remaining depth of TP/FE1, and from 0.55m to 0.70m bgl within WS2 and TP/FE2, the Made Ground was described as a dark brown/black gravelly sand. The sand was fine to coarse grained. The gravel was abundant, fine, sub-angular to sub-rounded carbonaceous material (ash/coal).

Head Deposits

Soils described as representative of Head Deposits were encountered underlying the Made Ground to a proved depth of 1.40m blgl/bgl within WS1 and WS2 and for the remaining depth of TP/FE2, a maximum of 1.20m bgl.

The Head Deposits were noted to comprise a red/orange brown and grey brown mottled sandy gravelly silty clay. The sand was fine to medium grained. The gravel was occasional, fine to coarse, sub-angular to rounded flint.

Bagshot Formation
Deposits of the Bagshot Formation were encountered underlying the Head Deposits within WS1 and WS2 to a proved depth of 2.20m blgl/bgl. The soils were noted to comprise a light to orange brown very sandy clay to clayey sand. The sand was fine grained.

Claygate Member of the London Clay Formation
From 2.20m blgl/bgl, and for the remaining depth of WS1 and WS2, a maximum of 6.00m blgl/bgl, soils described as representative of the Claygate Member of the London Clay Formation were encountered. The deposits were described as orange brown, with local grey brown mottling, alternating layers of very sandy silty clay and clayey sand. The sand was fine grained.

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

4.2 Foundation Exposures

A description of the foundation layout and ground conditions encountered within the hand dug trial pit foundation exposures are given within this section of the report.

TP/FE1
Trial pit foundation exposure TP/FE1 was hand excavated from ground level at the front of the property. The exact location of the trial hole can be seen in Figure 5 with a section drawing of the foundations encountered in Figure 6.

The foundation layout encountered consisted of a brick wall to ground level. The brick wall continued from ground level to a depth of 0.525m bgl and was noted to rest upon three brick steps which were each 0.075m in thickness and stepped out by 0.06m. The brick steps rested upon a poor grade lean mix at 0.75m bgl. The final depth of the poor grade lean mix could not be determined due to its depth (>1.20m bgl). The ground conditions encountered directly surrounding the foundation are shown in Figure 6 and described in Section 4.1.

TP/FE2
Trial pit foundation exposure TP/FE2 was hand excavated from ground level at the rear of the property. The exact location of the trial hole can be seen in Figure 5 with a section drawing of the foundations encountered in Figure 7.

The foundation layout encountered consisted of a brick wall to ground level. The brick wall continued from ground level to a depth of 0.34m bgl and was noted to rest upon three brick steps which were each 0.07m in thickness and stepped out by 0.04m. The brick steps rested upon a poor grade lean mix at 0.55m bgl which was 0.15m in thickness. The poor grade lean mix was noted to rest upon the soils of the Bagshot Formation comprising a red/orange brown and grey brown mottled sandy gravelly silty clay at 0.75m bgl. The ground conditions encountered directly surrounding the foundation are shown in Figure 7 and described in Section 4.1.

4.3 Roots Encountered

Roots were noted to 1.00m bgl within WS2. No roots were observed in the remaining trial holes.

It must be noted that the chance of determining actual depth of root penetration through narrow diameter trial holes 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.

4.4 Groundwater Conditions

Groundwater was encountered within the 4.00m and 5.00m blgl run within WS1. No groundwater was encountered within WS2. The standing groundwater level noted during a return visit to the site on the 03/03/2016 can be seen tabulated below.

WS1 was drilled from the level of the driveway in front of the property, ~2.40m below the ground floor of the existing property. WS2 was constructed to the rear of the property at ground level.

Groundwater Observations					
Project Ref	**Site Location**	**Borehole Ref.**	**Groundwater reading (m blgl)**	**Depth to base of borehole (m blgl)**	**Date**
GWPR1540	14 Rosecroft Avenue	WS1	3.30	3.90	03/03/2016

Exact groundwater levels may only be determined through long term measurements from monitoring wells installed on-site. It should be noted that changes in groundwater level do occur for a number of reasons including seasonal effects and variations in drainage.

The site investigation was conducted in February and March 2016, when groundwater levels should be falling from their annual maximum (i.e. highest). The long-term groundwater elevation might increase at some time in the future due to seasonal fluctuation in weather conditions. Isolated pockets of groundwater may be perched within any Made Ground found at other locations around the site.

4.5 Obstructions

No artificial or natural sub-surface obstructions were noted during construction of the trial holes.

5.0 INSITU AND LABORATORY GEOTECHNICAL TESTING

5.1 In-Situ Geotechnical Testing

Standard Penetration Testing (SPT) was undertaken within WS1 at 1.00m intervals to a depth of 6.00m blgl. The results of the SPT's have not been amended to take into account hammer efficiency, rod lengths and overburden pressure in accordance with Eurocode 7. A Super Heavy Dynamic Probe (SHDP) (DP1) was undertaken through the base of WS1 to a depth of 10.00m blgl.

Window and 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".

Super Heavy Dynamic Probing involves the driving of a metal cone into the ground via a series of steel rods. These rods are driven from the surface by a hammer system that lifts and drops a 63.5kg hammer onto the top of the rods through a set height, thus ensuring a consistent energy input. The number of hammer blows that are required to drive the cone down by each 100mm increment are recorded. These blow counts then provide a comparative assessment from which correlations have been published, based on dynamic energy, which permits engineering parameters to be generated. *(The Dynamic Probe 'Super Heavy' (SHDP) Tests were conducted in accordance with BS 1377; 1990; Part 9, Clause 3.2).*

The granular soils of the Claygate Member of the London Clay Formation were classified based on the table below.

Correlation between normalised SPT blow counts $(N_1)_{60}$ or equivalent 'SPT's derived from SHDP results and granular classification.	
Classification	**Equivalent SPT Blow Counts (N1)**
Extremely Dense	>58
Very Dense	42 – 58
Dense	25 – 42
Medium	8 – 25
Loose	3 – 8
Very Loose	0 – 3

The cohesive soils of the Claygate Member of the London Clay Formation were classified based on the table overpage.

Undrained Shear Strength from Field Inspection/ SPT blow counts $(N_1)_{60}$ or equivalent 'SPT's derived from SHDP results. 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 (SPT) (SHDP)					
Strata	**SPT "N" Blow Counts/Equivalent SPT "N" Blow Counts derived from SHDP**	**Equivalent Undrained Shear Strength (kPa) Cohesive Soils**	**Soil Type**		**Trial Hole/s**
			Cohesive	**Granular**	
Granular Claygate Member of the London Clay Formation	9 - 17	-	-	Medium Dense	WS1 (2.20 – 3.60m blgl) WS1 (4.80 – 5.70m blgl)
Cohesive Claygate Member of the London Clay Formation	9	45	Medium	-	WS1 (3.60 – 4.80m blgl) WS1 (5.70 – 6.00m blgl)
Assumed Cohesive Claygate Member of the London Clay Formation*	10 - 29	50 - 145	Medium - High	-	DP1 (6.00 – 10.00m blgl)

*Based on results of dynamic probing

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 Bagshot Formation and the Claygate Member of the 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 overpage.

Standard Methodology for Laboratory Geotechnical Testing		
Test	**Standard**	**Number of Tests**
Atterberg Limit Tests	BS1377:1990:Part 2:Clauses 3.2, 4.3 & 5	2
Particle Size Distribution	BS1377:1990:Part 2:Clause 9	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 two cohesive samples of the Claygate Member of the London Clay Formation can be seen tabulated below.

Atterberg Limit Tests Results Summary							
Stratum/Trial Hole/Depth (m blgl/bgl)	**Moisture Content (%)**	**Passing 425 µm sieve (%)**	**Modified PI (%)**	**Soil Class**	**Consistency Index (Ic)**	**Volume Change Potential**	
						BRE	**NHBC**
Claygate Member of the London Clay Formation WS1/4.00m blgl	30	100	14.00	MI	Firm	Low	Low
Claygate Member of the London Clay Formation WS2/3.50m bgl	20	100	21.00	CI	Stiff	Medium	Medium

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 ISO 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 two cohesive samples of the Claygate Member 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 overpage.

The test results are presented within Appendix C.

Liquidity Index Calculations Summary					
Stratum/Trial Hole/Depth (m bgl/blgl)	Moisture Content (%)	Plastic Limit (%)	Modified Plasticity Index (%)	Liquidity Index	Result
Claygate Member of the London Clay Formation WS1/4.00m blgl (Orangish brown and orange sandy very silty CLAY)	30	25	14.00	0.36	Overconsolidated
Claygate Member of the London Clay Formation WS2/3.50m bgl (Brown sandy silty CLAY)	20	19	21.00	0.05	Heavily Overconsolidated

The cohesive samples of the Claygate Member of the London Clay Formation were shown to be overconsolidated to heavily overconsolidated and showed no evidence for a potential moisture deficit.

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 (m bgl/blgl)/Soil Description	Moisture Content (MC) (%)	Liquid Limit (LL) (%)	40% Liquid Limit (LL)	Result
Claygate Member of the London Clay Formation WS1/4.00m blgl (Orangish brown and orange sandy very silty CLAY)	30	39	15.6	MC > 0.4 x LL (Not Significantly Desiccated)
Claygate Member of the London Clay Formation WS2/3.50m bgl (Brown sandy silty CLAY)	20	40	16.0	MC > 0.4 x LL (Not Significantly Desiccated)

The results in the table above indicate that no potential significant moisture deficits were present within the cohesive samples of the Claygate Member of the London Clay Formation tested. The moisture content values were above 40% of the liquid limits.

5.2.3 Particle Size Distribution (PSD) Tests

The results of PSD testing undertaken on two granular samples of the Claygate Member of the London Clay Formation encountered are tabulated overpage.

PSD Test Results Summary			
Trial Hole/Depth/Soil Description	Volume Change Potential Range		Passing 63µm sieve Range (%)
	BRE	NHBC	
Claygate Member of the London Clay Formation WS1/3.00m blgl (Orangish brown clayey SAND)	Yes	No	16.2
Claygate Member of the London Clay Formation WS2/6.00m bgl (Brown very clayey SAND)	Yes	No	20.6

NB Volume Change Potential refers to BRE Digest 240 (based on Grading test results).
Shrinkability refers to NHBC Standards Chapter 4.2 (based on Grading test results).

Volume Change Potential – BRE 240 states that a soil has a volume change potential when the clay fraction exceeds 15%. Only the silt and clay combined fraction are determined by sieving therefore the volume change potential is estimated from the percentage passing the 63µm sieve.

NHBC Standards Chapter 4.2 states that a soil is shrinkable if the percentage of silt and clay passing the 63µm sieve is greater than 35% and the Plasticity Index is greater than 10%.

5.2.4 BRE Special Digest 1

In accordance with BRE Special Digest 1 'Concrete in Aggressive Ground' (BRE, 2005) one sample of the Bagshot Formation (WS1/2.00m blgl) and one sample of the Claygate Member of the London Clay Formation (WS2/4.00m bgl) were scheduled for laboratory analysis to determine parameters for concrete specification.

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

Summary of Results of BRE Special Digest Testing			
Determinand	Unit	Minimum	Maximum
pH	-	8.3	8.4
Ammonium as NH_4	mg/kg	3.8	4.2
Sulphur	%	<0.02	0.04
Chloride (water soluble)	mg/kg	6	10
Magnesium (water soluble)	mg/l	0.2	1.3
Nitrate (water soluble)	mg/kg	<3	3
Sulphate (water soluble)	mg/l	19	39
Sulphate (total)	mg/kg	591	719

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 to 0.20m - >1.20m bgl/blgl.

  As a result of the inherent variability 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.

  Made Ground may be found to deeper depth at other locations on the site, especially close to former structures/foundations and service runs.

- Soils described as representative of Head Deposits were encountered underlying the Made Ground to a proved depth of 1.40m blgl/bgl within WS1 and WS2 and for the remaining depth of TP/FE2, a maximum of 1.20m bgl.

  The Head Deposits were noted to comprise a red/orange brown and grey brown mottled sandy gravelly silty clay. The sand was fine to medium grained. The gravel was occasional, fine to coarse, sub-angular to rounded flint.

  The Head Deposits are likely to have **low to medium volume change potential** in accordance with BRE240 and NHBC Standards Chapter 4.2.

  The cohesive Head Deposits were considered a suitable bearing stratum for moderately loaded footings/foundations. Settlements on loading are likely to be moderate.

- Deposits of the Bagshot Formation were encountered underlying the Head Deposits within WS1 and WS2 to a proved depth of 2.20m blgl/bgl.

  The soils were noted to comprise a light to orange brown very sandy clay to clayey sand. The sand was fine grained.

  Cohesive soils of the Bagshot Formation are likely to have **low to medium volume change potential** in accordance with BRE240 and NHBC Standards Chapter 4.2.

  Granular soils of the Bagshot Formation are likely to have **no volume change potential** in accordance with NHBC Standards Chapter 4.2 and **volume change potential** in accordance with BRE240.

  The granular and cohesive soils of the Bagshot Formation were considered a suitable bearing stratum for moderately loaded footings/foundations. Settlements on loading are likely to be moderate.

- From 2.20m blgl/bgl and for the remaining depth of WS1 and WS2, a maximum of 6.00m blgl/bgl, soils described as representative of the Claygate Member of the London Clay Formation were encountered.

  The deposits were described as orange brown, with local grey brown mottling, alternating layers of very sandy silty clay and clayey medium dense sand. The sand was fine grained.

  The granular soils of the Claygate Member of the London Clay Formation were shown to be medium dense. The cohesive soils of the Claygate Member of the London Clay Formation was shown to have a medium undrained shear strength (45kPa).

  Geotechnical testing revealed the cohesive soils of the Claygate Member of the London Clay Formation to have **low to medium volume change potential** in accordance with both BRE240 and NHBC Standards Chapter 4.2. Consistency Index calculations indicated these soils to be firm to stiff. The cohesive deposits of the Claygate Member of the London Clay Formation were shown to be overconsolidated to heavily overconsolidated soils.

  The granular soils of the Claygate Member of the London Clay Formation were shown to have **a volume change potential** in accordance with BRE240 and **no volume change potential** in accordance with NHBC Standards Chapter 4.2

  Based on the results of the dynamic probing, cohesive soils of the Claygate Member of the London Clay Formation were assumed to be present within DP1 from 6.00m blgl to the base of the probe at 10.00m blgl.

  The assumed Claygate Member of the London Clay Formation was shown to have a medium to high undrained shear strength (50 – 145kPa).

  The overconsolidated to heavily overconsolidated cohesive soils and medium dense granular soils of the Claygate Member of the London Clay Formation were considered a suitable bearing stratum for moderately loaded footings/foundations. Settlements 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 desiccation and the likely serviceability and settlement requirements of the proposed structure. These parameters for design are discussed in the next section of this report.

- Groundwater was encountered between 4.00m and 5.00m blgl during the construction of WS1. A standing water level of 3.30m blgl was recorded during a return visit to site on the 03/03/2016.

- Roots were noted to 1.00m bgl within WS2. No roots were observed in the remaining trial holes.

6.2 Basement Foundations

At the time of reporting, March 2016, the proposed development is understood to comprise the construction of a lower ground floor beneath the remaining footprint of the structure. The basement will be formed at ~3.00 – 3.50m below ground floor level, a similar level to the existing garage. A plan showing the proposed development can be seen in Figure 4

WS1 was drilled from the level of the driveway to the front of the property, ~2.40m below the ground floor of the existing property. WS2 was constructed to the rear of the property at ground level.

The basement will be formed at ~3.00 – 3.50m below the level of WS2 and ~0.80 – 1.50m below the level of WS1.

The proposed development is likely to fall 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.

Given the soils encountered mainly comprised interbedded sandy clays, locally gravelly, with clayey sands foundations should be designed in accordance with soils of **medium volume change potential** in accordance with BRE Digest 240 and NHBC Chapter 4.2.

Given the cohesive nature of the shallow deposits, foundations must therefore 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 (NHBC Standards Chapter 4.2). It is recommended that foundations are taken at least 300mm into non-root penetrated strata.

Roots were noted to 1.00m bgl within WS2. No roots were observed in the remaining trial holes. Given the proposed development the basement to the rear will extend beyond the influence of the root penetrated soils noted.

The following bearing capacities could be adopted for 5.0m long by 0.75m and 1.0m wide footings, at depths of 0.80m, 1.00m and 1.50m blgl for shallow footings at the front of the property associated with underpinning the garage which is at a lower ground floor level.

Limit State: Bearing Capacities Calculated (Based on WS1/DP1)		
Depth	**Foundation System**	**Limit Bearing Capacity (kN/m^2) (EC2)**
0.80m blgl	5.00m by 0.75m Strip	162.54
	5.00m by 1.00m Strip	149.75
1.00m blgl	5.00m by 0.75m Strip	118.45
	5.00m by 1.00m Strip	91.37
1.50m blgl	5.00m by 0.75m Strip	325.67
	5.00m by 1.00m Strip	341.27

Serviceability State: Settlement Parameters Calculated (Based on WS1/DP1)			
Depth	**Foundation System**	**Limit Bearing Capacity (kN/m²)**	**Settlement (mm)**
0.80m blgl	5.00m by 0.75m Strip	125	<25
	5.00m by 1.00m Strip	120	<25
1.00m blgl	5.00m by 0.75m Strip	110	<21
	5.00m by 1.00m Strip	90	<17
1.50m blgl	5.00m by 0.75m Strip	130	<22
	5.00m by 1.00m Strip	150	<25

The following bearing capacities could be adopted for 5.0m long by 0.75m and 1.0m wide footings, pads at depths of 3.00m and 3.60m bgl. This relates to the rear of the structure, located at ground level, where removal of overburden pressure is higher.

Limit State: Bearing Capacities Calculated (Based on WS1/DP1)		
Depth	**Foundation System**	**Limit Bearing Capacity (kN/m²) (EC2)**
3.00m bgl	5.00m by 0.75m Strip	210.00
	5.00m by 1.00m Strip	116.17
3.60m bgl	5.00m by 0.75m Strip	144.87
	5.00m by 1.00m Strip	144.85

Serviceability State: Settlement Parameters Calculated (Based on WS1/DP1)			
Depth	**Foundation System**	**Limit Bearing Capacity (kN/m²)**	**Settlement (mm)**
3.00m bgl	5.00m by 0.75m Strip	150	<22
	5.00m by 1.00m Strip	110	<13
3.60m bgl	5.00m by 0.75m Strip	140	<18
	5.00m by 1.00m Strip	140	<19

It must be noted that a bearing capacity of less than 56kN/m^2 and 66kN/m^2 at 3.00m and 3.60m bgl respectively could result in heave due to a reduction in effective stress at depth. This will need to be taken into account in final design.

General Recommendations for Spread Foundations:

- 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.

- 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.

- The excavation must be kept dry as accumulation of water could result in increased settlements.

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

- Any groundwater or surface water ingress must be prevented from entering foundation trenches.

- 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, volume change potential of the soils encountered and the developments proximity to former, present and proposed trees.

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 level 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.

Groundwater was encountered between 4.00m and 5.00m blgl during the construction of WS1. A standing water level of 3.30m blgl was recorded during a return visit to site on the 03/03/2016. No Groundwater was encountered within WS2.

The basement will be constructed at ~0.80 – 1.50m blgl at the location of WS1 and at 3.00 – 3.50m bgl at the location of WS2.

Based on the groundwater data obtained during the investigation it was considered unlikely that construction will take place at or below the groundwater table, but perched water may be encountered migrating through the Made Ground or granular strata underlying the site. 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. 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.

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

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, Head Deposits, Bagshot Formation and the Claygate Member of the London Clay Formation 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 lower ground floor 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 within the boreholes 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/m³)**	**Cohesion Intercept (c') (kPa)**	**Angle of Shearing Resistance (Ø)**	**Ka**	**Kp**
Head Deposits	~20	0	20	0.49	2.04
Bagshot Formation	~21	0	32	0.31	3.25
Granular Claygate Member of the London Clay Formation	~21	0	32	0.31	3.25
Cohesive Claygate Member of the London Clay Formation	~20 - 22	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.

Groundwater was encountered between 4.00m and 5.00m blgl during the construction of WS1. A standing water level of 3.30m blgl was recorded during a return visit to site on the 03/03/2016. No Groundwater was encountered within WS2.

The basement will be constructed at ~0.80 – 1.50m blgl at the location of WS1 and at 3.00 – 3.50m bgl at the location of WS2.

Based on the groundwater data obtained during the investigation it was considered unlikely that construction will take place at or below the groundwater table, but perched water may be encountered migrating through the Made Ground or granular strata underlying the site. 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.

6.5 Assessment of Ground Movement

An assessment of ground movements has been carried out as follows:

- Movement has been assessed for the neighbouring properties due to the excavation of the basement. The site was surrounded by two storey brick built residential properties.
- The northern flank wall of No.16 Rosecroft Avenue at its closest point to the proposed basement was ~10.50m away with its southern flank wall adjoining No.14 Rosecroft Avenue.
- The northern flank wall of No.12 Rosecroft Avenue at its closest point to the proposed basement was ~2.00m away with its southern flank wall ~12.00m away.
- The magnitude of ground movements has been assessed for the excavation in front of the traditional underpinned retaining wall structures.
- It is important to note that CIRIA Report C580 was written for embedded retaining walls. Therefore movement calculations for the excavation of soil and installation of the underpins does not strictly apply to C580.

The following parameters have been used to inform this assessment:

- The maximum excavation depth is approximately 4.00m bgl.
- The method of basement construction will be traditional underpinning;
- A high wall stiffness has been assumed;
- In the permanent case the wall will always be propped at high level;
- The width of No. 16 adjacent to the subject site is ~10.50m. The width of No. 12 neighbouring the subject site is 10.00m.
- Both buildings are estimated to be ~13.5m high.
- Soil comprising a stiff clay has been assumed.

Based on reference to C580 the following ground movements have been developed based on of the excavation of soils to form the basement.

No. 16 Rosecroft Avenue:

The total horizontal movement due to the excavation was calculated to be 6.00mm at the nearest wall, reducing to 2.06mm at its far end.

The total vertical movement due to the excavation was calculated to be 1.60mm at the nearest wall, reducing to 1.00mm at its far end.

No. 12 Rosecroft Avenue:

The total horizontal movement due to the excavation was calculated to be 5.25mm at the nearest wall, reducing to 1.50mm at its far end.

The total vertical movement due to the excavation was calculated to be 3.40mm at the nearest wall, reducing to 0.57mm at its far end.

Other issues to note:

- The ground conditions underlying the site alternated between sand and clay.
- Trees are present close to the proposed structure. Removal of trees and bushes, or their retention and its effect on ground movement has not been accounted for in the calculations.

In terms of building damage assessment and with reference to Table 2.5 of C580 (after Burland et al, 1977), the 'Description of typical damage' given the calculated movements it is likely that the damage assessment will fall into Category 0, 'Negligible'.

There are a number of key points to note in using this assessment:

- Most ground movement will occur during excavation and construction so the adequacy of temporary support will be critical in limiting ground movements;
- The speed of propping and support is key to limiting ground movements;
- Good workmanship will contribute to minimising ground movements;
- The assessment assumed the wall was in competent clay, whereas ground conditions encountered were for low to high undrained shear strength clay;
- Larger movements will be expected where soft soils are encountered at, above and below formation level;
- Ground movement can be minimised by adopting a number of measures, including:
    - Ensuring that adequate propping is in place at all times during construction;
    - Installation of the first (stiff) support quickly and early in the construction sequence for each underpin panel.

6.6 Hydrogeological Effects

A study of the aquifer maps on the Environment Agency website revealed the site to be located on a **Secondary (A) Aquifer** relating to the bedrock deposits of the Bagshot Formation and the Claygate Member of the London Clay Formation. No designation was given for any superficial deposits due to their likely absence.

The ground conditions encountered within the trial holes constructed on the site generally conformed to that anticipated from examination of the geology map. Made Ground was noted to overlie Head Deposits over the Bagshot Formation and the Claygate Member of the London Clay Formation.

Based on a visual appraisal of the soils encountered, the permeability of the Head Deposits and the cohesive Claygate Member of the London Clay Formation was considered to be negligible to low. The Bagshot Formation and the granular Claygate Member of the London Clay Formation was considered likely to have low permeability.

The basement will be constructed at ~0.80 – 1.50m blgl at the location of WS1 and at 3.00 – 3.50m bgl at the location of WS2.

Based on the groundwater data obtained during the investigation it was considered unlikely that construction will take place at or below the groundwater table, but groundwater may be encountered migrating through the Made Ground or granular strata underlying the site. 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.

Higher groundwater levels during winter months or during inclement weather may affect basement construction.

Once constructed, the Bagshot Formation and the granular Claygate Member of the London Clay Formation may act as a porous medium for water to migrate through, however additional drainage should be considered.

6.7 Sub-Surface Concrete

Sulphate concentrations were measured in 2:1 water/soil extracts taken from the Bagshot Formation and the Claygate Member of the London Clay Formation fell into class DS-1 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-1. For the classification given, the "mobile" and "natural" case was adopted given the nature of the soils encountered (granular with water strike) and the residential use of the site. The sulphate concentration in the samples ranged from 19 - 39mg/l with a pH range of 8.30 – 8.40. The total potential sulphate concentrations ranged from 0.06 – 0.07%.

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.

It is prudent to note that pyrite nodules may be present within the Claygate Member of the London Clay Formation. Pyrite can oxidise to gypsum and this normally only occurs in the upper weathered layer, but excavation allows faster oxidation and water soluble sulphate values can rapidly increase during construction. Therefore rising sulphate values should be taken into account should ferruginous staining/pyrite nodules be encountered within the Claygate Member of the London Clay Formation.

6.8 Surface Water Disposal

Infiltration tests were beyond the scope of the investigation.

At the time of reporting, March 2016, the proposed development is understood to comprise the construction of a lower ground floor beneath the remaining footprint of the structure. The basement will be formed at ~3.00 – 3.50m ground floor level, a similar level to the existing garage. A plan showing the proposed development can be seen in Figure 4.

The amount of hardstanding created by the development is considered unlikely to change considerably.

Soakaways constructed within the Bagshot Formation and granular soils of the Claygate Member of the London Clay Formation are unlikely to prove satisfactory due to low 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.

6.9 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.

6.10 Waste Disposal

Foundation excavations on-site are 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.

INERT waste classification should be undertaken to determine if the proposed waste confirms to INERT or NON-HAZARDOUS Waste Acceptable Criteria (WAC).

6.11 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.

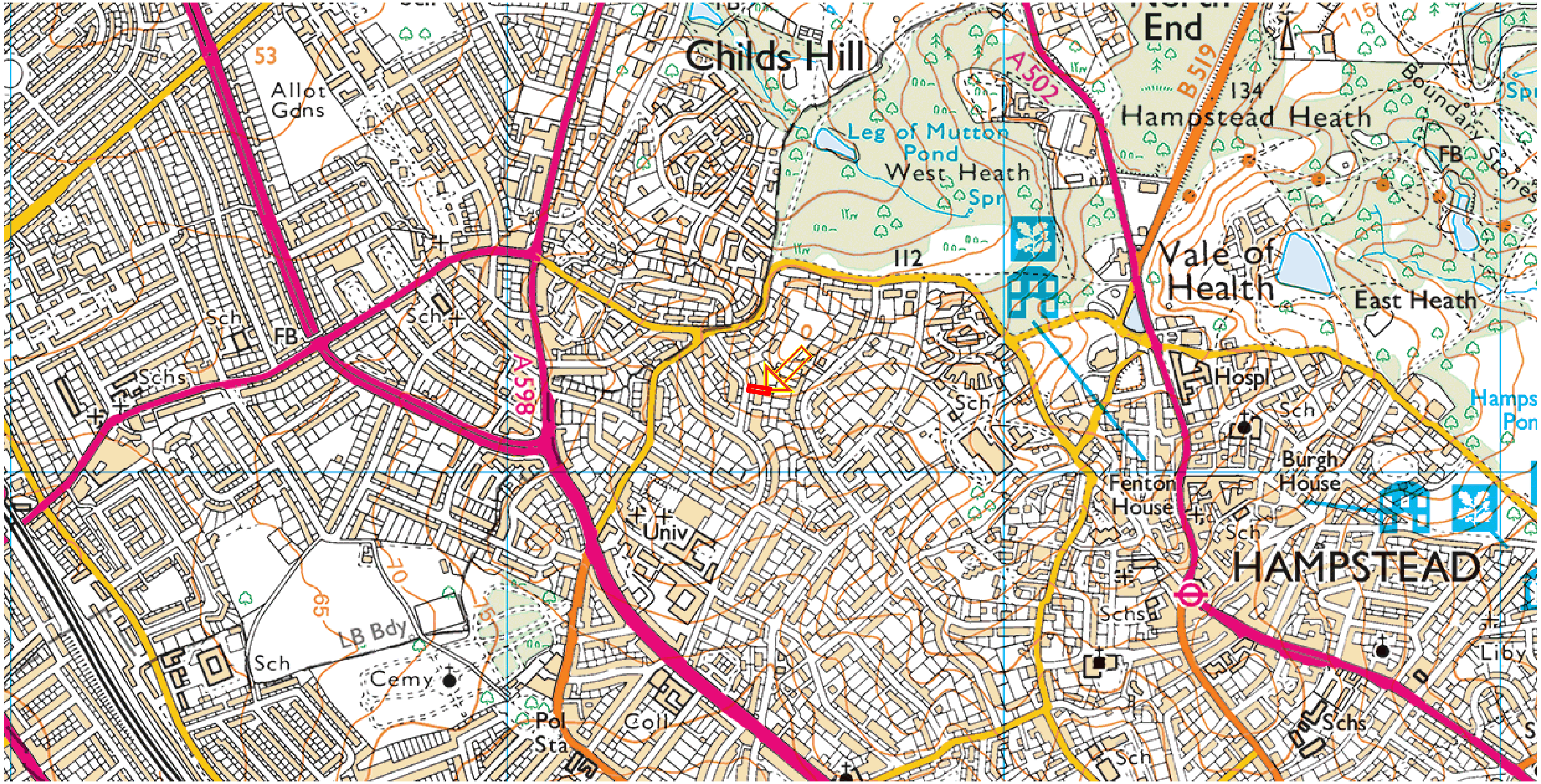
6.12 Duty of Care

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



APPROXIMATE SITE BOUNDARY

NOTE: NOT TO SCALE

Project: 14 Rosecroft Avenue, Hampstead, London NW3 7QB		**Figure 1**
Client: Vincent and Rymill	**Date:** March 2016	ground&water
Site Location Plan	**Ref:** GWPR1540	

APPROXIMATE SITE BOUNDARY

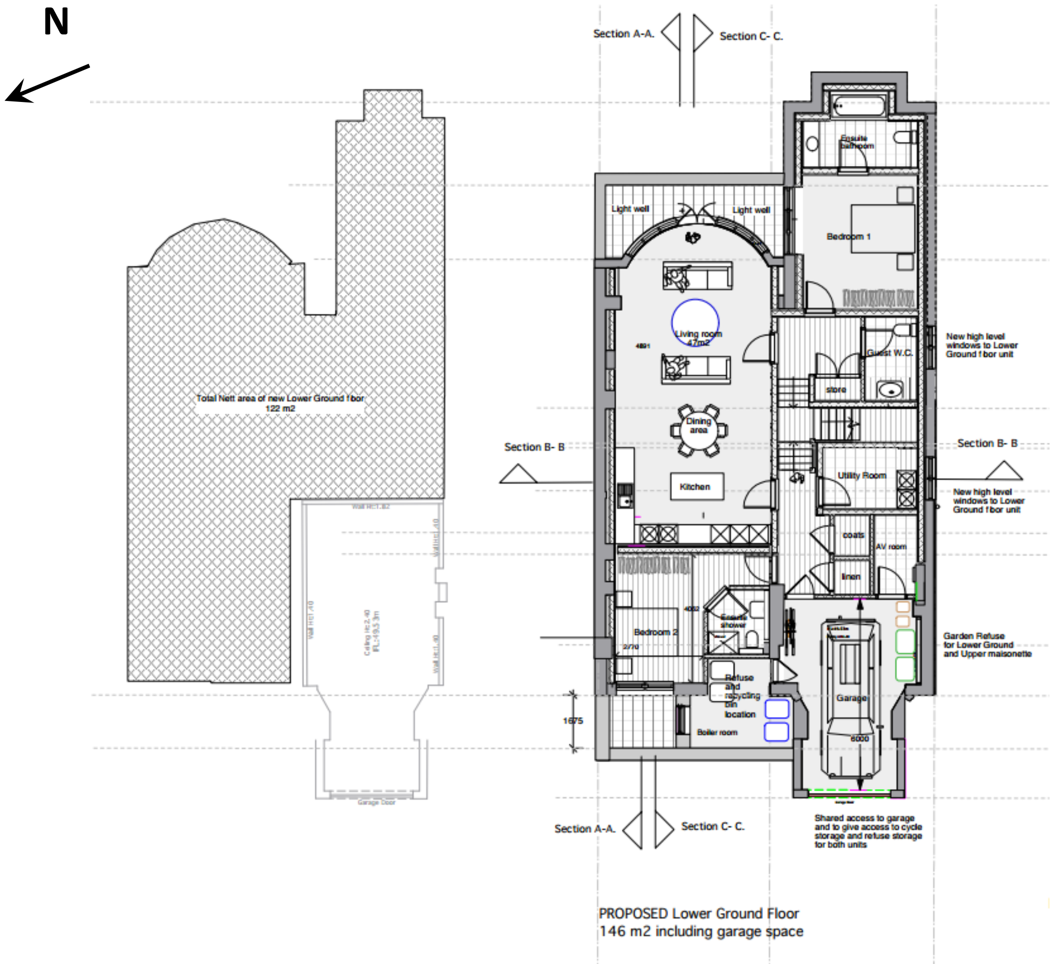
NOTE: NOT TO SCALE

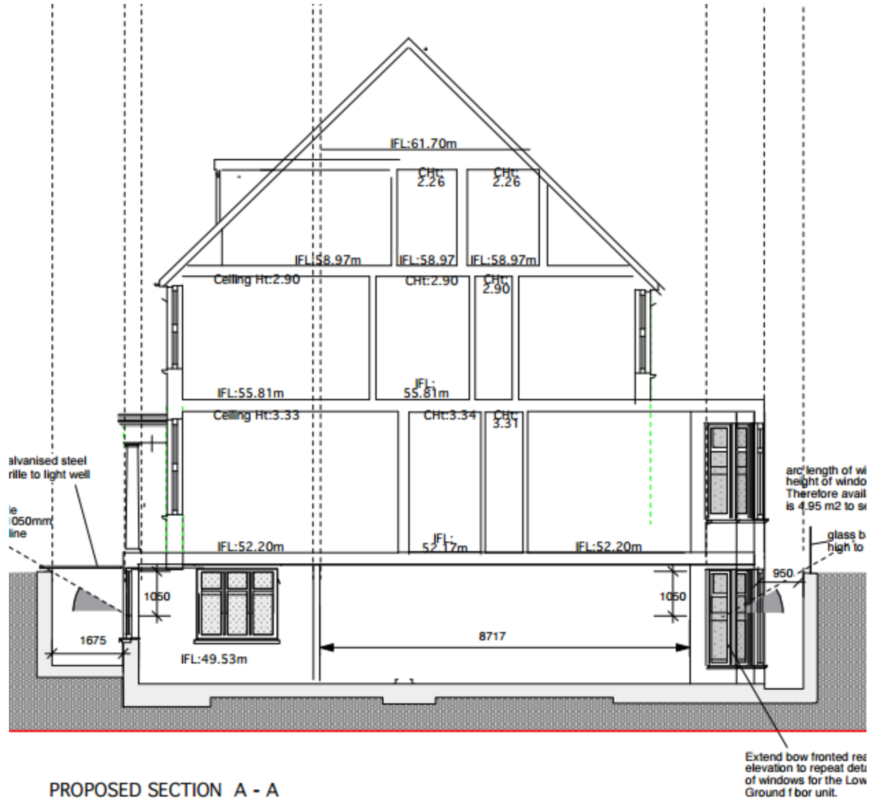
Project: 14 Rosecroft Avenue, Hampstead, London NW3 7QB		**Figure 2**
Client: Vincent and Rymill	**Date:** March 2016	ground&water
Site Development Area	**Ref:** GWPR1540	

APPROXIMATE SITE BOUNDARY

NOTE: NOT TO SCALE

Project: 14 Rosecroft Avenue, Hampstead, London NW3 7QB		**Figure 3**
Client: Vincent and Rymill	**Date:** March 2016	ground&water
Aerial View of Site	**Ref:** GWPR1540	

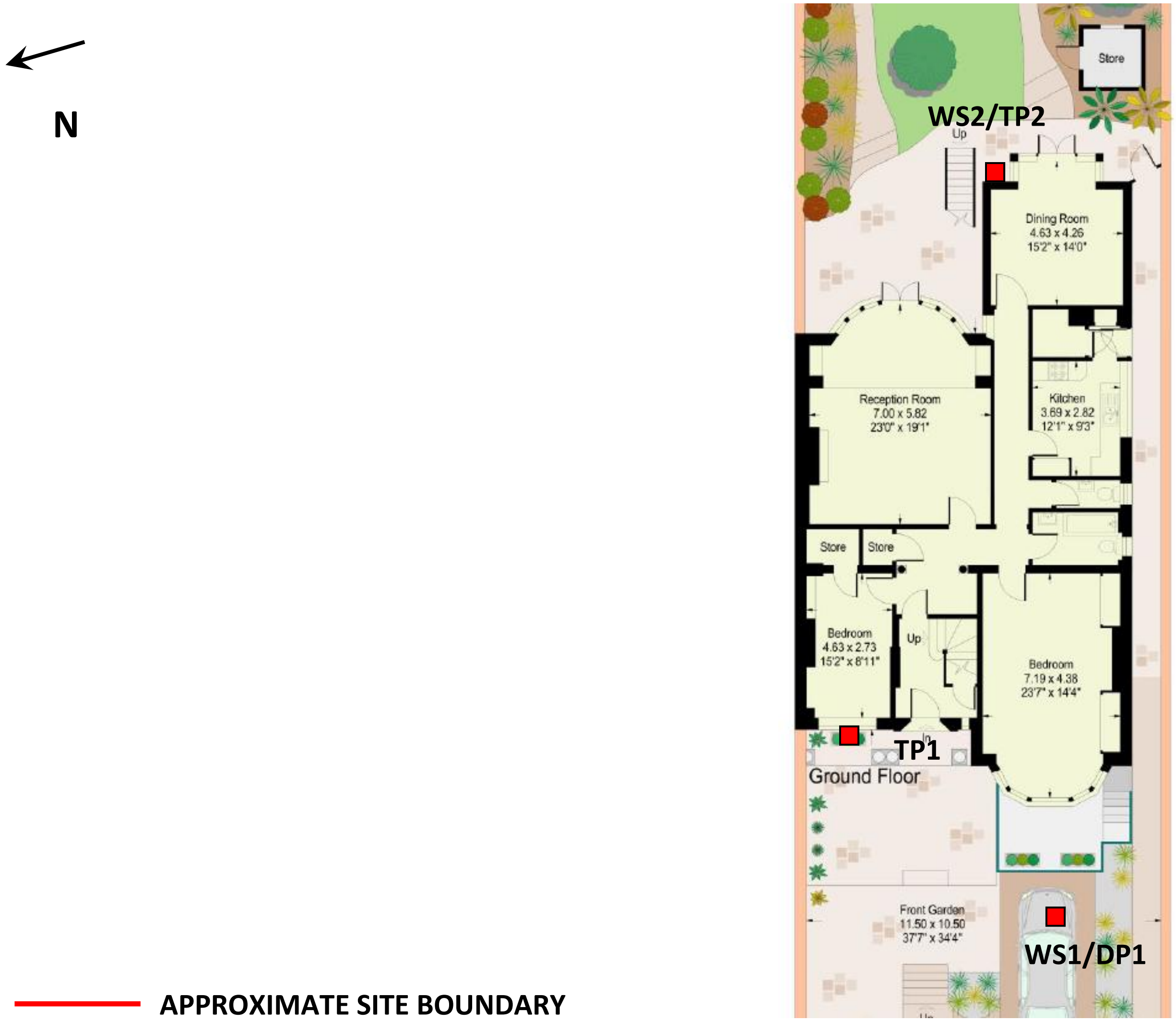




APPROXIMATE SITE BOUNDARY

NOTE: NOT TO SCALE

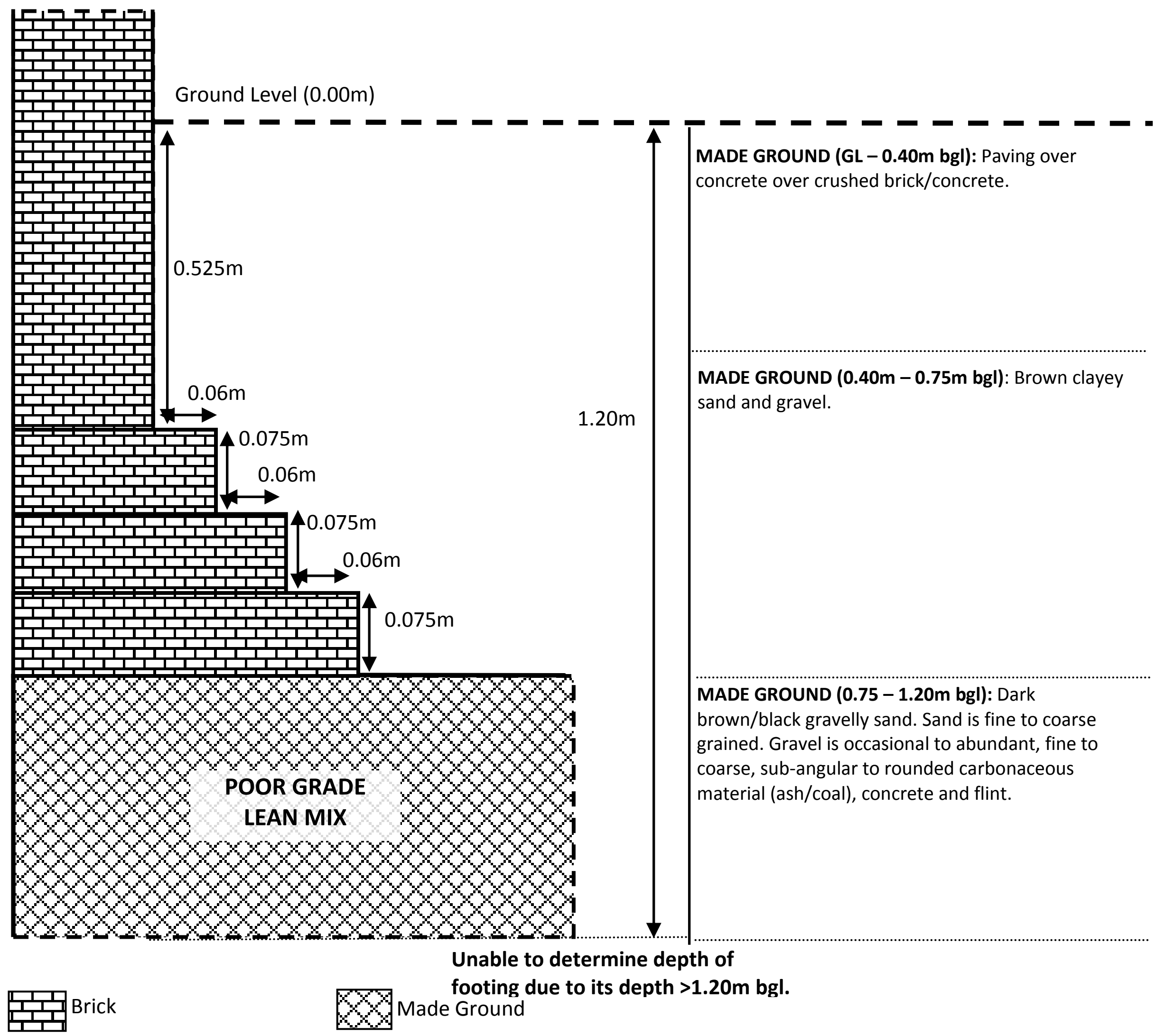
Project: 14 Rosecroft Avenue, Hampstead, London NW3 7QB		**Figure 4**
Client: Vincent and Rymill	**Date:** March 2016	ground&water
Proposed Development Plan	**Ref:** GWPR1540	



APPROXIMATE SITE BOUNDARY

NOTE: NOT TO SCALE

Project: 14 Rosecroft Avenue, Hampstead, London NW3 7QB		**Figure 5**
Client: Vincent and Rymill	**Date:** March 2016	ground&water
Trial Hole Location Plan	**Ref:** GWPR	



NOTE: NOT TO SCALE

Project: 14 Rosecroft Avenue, Hampstead, London NW3 7QB	**Figure 6**
Client: Vincent and Rymill	**Date:** March 2016
Section Drawing: Foundation Exposure TP/FE1	**Ref:** GWPR1540

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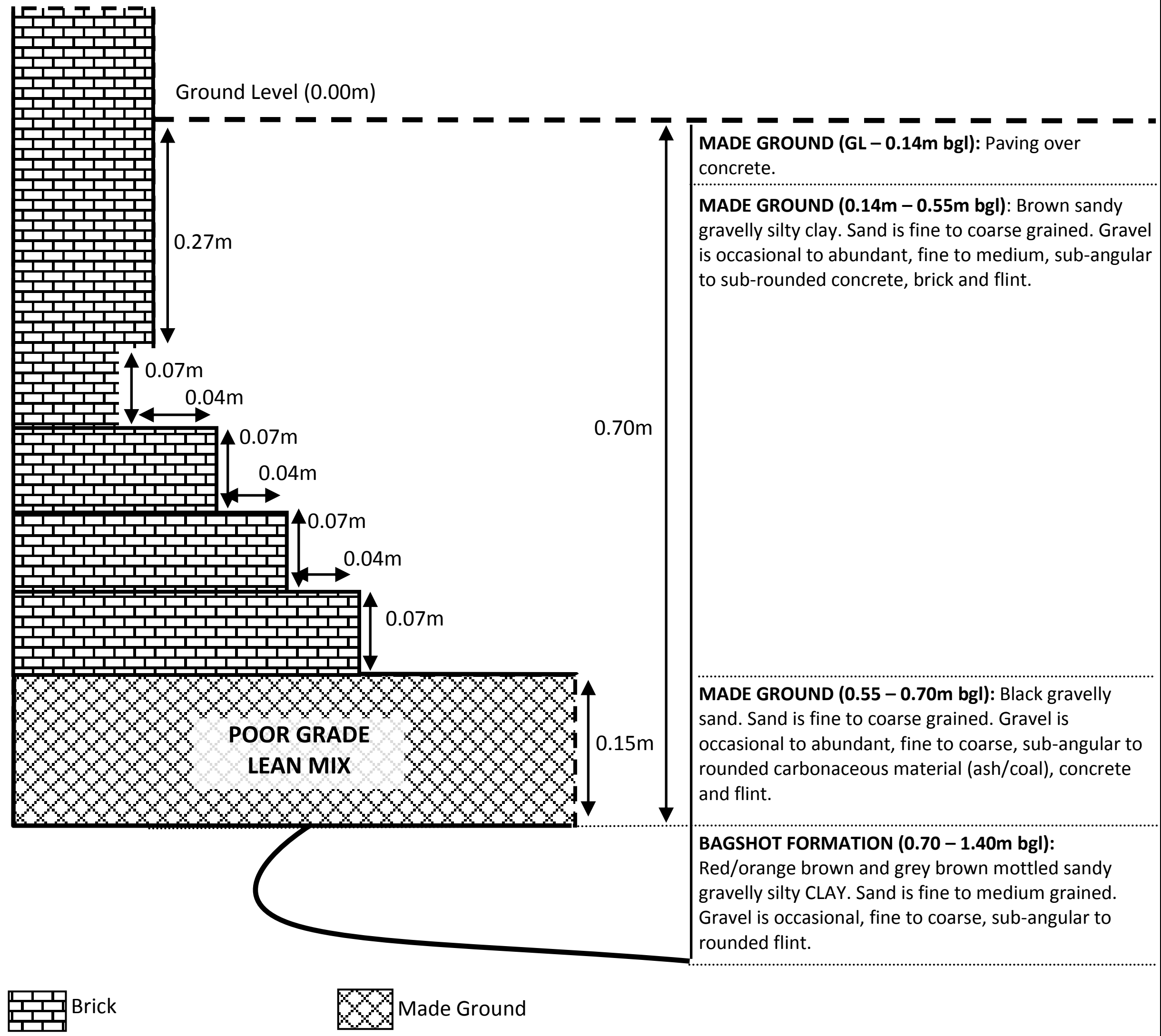

NOTE: NOT TO SCALE

Project: 14 Rosecroft Avenue, Hampstead, London NW3 7QB	**Figure 3**
Client: Vincent and Rymill	**Date:** March 2016
Section Drawing: Foundation Exposure TP/FE2	**Ref:** GWPR1540

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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 14 Rosecroft Avenue, Hampstead, London NW3

7QB.

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.

APPENDIX B
Fieldwork Logs

Ground and Water Ltd

Borehole No WS1

Sheet 1 of 1

Project Name	Project No.	Co-ords:	Hole Type
14 Rose Croft Avenue	GWPR1540	-	WLS

Location: Hampstead, London NW3 7QB

Level: -

Scale 1:50

Client: Vincent and Rymill

Dates: 22/01/2016

Logged By MJ

Water Strikes	Depth (m)	Type	Results
	0.30	D	
	0.50	D	
	0.80	D	
	1.20	D	
	1.50	D	
	2.00	SPT	N=17 (2,3/ 3,4,5,5)
	2.00	D	
	2.50	D	
	3.00	SPT	N=14 (2,3/ 3,3,4,4)
	3.00	D	
	3.50	D	
	4.00	SPT	N=9 (1,1/ 2,2,2,3)
	4.00	D	
	4.50	D	
	5.00	SPT	N=9 (2,1/ 2,2,2,3)
	5.00	D	
	5.50	D	
	6.00	D	

Depth (m)	Level (m AOD)	Stratum Description
0.20		MADE GROUND: CONCRETE
1.40		HEAD DEPOSITS: Red/orange brown with occasional grey mottling slightly sandy gravelly silty CLAY. Sand is fine to medium grained. Gravel is occasional, fine to coarse, sub-angular to rounded flint.
2.20		BAGSHOT FORMATION: Light to orange brown fine SAND.
3.60		CLAYGATE MEMBER OF THE LONDON CLAY FORMATION: Orange brown and grey brown mottled clayey SAND. Sand is fine grained.
4.80		CLAYGATE MEMBER OF THE LONDON CLAY FORMATION: Orange brown and grey brown mottled sandy silty CLAY. Sand is fine grained.
5.70		CLAYGATE MEMBER OF THE LONDON CLAY FORMATION: Orange brown clayey SAND. Sand is fine grained.
6.00		CLAYGATE MEMBER OF THE LONDON CLAY FORMATION: Orange brown sandy silty CLAY. Sand is fine grained.

End of Borehole at 6.00 m

Remarks: Groundwater strike encountered within 4.00-5.00m bgl run.
33mm diameter standpipe installed to 5.25m bg.
No roots noted.

AGS

Ground and Water Ltd

Borehole No
WS2
Sheet 1 of 1

Project Name	Project No.	Co-ords: -	Hole Type
14 Rose Croft Avenue	GWPR1540		WLS
Location: Hampstead, London NW3 7QB		Level: -	Scale 1:50
Client: Vincent and Rymill		Dates: 22/01/2016	Logged By MJ

Sample Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Stratum Description
			0.04		MADE GROUND: Paving
0.20	D		0.14		CONCRETE
0.50	D				
0.55	D		0.55		MADE GROUND: Brown sandy gravelly silty clay. Sand is fine to coarse grained. Gravel is occasional to abundant, fine to medium, sub-angular to sub-rounded concrete, brick and flint.
			0.70		MADE GROUND: Black gravelly sand. Sand is fine to coarse grained. Gravel is abundant, fine, sub-angular to sub-rounded carbonaceous material (ash/coal).
1.00	D				
			1.40		HEAD DEPOSITS: Red/orange brown and grey brown mottled sandy gravelly silty CLAY. Sand is fine to medium grained. Gravel is occasional, fine to coarse, sub-angular to rounded flint.
1.50	D				BAGSHOT FORMATION: Light to orange brown very sandy CLAY to clayey SAND. Sand is fine grained.
2.00	D				
			2.20		CLAYGATE MEMBER OF THE LONDON CLAY FORMATION: Orange brown and grey brown mottled very sandy silty CLAY.
2.50	D				
3.00	D				
3.50	D				
4.00	D				
4.50	D				
5.00	D				
5.50	D				
			5.60		CLAYGATE MEMBER OF THE LONDON CLAY FORMATION: Orange brown fine SAND with occasional pockets of very sandy clay.
6.00	D		6.00		End of Borehole at 6.00 m

Remarks: No groundwater encountered.
Roots noted to 1.00m bgl.

AGS

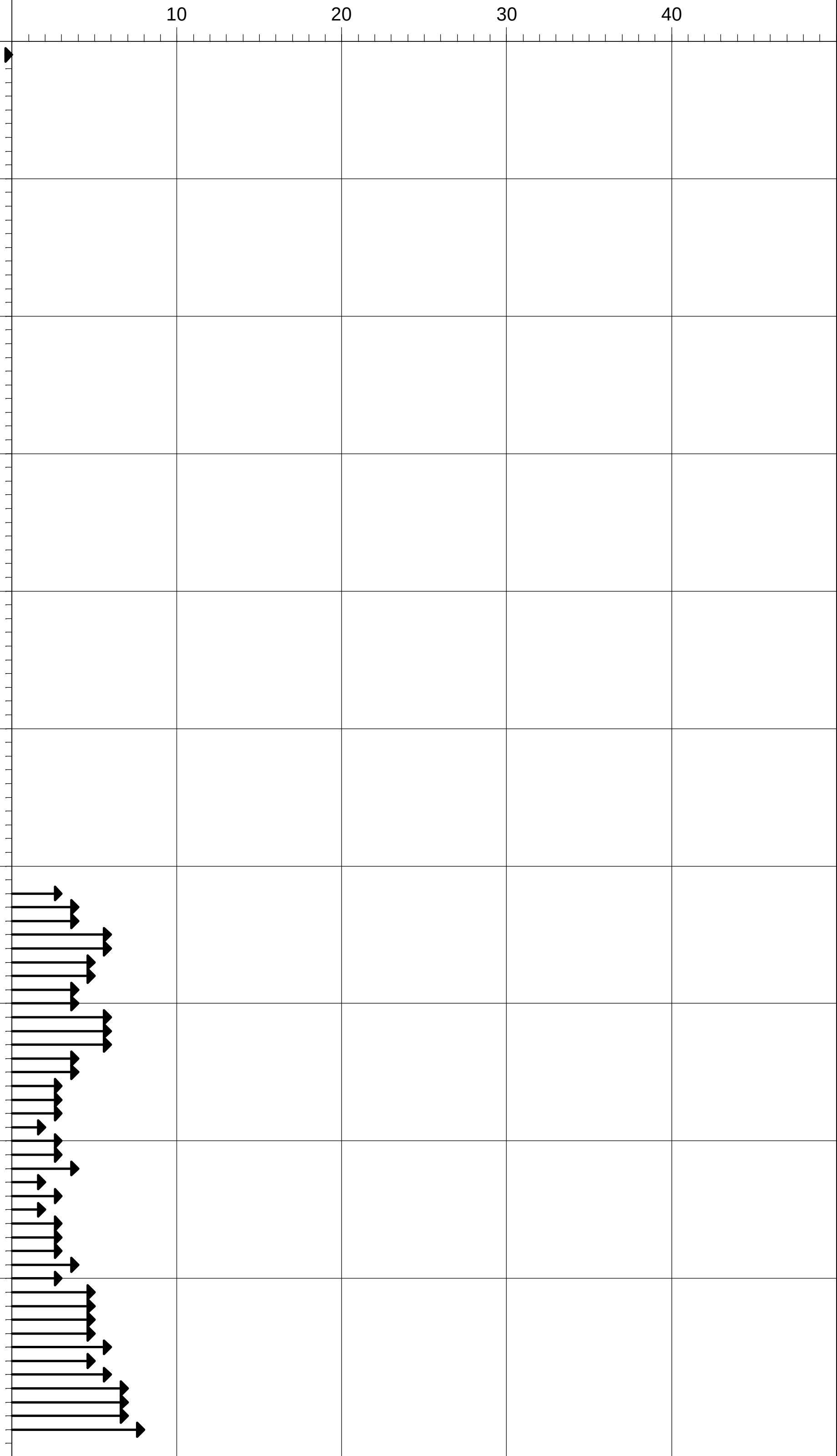
DYNAMIC PROBING

Probe No **DP1**			
Client **Vincent and Rymill**		Sheet 1 of 1	
Site **14 Rose Croft Avenue**		*Project No* **GWPR1540**	
E **-**	*N* **-**	*Level* **-**	*Date* **22/01/2016** — *Logged by* **TK**

Readings – Blows/100mm (Depth (m))

Depth (m)					
0.0	0	-	-	-	-
0.5	-	-	-	-	-
1.0	-	-	-	-	-
1.5	-	-	-	-	-
2.0	-	-	-	-	-
2.5	-	-	-	-	-
3.0	-	-	-	-	-
3.5	-	-	-	-	-
4.0	-	-	-	-	-
4.5	-	-	-	-	-
5.0	-	-	-	-	-
5.5	-	-	-	-	-
6.0	-	3	4	4	6
6.5	6	5	5	4	4
7.0	6	6	6	4	4
7.5	3	3	3	2	3
8.0	3	4	2	3	2
8.5	3	3	3	4	3
9.0	5	5	5	5	6
9.5	5	6	7	7	7
10.0	8				

Diagram (N100 Values)



Torque (Nm): 0

Ground and Water Ltd

Fall Height	**750**	*Cone Base Diameter*	**43**
Hammer Wt	**63.50**	*Final Depth*	**10.00**
Probe Type	**DPSH**	*Log Scale*	1:50

AGS

APPENDIX C
Geotechnical Laboratory Test Results

Summary of Classification Test Results

Job No.	Project Name	Programme	
20362	14 Rosecroft Avenue, Hampstead	Samples received	12/02/2016
		Schedule received	12/02/2016
Project No.	Client	Project started	15/02/2016
GWPR1540	Ground and Water Ltd	Testing Started	29/02/2016

Hole No.	Sample				Soil Description	NMC	Passing 425µm	LL	PL	PI	Remarks
	Ref	Top	Base	Type		%	%	%	%	%	
WS1		4.00		D	Orangish brown and orange sandy very silty CLAY	30	100	39	25	14	
WS2		3.50		D	Brown sandy silty CLAY	20	100	40	19	21	

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: 01/03/2016

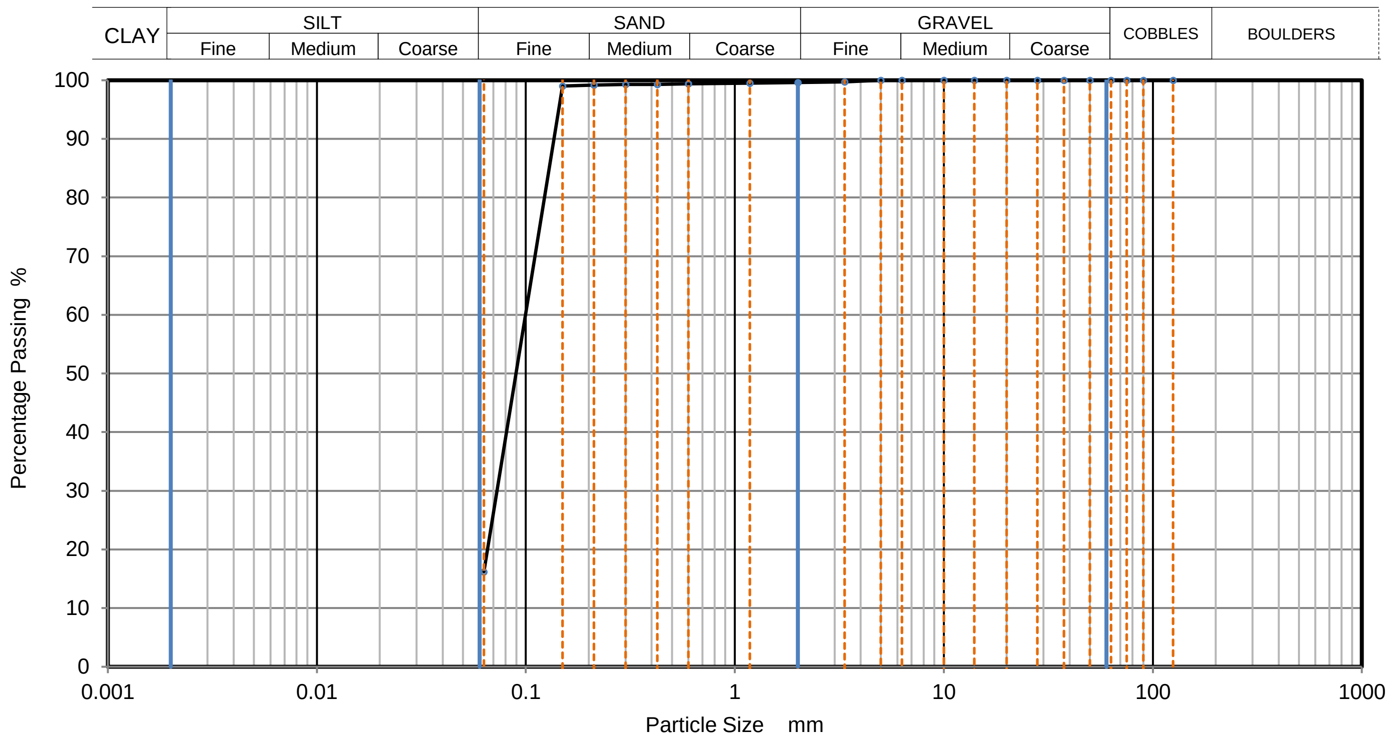
UKAS TESTING 2519

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

MSF-5-R1(a) -Rev. 0

PARTICLE SIZE DISTRIBUTION

Job Ref	20362				
Borehole/Pit No.	WS1				
Site Name	14 Rosecroft Avenue, Hampstead			Sample No.	
Project No.	GWPR1540	Client	Ground and Water Ltd	Depth	3.00 m
Soil Description	Orangish brown clayey SAND			Sample Type	D
				Samples received	12/02/2016
				Schedules received	12/02/2016
Test Method	BS1377:Part 2: 1990, clause 9.0			Project started	15/02/2016
				Date tested	26/02/2016



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	100		
0.6	99		
0.425	99		
0.3	99		
0.212	99		
0.15	99		
0.063	16		

Dry Mass of sample, g	530

Sample Proportions	% dry mass
Very coarse	0.0
Gravel	0.4
Sand	83.3
Fines <0.063mm	16.2

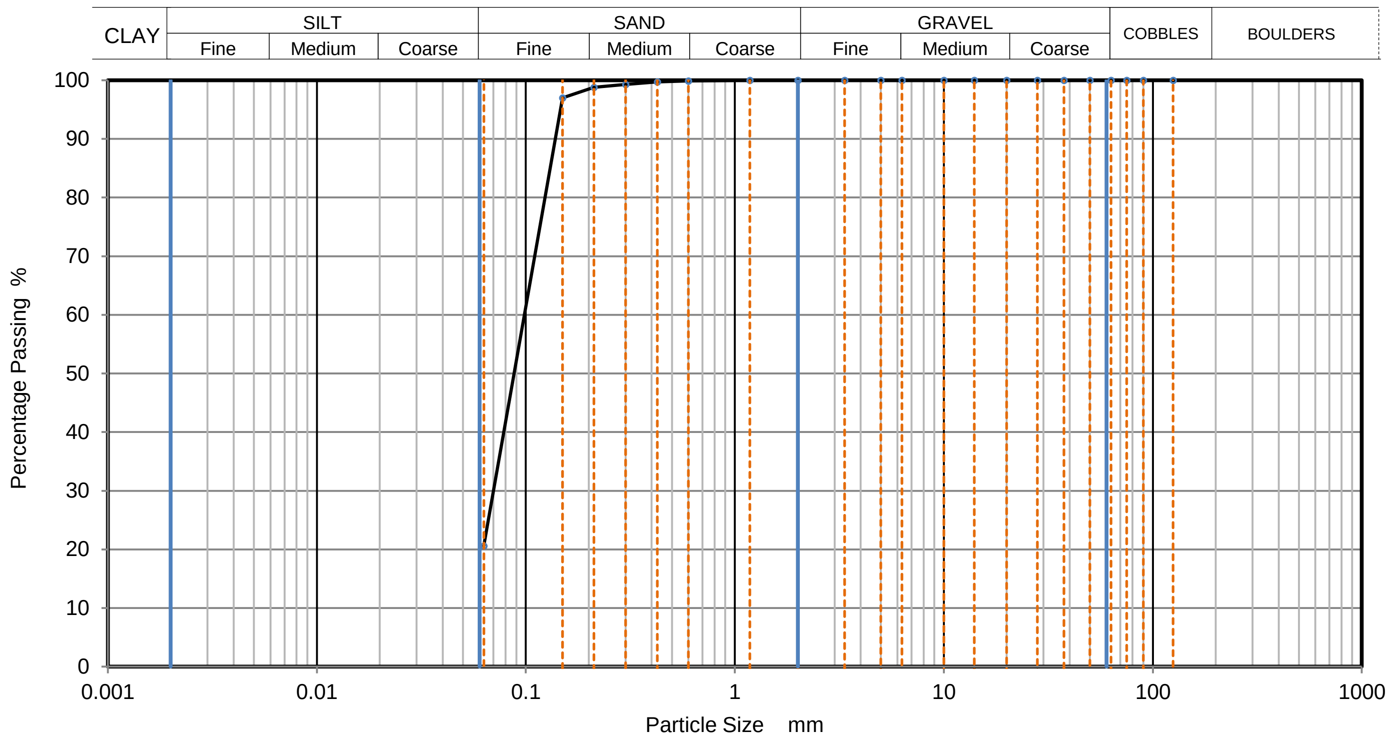
Grading Analysis	
D100 mm	
D60 mm	0.0997
D30 mm	0.0728
D10 mm	
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

PARTICLE SIZE DISTRIBUTION

Site Name	14 Rosecroft Avenue, Hampstead			Job Ref	20362
				Borehole/Pit No.	WS2
				Sample No.	
Project No.	GWPR1540	Client	Ground and Water Ltd	Depth	6.00 m
Soil Description	Brown very clayey SAND			Sample Type	D
				Samples received	12/02/2016
				Schedules received	12/02/2016
Test Method	BS1377:Part 2: 1990, clause 9.0			Project started	15/02/2016
				Date tested	26/02/2016



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	100		
0.6	100		
0.425	100		
0.3	99		
0.212	99		
0.15	97		
0.063	21		

Dry Mass of sample, g	164

Sample Proportions	% dry mass
Very coarse	0.0
Gravel	0.0
Sand	79.4
Fines <0.063mm	20.6

Grading Analysis	
D100 mm	
D60 mm	0.0986
D30 mm	0.0701
D10 mm	
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

K4 Soils Laboratory
Unit 8, Olds Close, Watford, Herts, WD18 9RU
Email: james@k4soils.com
Tel: 01923 711288

UKAS TESTING 2519

Checked and Approved
Initials: **J.P**
Date: 01/03/2016

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

MSF-5-R3 (Rev.0)

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GU34 3NB

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

QTS Environmental Report No: 16-40618

Site Reference: 14 Rosecroft Avenue, Hampstead, London NW3 7QB

Project / Job Ref: GWPR1540

Order No: None Supplied

Sample Receipt Date: 12/02/2016

Sample Scheduled Date: 12/02/2016

Report Issue Number: 1

Reporting Date: 18/02/2016

Authorised by:

Russell Jarvis
Associate Director of Client Services
On behalf of QTS Environmental Ltd

Authorised by:

Kevin Old
Associate Director of Laboratory
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

4480

Soil Analysis Certificate						
QTS Environmental Report No: 16-40618	**Date Sampled**	01/02/16	01/02/16			
Ground & Water Ltd	**Time Sampled**	None Supplied	None Supplied			
Site Reference: 14 Rosecroft Avenue, Hampstead, London NW3 7QB	**TP / BH No**	WS1	WS2			
Project / Job Ref: GWPR1540	**Additional Refs**	None Supplied	None Supplied			
Order No: None Supplied	**Depth (m)**	2.00	4.00			
Reporting Date: 18/02/2016	**QTSE Sample No**	191837	191838			

Determinand	**Unit**	**RL**	**Accreditation**					
pH	pH Units	N/a	**MCERTS**	8.3	8.4			
Total Sulphate as SO_4	mg/kg	< 200	NONE	719	591			
Total Sulphate as SO_4	%	< 0.02	NONE	0.07	0.06			
W/S Sulphate as SO_4 (2:1)	mg/l	< 10	**MCERTS**	19	39			
W/S Sulphate as SO_4 (2:1)	g/l	< 0.01	**MCERTS**	0.02	0.04			
Total Sulphur	%	< 0.02	NONE	< 0.02	0.04			
Ammonium as NH_4	mg/kg	< 0.5	NONE	3.8	4.2			
Ammonium as NH_4	mg/l	< 0.05	NONE	0.38	0.42			
W/S Chloride (2:1)	mg/kg	< 1	**MCERTS**	6	10			
W/S Chloride (2:1)	mg/l	< 0.5	**MCERTS**	2.9	5.1			
Water Soluble Nitrate (2:1) as NO_3	mg/kg	< 3	**MCERTS**	< 3	3			
Water Soluble Nitrate (2:1) as NO_3	mg/l	< 1.5	**MCERTS**	< 1.5	1.6			
W/S Magnesium	mg/l	< 0.1	NONE	0.2	1.3			

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

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Soil Analysis Certificate - Sample Descriptions	
QTS Environmental Report No: 16-40618	
Ground & Water Ltd	
Site Reference: 14 Rosecroft Avenue, Hampstead, London NW3 7QB	
Project / Job Ref: GWPR1540	
Order No: None Supplied	
Reporting Date: 18/02/2016	

QTSE Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
$ 191837	WS1	None Supplied	2.00	5.9	Beige sand
$ 191838	WS2	None Supplied	4.00	15.4	Brown sandy 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

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Soil Analysis Certificate - Methodology & Miscellaneous Information
QTS Environmental Report No: 16-40618
Ground & Water Ltd
Site Reference: 14 Rosecroft Avenue, Hampstead, London NW3 7QB
Project / Job Ref: GWPR1540
Order No: None Supplied
Reporting Date: 18/02/2016

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