2 Oakhill Avenue
London NW3 7RE

Construction Method Statement

Contents

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June 2013
21915

1 Introduction

Price & Myers have been appointed Mr. Ruparell to assist their Architect, Maneesha Sonawane, in the preparation of proposals for the refurbishment and extension of their property at 2 Oakhill Avenue in Hampstead, London. The house will be split into two flats.

This report outlines the progress of the design at Planning Application stage.

The information in this report is based on a visual survey of the existing property and desk study searches of the area, and results of the site-specific geotechnical investigation carried out by Geotechnical & Environmental Associates (GEA); Report Reference J13073, June 2013.

1.1 The Site

Oakhill Avenue runs northeast to southwest between Redington Road and Bracknell Gardens. The site occupies a large rectangular, 50m north-south x 6m east-west sloping plot on the west side of the street, towards the junction with Redington Road. The site is occupied by an end of terrace house, which is set back from the pavement and has its own private driveway. The main building occupies nearly the entire width of the site, with a small passageway on its south side for a garage and access to the rear garden. Steps lead down from the initial rear patio to a rear garden which is separated from the patio by a low retaining wall. The garden continues to slope downwards towards the northwest boundary.

Historic maps included in Appendix A show the site to be undeveloped and occupied by fields, with a stream shown roughly 25m to the north. This stream was completely covered or culverted by 1985. At some time between 1896 and 1915 the site was occupied by part of a large house which covered the southeastern half of the site. At some point between 1966 and the present day this building was demolished and the existing row of three terraced houses was constructed. Online planning records indicate the current development was completed in the early 1970s.

1.2 The Existing Building

The building is used as a single occupancy house, and from a visual inspection of the building the structure appears to consist primarily of loadbearing masonry cavity walls, with a concrete floor slab at ground and first floor level, changing to timber joists at second floor level. Timber construction is assumed at roof level.

As described in section 1.1, it appears that the original parts of the existing building dates from the early 1970s. The WWII Bomb Damage Maps suggest that the site and immediately surrounding areas were unaffected.

1.3 Scoping of Issues

Subterranean, ground water, flow	Response	Refer to:
Is the site located directly above an aquifer?	Yes	Appendix C & section 4
Will the proposed basement extended beneath the water table surface?	No	Appendices C & D & section 4
Is the site within 100m of a watercourse, well (used/disused) or potential spring line?	Yes	Appendices A & C & section 4
Is the site within the catchment of the pond Chains on Hampstead Heath, or within 50m of the ponds?	No	Appendices A & C
Will the proposed basement development result in a change in the proportion of hard surfaced/paved areas?	No	Appendix D & section 4
As part of the site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or SUDS)?	No	
Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to, or lower than, the mean water level in any local pond (not just ponds chains on Hampstead Heath) or spring line.	No	Appendices C & D
Slope Stability		
Does the existing site include slopes, natural or manmade, greater than 7°? (approximately 1 in 8)	No	Appendix D & section 3
Will the proposed re-profiling of landscaping at site change slopes at the property boundary to more than 7°? (approximately 1 in 8)	No	Appendix D & section 3
Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°? (approximately 1 in 8)	Yes	Appendix C
Is the site within a wider hillside setting in which the general slope is greater than 7° ? (approximately 1 in 8)	No	Appendix D & section 3
Is the London Clay the shallowest strata at the site?	Yes	Appendix C & section 3
Will any tree/s be felled as part of the proposed development and/or are any works proposed within any tree zones where trees are to be retained?	Yes	Appendix D

Is there a history of seasonal shrink-swell subsidence in the local area, and/or evidence of such effects at the site?	No	There is no evidence of heave related movement in the existing building.
Is the site within an area of previously worked ground?	No	Appendix C & section 3
Is the site within an aquifer? If so, will the proposed basement extend beneath the water table such that dewatering may be required during construction?	No	Appendix C & section 3
Is the site within 5m of a highway or pedestrian right of way?	Yes	Appendix A & section 3
Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Yes	Appendix D & section 3 & 5.1
Is the site over (or with the exclusion zone of) any tunnels e.g. railway lines?	No	Appendix B
Surface flow and flooding		
As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route?	No	
Will the proposed basement result in changes to the profile of the inflows (instantaneous and long-term) of surface water being received by adjacent properties or downstream watercourses?	No	
Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	No	
Is the site in an area known to be at risk from Surface water flooding, such as South Hampstead, West Hampstead, Gospel Oak and King's Cross, or is it at risk from flooding, for example because the proposed basement is below the static water level of a nearby surface water feature?	No	

2 Surveys and Ground Conditions

The published geological maps of the area are included in Appendix A and indicate that the site is underlain by the Claygate Member (a finely laminated brown sand a silt) of the London Clay, below an unknown thickness of Made Ground. As the ground rises away from the house to the Northeast, the more sandy Bagshot Beds, which overlie Hampstead Heath, start to be encountered. As the ground falls away to the southwest the London Clay starts to be encountered.

Geotechnical & Environmental Associates (GEA) carried out a site investigation in April 2013. The purpose of the investigation was to:

- check the history of the site and surrounding area with respect to previous uses
- determine the ground conditions and their engineering properties
- assess the possible impact of the proposed development on the local hydrogeology
- to investigate the configuration of the existing foundations
- to provide advice with respect to the design of suitable foundations and retaining walls for the proposed development
- provide a preliminary assessment of the presence of soil contamination and assess the risk that any such contamination may pose to the proposed development, its users or the wider environment.

GEAs report (Report Reference J13073, June 2013) is included in Appendix B.

The site investigation confirmed (see section 7.0 of GEA report) the site to be underlain by a layer of made ground, which is in turn underlain by the Claygate Member. The boreholes, which formed part of the investigation, were terminated at 15.0m, and within the Claygate Member.

Groundwater was encountered during the drilling of the boreholes at depths of 1.80m (95.08m OD) and 7.40m (91.73m OD) from within the Claygate Member. Subsequent groundwater monitoring showed groundwater to be present at a depth varying between 93.76m OD and 95.03m OD over a period of four weeks.

3 Proposals

3.1 Introduction

In order to increase the living spaces within the building, and split the building from its current single occupancy to two separate flats, it is proposed to construct an additional level below the current ground floor..

3.2 Permanent Works

A new retaining structure will be required along the north and south boundaries in order to form the new lower ground floor level; this will be achieved using a contiguous piled wall along the southern boundary, and sequential reinforced underpinning along the north and below the Party Wall. Reinforced underpinning will need to be agreed under the Party Wall Agreement.

The existing building will be resupported on new steelwork, which will bear onto new reinforced concrete footings and ground beams, which distribute the load to new piles. The piles will also provide resistance to heave, which may be encountered.

A new reinforced concrete slab on metal decking will form the new floor at ground floor level; this will also act as a diaphragm redistributing lateral loads to the braced steel framing below.

Schematics of the proposed structural arrangement are given in Appendix D.

3.3 Temporary Works

The reinforced underpins and contiguous piled wall will be designed as cantilevers, to avoid temporary propping during the bulk excavation.

During the bulk excavation, the existing structure will be temporarily supported off new piles, which will also be used in the permanent structure.

3.4 External Works

The proposals for the external finishes are similar to those already on site; with a mixture of soft and hard landscaping. It is expected that the landscaping proposals will not alter the existing discharge volumes of the surface water run-off into the ground/the public sewer.

A green roof is to be specified to the new rear extension, which will help to attenuate rainwater within its medium.

As part of the proposals, it is likely that one of more of the existing trees on site will need to be felled. Due to the moderate potential for shrinking or swelling of the clay, consideration will need to be given where it is proposed to remove trees adjacent to existing structures, and how this movement may affect them. This will be given further consideration in the next stage.

Excavations in and around tree roots will be dug by hand and Protection to the root zone will be provided

4 Site Drainage & Ground Water

4.1 Site Drainage

The site drainage strategy will remain largely as existing, with consideration given to the use of SUDs, in line with the Camden Development Policy DP27, the London Plan and the National Planning Policy Framwork.

Due to the site being underlain by clay, options such as soakaways and permeable paving will not be feasible solutions to minimise any discharge into the public sewer. It is therefore assumed that where possible attenuation measures will be incorporated into the design, to restrict the flow rates into the public sewer during peak periods. The design and detail of this will need to be developed in the next stage, and agreed with Thames Water.

The level of the public sewer is unknown, but it is assumed the new basement level drainage will need to be pumped.

4.2 Ground Water and Local Hydrogeology

Rainwater falling on the Heath soaks through the permeable sands and forms into springs where it meets the impermeable clay layers. Many of London's Lost Rivers have their sources at this junction, and one of the tributaries of the River Westbourne is recorded as having passed close to the site – refer to the Lost Rivers of London map in Appendix A and the more detailed information in GEA report.

The small stream noted on the historic maps is likely to have been a tributary of the River Westbourne.

The groundwater that was encountered as part of the site investigation suggest that its level is just over 5 metres below the existing ground floor level. As the construction for the new lower ground floor level will only extend approximately 3.5 metres below this existing level, the new extension cannot have an impact on the existing ground water flows.

The Royal Borough of Kensington and Chelsea recently employed engineers, Ove Arup & Partners to carry out an investigation of the effects of below ground development on local hydrogeology. Arup Geotechnics subsequently published a ‘Subterranean Development Scoping Study’, the conclusions of which include the statement that ‘..[c]oncerns about the significance of the impact of subterranean development on groundwater levels and groundwater flows are likely to be misplaced. It is likely that such effects, if any, will be small and that they may be less significant than seasonal or other variations in the groundwater level.’

5 Construction Methodology

5.1 Construction Method

The basement extension is to be constructed using two different techniques.

Along the southern boundary, a contiguous bored piled wall will a reinforced concrete lining wall will be constructed, designed to resist the lateral pressures of the ground and neighbouring building behind. While the pile rig is on site, piles will also be installed to support the vertical loads at the new lower ground floor level and to provide resistance to heave at this level. As well as providing support for the permenant works, a number of these piles will provide a foundation for the temporary propping required to enable to demolition of existing walls and excavation of the ground levels.

After the piling has been completed, and before the excavation commences, the existing footings to the Party Wall and part of the front elevation will be lowered using a sequential underpinning process. Underpinnning is a quiet and gradual process, well known and understood. The underpins will be reinforced to help resist the lateral pressures exerted on them.

On the completion of the bored pile wall and underpinning, the main bulk excavation for the new lower floor would be completed. This would allow the new structural slabs and foundations to the substructure to be cast. The construction of the superstructure would follow, with the installation of the new steel framework, and metal decking reinforced concrete slab at ground floor level.

This assumed construction sequence is given in Appendix B

There is a single storey lean-to to the neighbouring building at no.4 appears to extend to the boundary with no. 2. More investigation is required to confirm where this sits relative to the boundary, but it is assumed that the construction of the retaining structure in this area will have to be cast using the sequential underpinning technique, as it is unlikely a piles will be able to installed close up to this is existing structure.

The existing building is founded on the Claygate member, and the new extension will also be founded on this strata. The piles will be specified to allow only minimal settlement (10mm) and therefore the risks to adjoining owners is negligible. Movement to the adjacent buildings due to the heave potential from the basement excavation is also considered negligible. Further consideration will be given to this in the next design stage and the design proposals will ensure that movement does not affect the structural integrity of any nearby buildings. The normal Party Wall processes will be undergone in due course to resolve any technical issues that might arise in this respect.

During the works an appropriate movement monitoring strategy should be implemented. This will be agreed during the Party Wall processes and implemented by the main contractor

5.2 Site Hoardings and Security

Site hoardings and security should be agreed with the contractor before works commence. Due to the nature of the work, it is assumed that the hoarding on the boundaries with the neighbouring properties will need to extend into their gardens. This will need to be agreed with the adjoining owners.

5.3 Site Logistics and Management

Good access to the site is available off the Finchley Road (A41), approximately 300m south of the site, and this will make deliveries to and from the site easy, with little impact to the surrounding streets.

A solid timber hoarding will be required along the side boundary, to restrict any public access into the site. There are currently no parking bays in front of the site, due to the private driveways, so it is unlikely that there will need to be any parking suspensions enforced during the construction. Materials can be unloaded at the front of the site, where it would be possible to create a storage zone, or alternatively carried through the existing garage and stored within the garden. Site waste could follow a similar route, and waste from the basement excavation could leave through a conveyor to an awaiting skip.

The chosen Contractor will be required to participate in the Considerate Constructors Scheme, and special consideration will need to be working hours and the potential for noise pollution in accordance with Camden Development Policy DP28

6 Design Criteria

6.1 Codes and Standards

The design will be developed based on the current relevant British Standards.

6.2 Loadings

Typical domestic floor loads of 1.5kN/sqm will be used generally with additional allowances made for heavy floor finishes.

6.3 Design Fire Periods

Fire periods of one hour are achieved generally by the appropriate thicknesses of fireboard or plasterboard. This will be specified by the Architect.

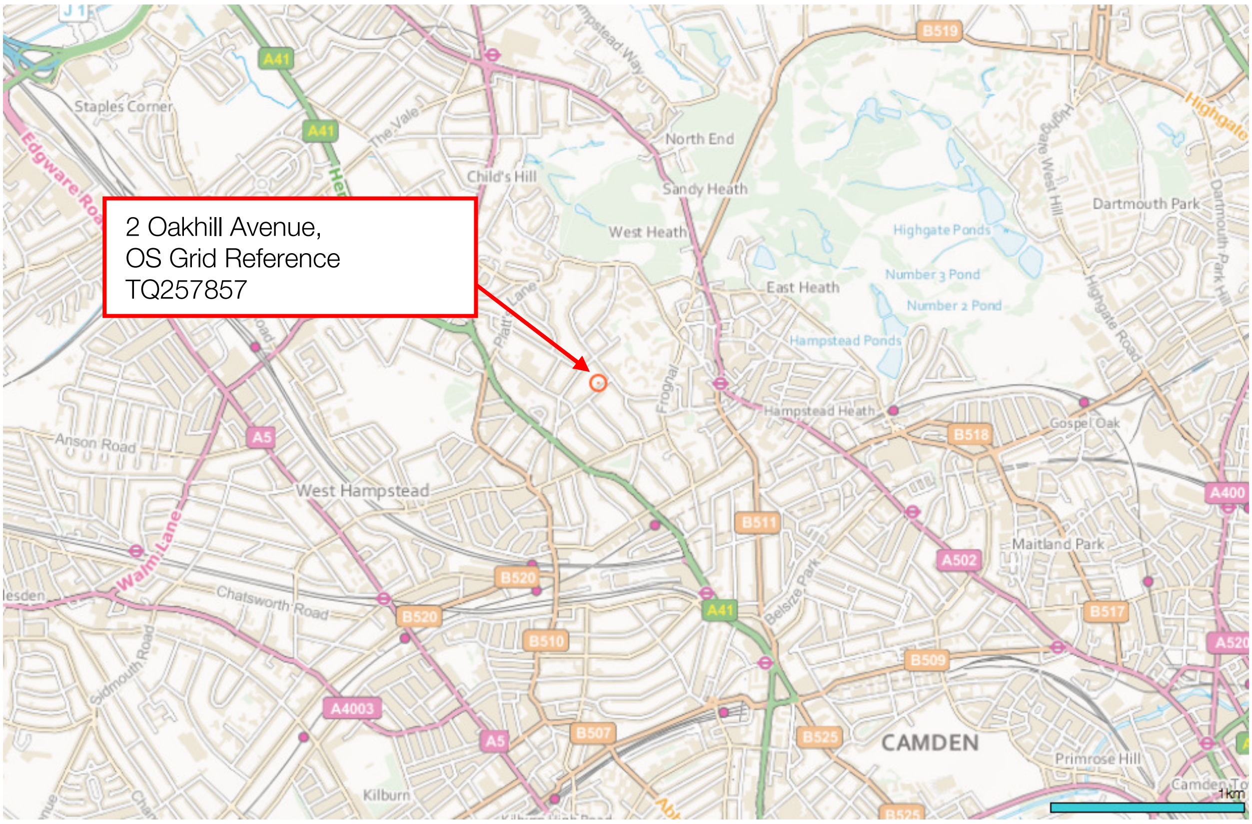
6.4 Disproportionate Collapse

As described in the NHBC Technical Guidance Note (November 2005), for buildings above basements, the minimum robustness measures required to the part of the building above the basement depend on the total number of storeys and the robustness measures applied to the basement storey. For four storeys of multiple occupancy above a basement, providing the basement meets Class 2B, then the remaining structure above can be designed to meet Class 2A.

Therefore the new lower ground floor structure will therefore be designed to meet Category 2B under the Building Regulations Part A3, which requires the incorporation of horizontal ties and vertical ties into the structure, which can be easily detailed as part of the steel frame solution.

It is assumed that the remaining structure, which is mostly existing, will already meet Category 2A, which requires the incorporation of horizontal ties. The existing structure will need to be fully investigated in due course to establish this.

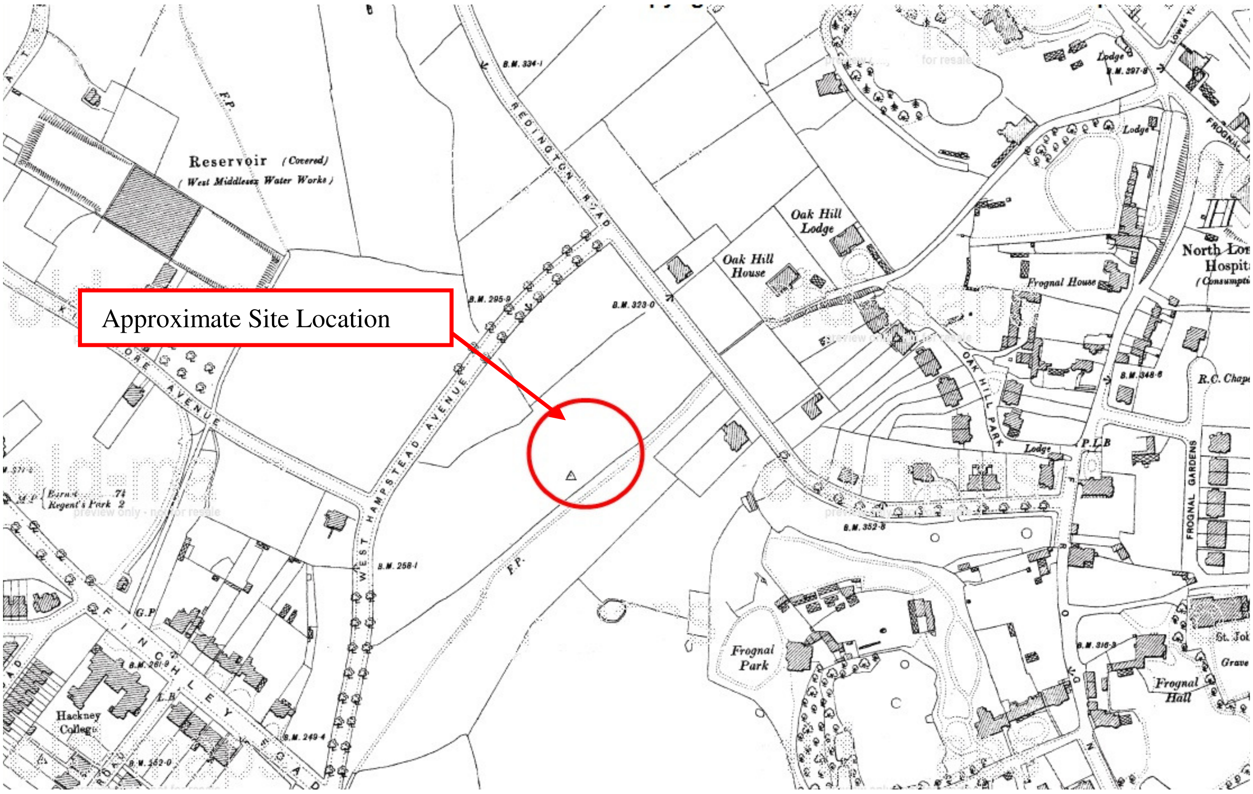
Appendix A – Site Location Plan



Map 1a: OS Map Extract

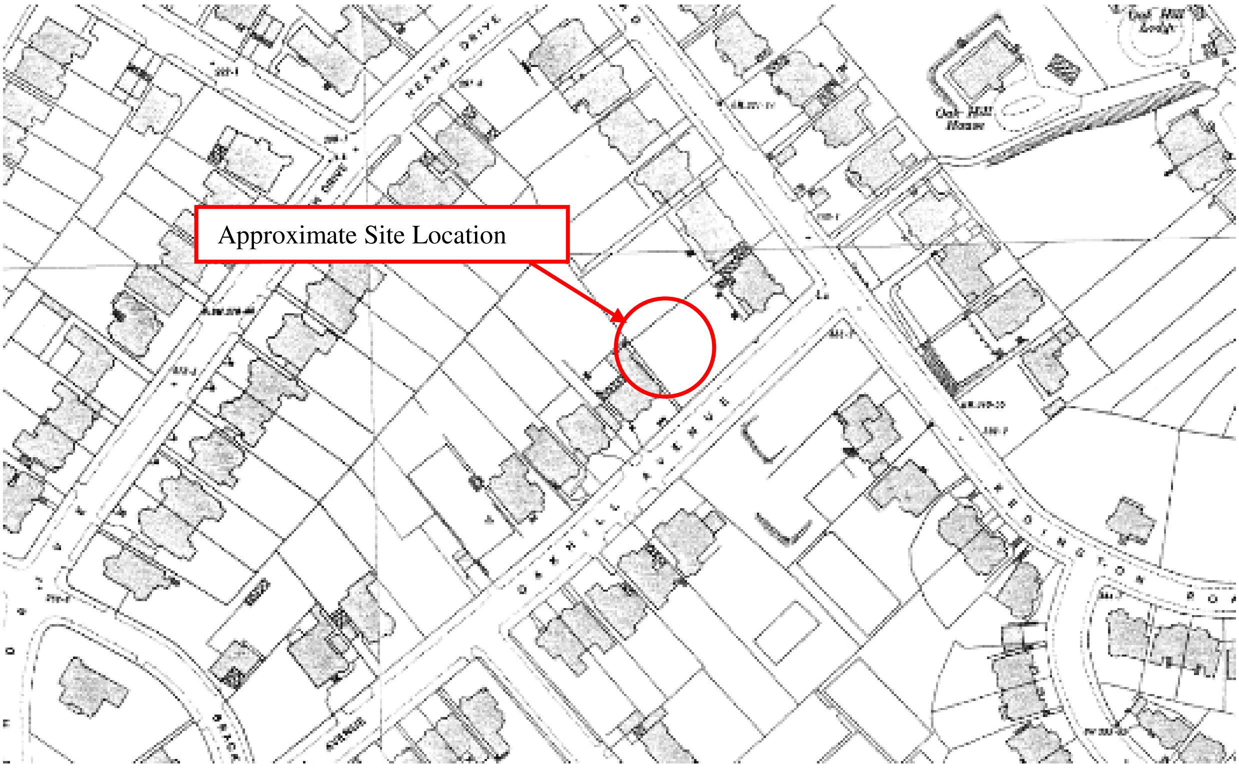
Map 1b: OS Map Extract 2

Appendix B – Desk Study Searches

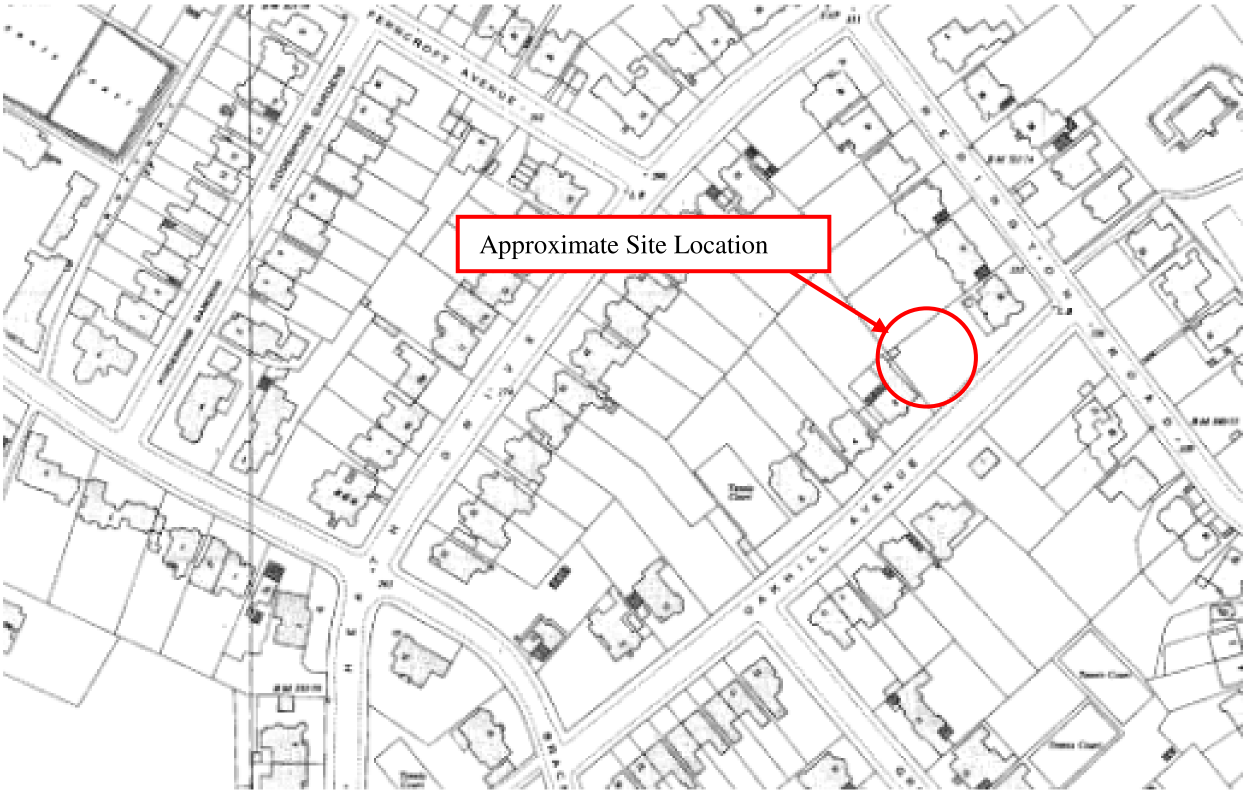


Map 2a: Ordnance Survey Map 1896

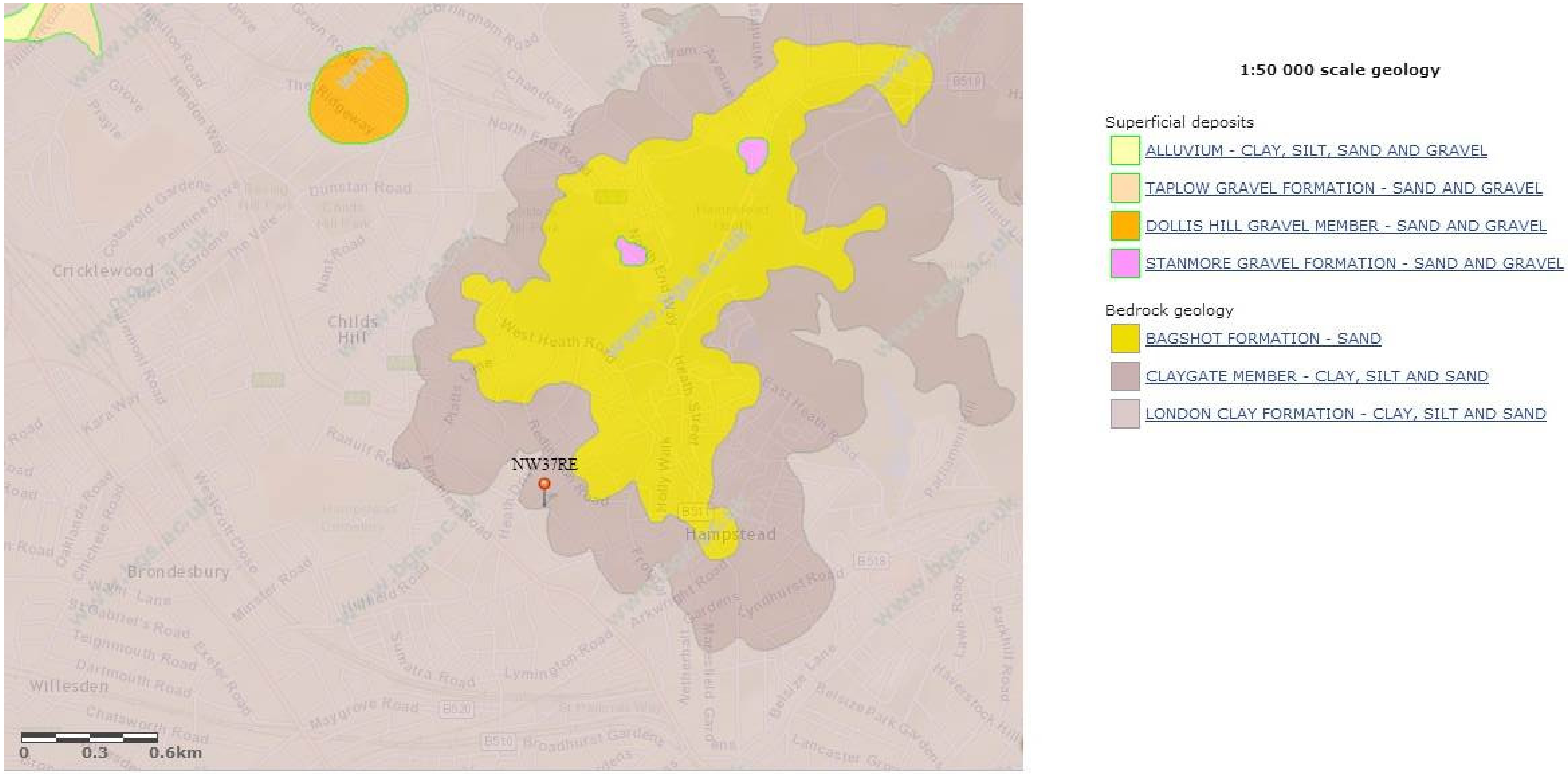
Map 2b: Ordnance Survey Map Extract 1915



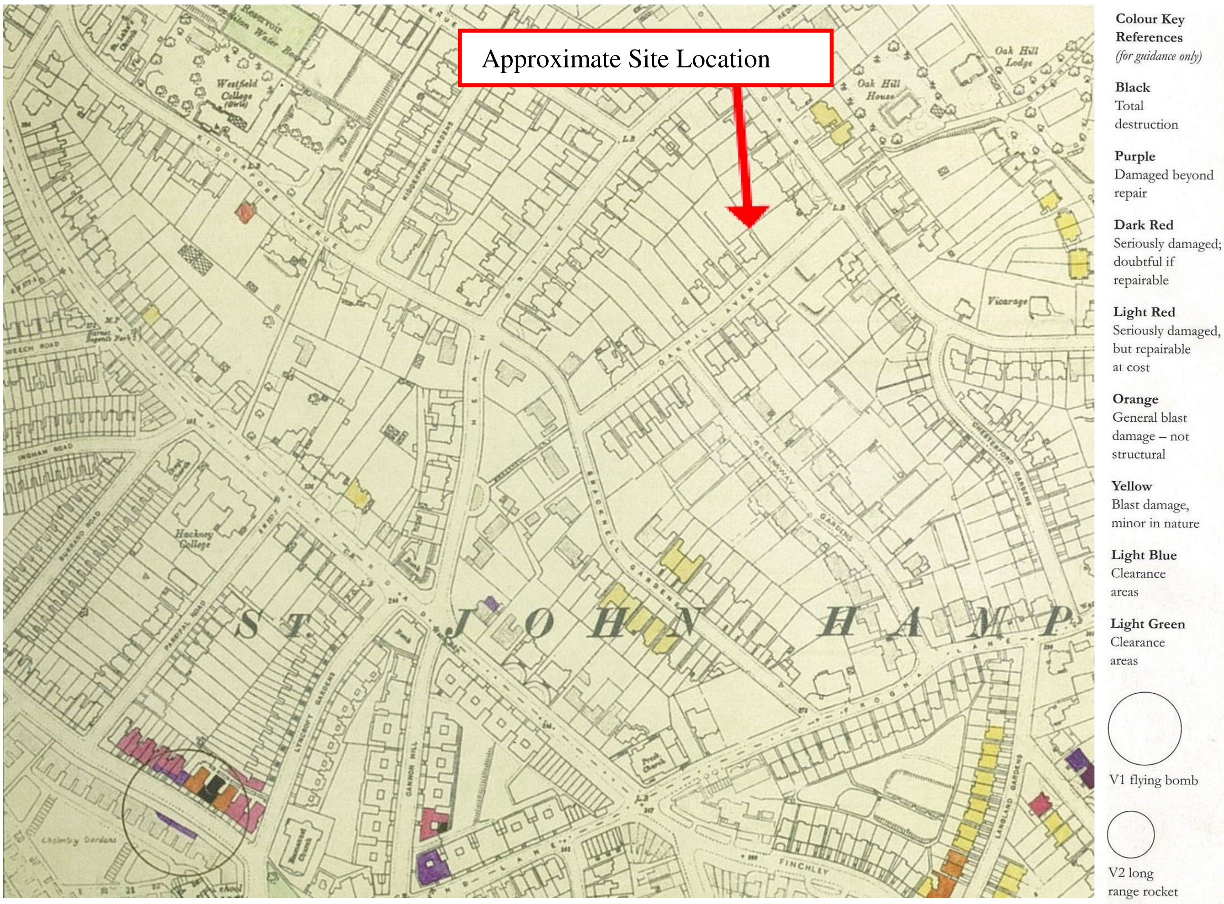
Map 2c: Ordnance Survey Map Extract 1936



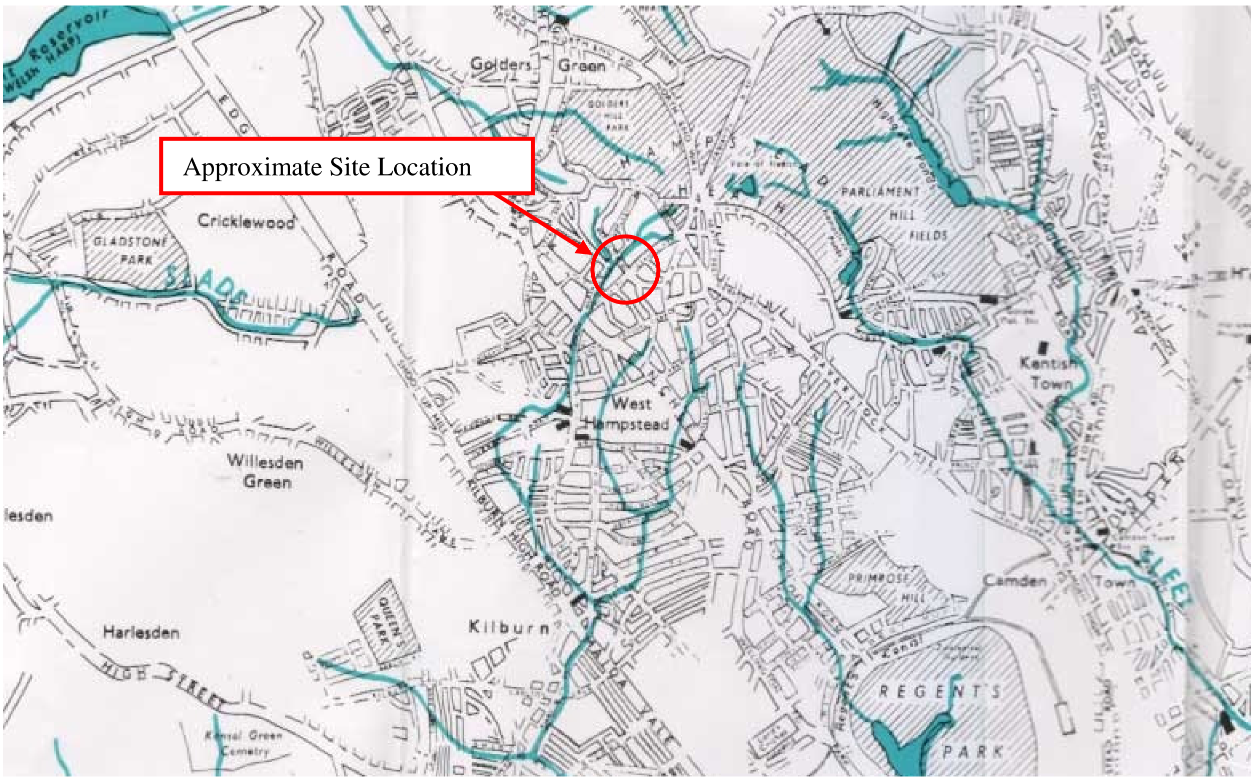
Map 2d: Ordnance Survey Map Extract 1954-1955



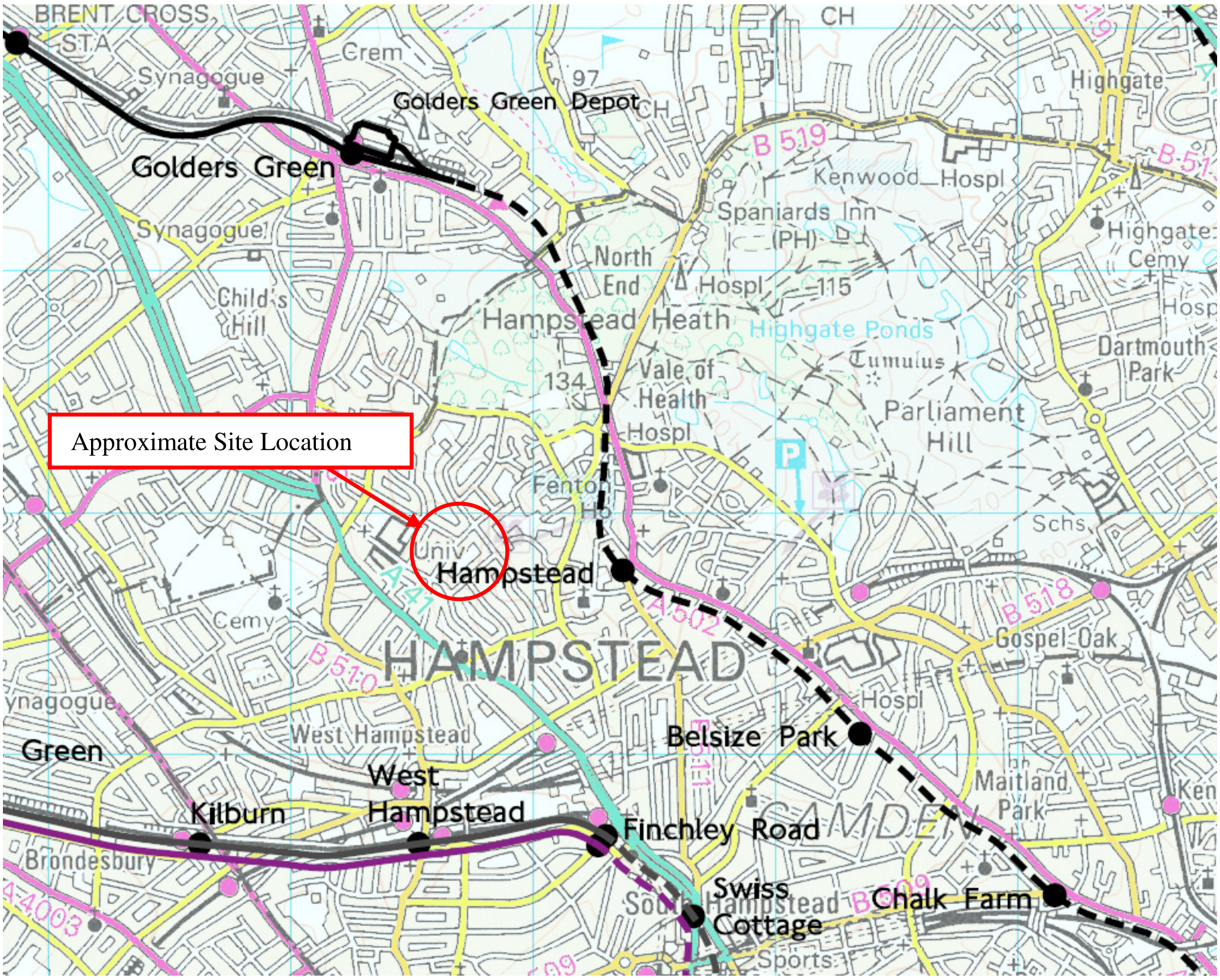
Map 3: British Geological Survey Map Extract



Map 4: World War II Bomb Damage Map Extract



Map 5: Lost Rivers of London Map



Map 6: TfL Tube Map Extract

Appendix C – Site Investigation Report

GEA Report Ref. J13073 (Issue 2) June 2013

Desk Study and Basement Impact Assessment Report

2 Oakhill Avenue
London
NW3 7RE

Client	Mr Abhay Ruparell
Engineer	Price & Myers

J13073

July 2013




Geotechnical & Environmental Associates

Document Control

Project title	2 Oakhill Avenue, Hampstead, London, NW3 7RE		**Project ref**	J13073
Report prepared by	Douglas Atkinson			
With input from	P.P. Martin Cooper BEng CEng MICE FGS	John Evans MSc FGS CGeol		
Report checked and approved for issue by	Steve Branch BSc MSc CGeol FGS FRGS MIEnvSc			

Issue No	**Status**	**Date**	**Approved for Issue**
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3	Final (amended)	3 July 2013	

This report has been issued by the GEA office indicated below. Any enquiries regarding the report should be directed to the office indicated or to Steve Branch in our Herts office.

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CONTENTS

EXECUTIVE SUMMARY

This executive summary contains an overview of the key findings and conclusions. No reliance should be placed on any part of the executive summary until the whole of the report has been read. Other sections of the report may contain information that puts into context the findings that are summarised in the executive summary

BRIEF

This report describes the findings of a ground investigation carried out by Geotechnical and Environmental Associates Limited (GEA) on the instructions of Price and Myers, on behalf of Mr Abhay Ruparell, with respect to the construction of a basement beneath the existing house and rear patio. The purpose of the investigation has been to research the history of the site, to investigate the ground conditions and hydrogeology, to investigate the existing foundations, to assess the extent of any contamination and to provide information to assist in the design of suitable foundations and retaining walls. The report also includes information required to comply with the London Borough of Camden (LBC) Planning Guidance CPG4, relating to the requirement for a Basement Impact Assessment (BIA).

DESK STUDY FINDINGS

The earliest map studied, dated 1871, shows the site to be undeveloped and occupied by fields, with a stream shown roughly 25 m to the north of the site, flowing north north-west, which is likely to be a tributary of the former River Westbourne. This stream was completely covered over or culverted by 1895. At some time between 1896 and 1915 the site was occupied by part of a large house which covered the southeastern-most half of the site. At some point between 1966 and the present day this building was demolished and the existing row of three terraced houses, Nos 2, 2b and 2c Oakhill Avenue, was constructed. A search of online planning records indicates that this development was completed in the early 1970s.

GROUND CONDITIONS

Beneath a nominal to moderate thickness of topsoil and / or made ground, extending to depths of between 0.40 m (96.48 m OD) and 1.10 m (98.17 m OD), the Claygate Member was encountered and proved to the full depth investigated. The Claygate Member initially comprised soft becoming firm orange-brown silty very sandy clay with occasional pockets of fine sand which extended to depths of between 4.30 m (92.58 m OD) and 6.20 m (93.07 m OD), whereupon firm becoming stiff grey silty sandy clay with occasional pockets of grey silty fine sand was encountered and proved to the maximum depth investigated, of 15.00 m (84.13 m OD). Roots were noted in all of the boreholes and were found to extend to depths of between about 1.2 m and 2.0 m. The Claygate Member was noted to be desiccated to a maximum depth of 2.0 m in Borehole No 3, which was advanced in the rear garden area, in close proximity to a 10 m high deciduous tree. Groundwater was encountered during drilling of the boreholes at depths of between 1.80 m (95.08 m OD) and 7.40 m (91.73 m OD). Subsequent monitoring of the standpipes measured groundwater at depths of between 1.60 m (95.03 m OD) from the lower rear garden area and 5.37 m (93.76 m OD) from the higher level on the driveway at the front of the house. The foundations of the existing house are bearing at a depth of 1.18 m on firm sandy clay of the Claygate Member. The contamination analyses have revealed elevated concentrations of arsenic and total PAH including benzo(a) pyrene within samples tested.

RECOMMENDATIONS

Formation level for the 3 m deep basement is likely to be within the Claygate Member and it may be possible to adopt spread foundations, subject to the findings of continued groundwater monitoring and trial excavations. Moderate width pad or strip footings bearing on the firm orange-brown silty sandy clay of the Claygate Member may be designed to apply a net allowable bearing pressure of 125 kN/m^2, below the level of the proposed basement floor. Consideration may also be given to piled foundations. Excavations for the basement structure will require temporary support to maintain stability and prevent any excessive ground movements. The existing foundations will need to be underpinned prior to construction of the proposed basement or be supported by the new retaining walls. The BIA has not indicated any concerns with regard to the effects of the proposed basement on the site and surrounding area. It is recommended that additional sampling and contamination testing is carried out to zone the extent of contamination in the proposed garden areas, once the redevelopment proposals are finalised.

Part 1: INVESTIGATION REPORT

This section of the report details the objectives of the investigation, the work that has been carried out to meet these objectives and the results of the investigation. Interpretation of the findings is presented in Part 2.

1.0 INTRODUCTION

Geotechnical and Environmental Associates (GEA) has been commissioned by Price and Myers, on behalf of Mr Abhay Ruparell, to carry out a desk study and ground investigation at 2 Oakhill Avenue, Hampstead, London, NW3 7RE. This report also forms part of a Basement Impact Assessment (BIA), which has been carried out in accordance with guidelines from the London Borough of Camden (LBC) in support of a planning application.

1.1 Proposed Development

It is understood that it is proposed to excavate a basement beneath the existing house and patio area to the northwest of the house as part of a programme of refurbishment. It is understood that the basement will extend to a depth of about 3.0 m below ground level (96.4 m OD).

This report is specific to the proposed development and the advice herein should be reviewed if the development proposals are amended.

1.2 Purpose of Work

The principal technical objectives of the work carried out were as follows:

- to check the history of the site and surrounding area with respect to previous contaminative uses;
- to determine the ground conditions and their engineering properties;
- to assess the possible impact of the proposed development on the local hydrogeology;
- to investigate the configuration of the existing foundations;
- to provide advice with respect to the design of suitable foundations and retaining walls;
- to provide a preliminary assessment of the presence of soil contamination; and
- to assess the risk that any such contamination may pose to the proposed development, its users or the wider environment.

1.3 Scope of Work

In order to meet the above objectives, a limited desk study was carried out, followed by a ground investigation. The desk study comprised:

- a review of readily available geological maps;

- a review of historical Ordnance Survey (OS) maps sourced from the Envirocheck database; and
- a walkover survey of the site carried out in conjunction with the fieldwork.

In the light of this desk study an intrusive ground investigation was carried out which comprised, in summary, the following activities:

- a single cable percussion borehole drilled to a depth of 15.0 m;
- a series of three window sampler boreholes advanced to a maximum depth of 7.0 m;
- Standard Penetration Tests (SPTs), carried out at regular intervals in the cable percussion borehole, to provide quantitative data on the in-situ strength of the soils;
- installation of groundwater monitoring standpipes in the three of the boreholes and three subsequent monitoring visits over a period of roughly four weeks;
- two trial pits manually excavated to depths of 1.3 m and 1.8 m, in order to investigate the configuration of the foundations of the existing house;
- laboratory testing of selected soil samples for geotechnical purposes and for the presence of contamination; and
- provision of a report presenting and interpreting the above data, together with our advice and recommendations with respect to the proposed development.

The report includes a contaminated land assessment which has been undertaken in accordance with the methodology presented in Contaminated Land Report (CLR) 11[1] and involves identifying, making decisions on, and taking appropriate action to deal with, land contamination in a way that is consistent with government policies and legislation within the United Kingdom. The risk assessment is thus divided into three stages comprising Preliminary Risk Assessment, Generic Quantitative Risk Assessment, and Site-Specific Risk Assessment.

1.3.1 Basement Impact Assessment (BIA)

The work carried out also includes a Hydrogeological Assessment, Land Stability Assessment (also referred to as Slope Stability Assessment) and a Surface Water and Flooding Risk Assessment, all of which form part of the BIA procedure specified in the London Borough of Camden (LBC) Planning Guidance CPG4[2] and their Guidance for Subterranean Development[3] prepared by Arup. The aim of the work is to provide information on land stability and in particular to assess whether the development will affect the stability of neighbouring properties and whether any identified impacts can be appropriately mitigated by the design of the development.

1.3.2 Qualifications

The land stability element of the Basement Impact Assessment (BIA) has been carried out by Martin Cooper, a BEng in Civil Engineering, a chartered engineer (CEng), member of the Institution of Civil Engineers (MICE), and Fellow of the Geological Society (FGS) who has over 20 years specialist experience in ground engineering. The subterranean (groundwater) flow

1 *Model Procedures for the Management of Land Contamination* issued jointly by the Environment Agency and the Department for Environment, Food and Rural Affairs (DEFRA) Sept 2004
2 London Borough of Camden Planning Guidance CPG4 *Basements and lightwells*
3 Ove Arup & Partners (2010) *Camden geological, hydrogeological and hydrological study. Guidance for Subterranean Development.* For London Borough of Camden November 2010

assessment has been carried out by John Evans, MSc in Hydrogeology, Chartered Geologist (CGeol) and Fellow of the Geological Society of London (FGS). The assessments have been made in conjunction with Steve Branch, a BSc in Engineering Geology and Geotechnics, MSc in Geotechnical Engineering, a chartered geologist (CGeol) and Fellow of the Geological Society (FGS) with 25 years' experience in geotechnical engineering and engineering geology. All assessors meet the Geotechnical Adviser criteria of the Site Investigation Steering Group and satisfy the qualification requirements of the Council guidance.

The surface water and flooding element of the BIA is provided for guidance only and should be confirmed by a suitably qualified engineer experienced in carrying out surface water assessments.

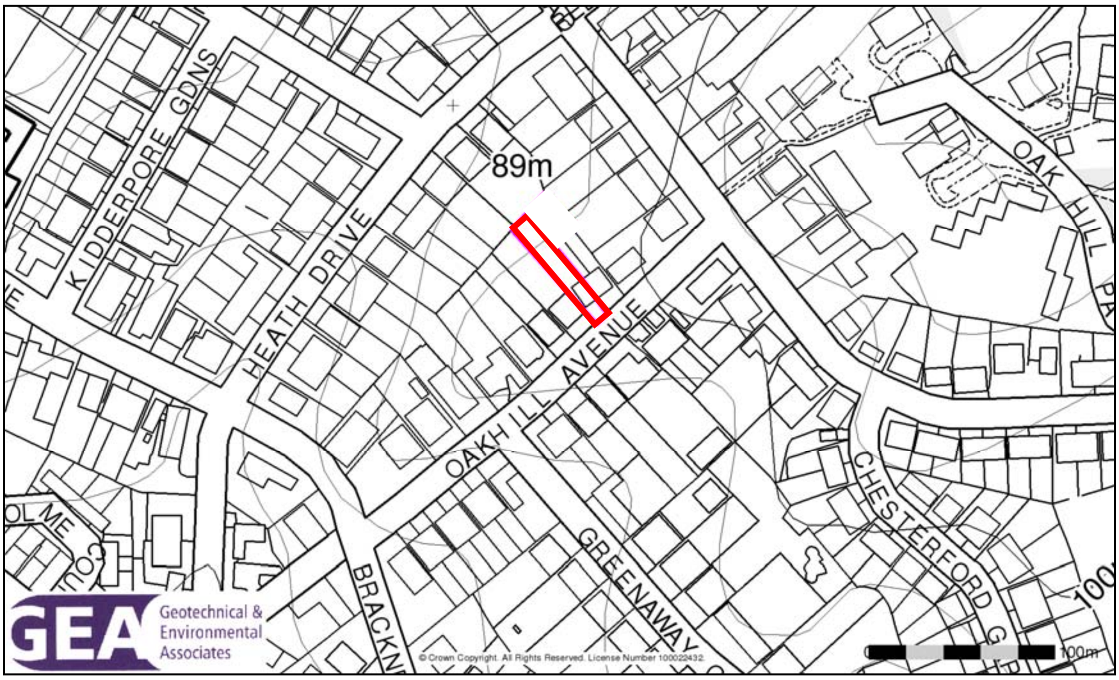
1.4 Limitations

The conclusions and recommendations made in this report are limited to those that can be made on the basis of the investigation. The results of the work should be viewed in the context of the range of data sources consulted, the number of locations where the ground was sampled and the number of soil, gas or groundwater samples tested; no liability can be accepted for information in other data sources or conditions not revealed by the sampling or testing. Any comments made on the basis of information obtained from the client or other third parties are given in good faith on the assumption that the information is accurate; no independent validation of such information has been made by GEA.

2.0 THE SITE

2.1 Site Description

The site is located approximately 750 m to the west of Hampstead London Underground station and fronts onto Oakhill Avenue to the southeast. It is bounded by No 4 Oakhill Avenue a detached three-storey house to the southwest, by No 2c Oakhill Avenue to the northeast and by the rear gardens of houses fronting onto Heath Drive and Redington Road to the northwest and northeast respectively. The site may be additionally located by National Grid Reference 525730, 185770 and is shown on the map below.



The site is roughly rectangular in shape and measures roughly 50 m north-south by 6 m east-west and the garden generally slopes down towards the northwest. The site has been regraded to form a number of different levels and is currently occupied by an end-terrace three-storey house in the southeastern half of the site with associated patio area and rear garden to the northwest of the house. The ground floor level of the house lies at an elevation of about 99.3 m OD and the patio area lies approximately 1.1 m lower.

Steps lead down from the patio area at the rear of the house, to a rear garden which is separated from the patio by a low retaining wall. The garden occupies the northwestern half of the site and is laid to lawn with planted borders and contains assorted shrubs and bushes, together with four mature trees of up to 15.0 m in height located along the southeastern border. Nearest to the house the garden lies at an elevation of about 96.9 m OD and gently slopes down towards the northwestern boundary where it lies at an elevation of 96.69 m. A small man-made pond, measuring about 1.0 m by 1.0 m is present in the rear garden, close to the southwestern boundary.

No 2 Oakhill Avenue; view southeast

Rear garden; view northwest

2.2 Site History

The history of the site and surrounding area has been researched by reference to historical Ordnance Survey (OS) maps sourced from the Envirocheck database.

The earliest map studied, dated 1871, shows the site to be undeveloped and occupied by fields with a stream shown roughly 25 m to the north of the site, flowing north north-west, which is likely to be a former tributary to the River Westbourne; this was culverted or covered by 1895. At some time between 1896 and 1915 a semi-detached house was constructed in the southeastern part of the site. At some point between 1966 and the present day this building was demolished and the existing row of three terraced houses, Nos 2, 2b and 2c Oakhill Avenue were constructed in its place. A search of online planning records indicates that this development was completed in the early 1970s and the site has remained unchanged to the present day.

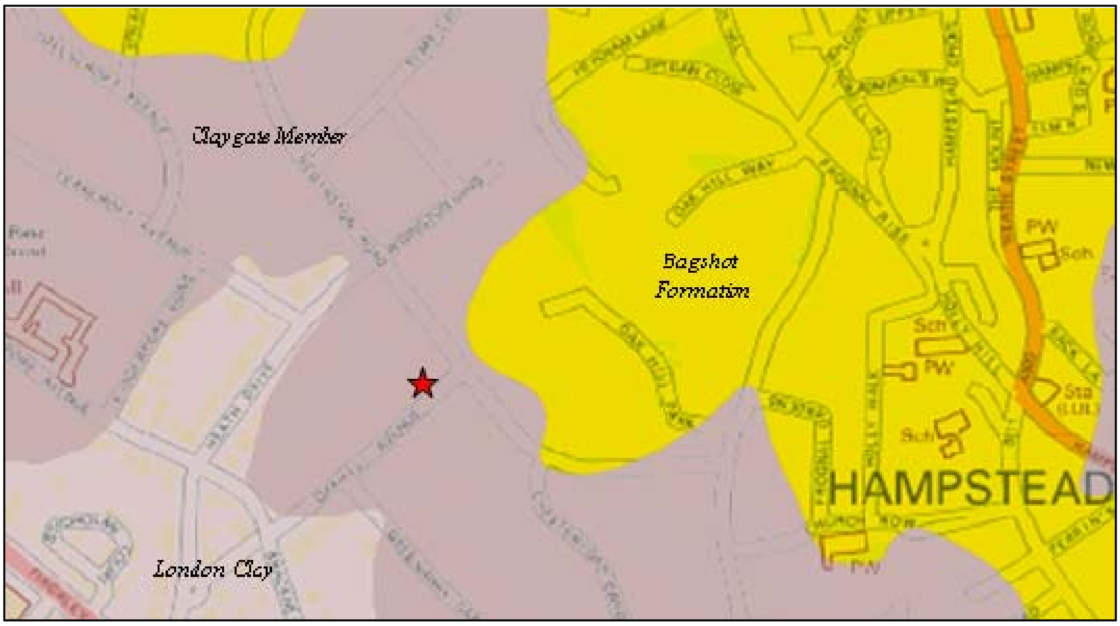
2.3 Geology

The British Geological Survey ((BGS sheet 256) map of the area indicates the site to be underlain by the Claygate Member of the London Clay.

The geology in this area is generally horizontally bedded such that the boundary between the lithologies roughly follows the contour lines. The boundary between the Bagshot Formation and the underlying Claygate Member is located approximately 80 m to the northeast and the boundary between the Claygate Member and London Clay is located roughly 130 m to the south of the site.

Archives of nearby investigations and the published geological map indicate that the Bagshot Formation extends to a level of approximately 115 m OD to 110 m OD and the Claygate Member extends to a level of roughly 90 m OD to 85 m OD in this area.

The Claygate Member generally comprises alternating beds of clay, silt and fine grained sand, whereas the London Clay is generally homogenous, slightly calcareous silty clay to very silty clay, with some beds of clayey silt grading to silty fine grained sand.



A previous investigation carried out 125 m to the southwest of the site, at No 14 Oakhill Avenue, encountered a limited thickness of made ground extending to a maximum depth of 0.75 m, underlain by the Claygate Member, which was found to overlie the London Clay. The Claygate Member was found to initially comprise firm orange-brown mottled brown and grey silty sandy clay extending to depths of between 1.70 m (89.60 m OD) and 3.5 m (88.90 m OD), and was underlain by firm becoming stiff orange-brown and grey very silty clay to depths of between 3.40 m (87.90 m OD) and 5.30 m (85.80 m OD), whereupon firm becoming stiff grey fissured silty clay of the London Clay Formation was encountered and proved to the maximum depth investigated, of 15.0 m (76.30 m OD). Groundwater was encountered within the Claygate Member in all of the boreholes, at depths of between 3.5 m (87.80 m OD) and 6.5 m (84.80 m OD) and groundwater monitoring approximately six weeks after installation recorded water at a depth of 3.0 m (88.30 m OD).

2.4 Hydrogeology and Hydrology

The Claygate Member is classified by the Environment Agency (EA) as a Secondary 'A' Aquifer, which is a permeable layer capable of supporting water supply at local rather than strategic scale, and in some cases proving an important source of base flow to rivers; however this classification is based on the presence of continuous saturated sand bed horizons within the Claygate Member. The underlying London Clay is classified as an Unproductive Stratum, defined by the EA as a rock or drift deposit with low permeability and of negligible significance for water supply or river base flow.

There are no listed water abstraction points or EA designated Source Protection Zones (SPZs) within 1 km of the site. According to the Envirocheck Report the nearest natural surface water feature is a spring that issues from the West Heath, approximately 739 m to the north of the site and up topographic gradient, which flows northwest towards Leg of Mutton Pond.

On the historical maps a headwater of the River Westbourne is shown to have risen roughly 25 m to the north of the site and flowed north-northwest before joining other tributaries and flowing in a generally southerly direction, passing through Hyde Park, where its valley is occupied by The Serpentine, continuing south though Chelsea and issuing into the River Thames opposite Battersea Park. Given the location of the source of this tributary of the River Westbourne, it is likely that it was formed by a spring issuing from close to the boundary between the silty sandy clay of the Claygate Member and the overlying sands of the Bagshot Formation.

Groundwater is likely to be present within the Claygate Member beneath the site and is likely to flow in a generally southwesterly direction, downslope towards the course of the former River Westbourne.

The site is not located within an area at risk of flooding from rivers or sea, as defined by the Environment Agency.

2.5 Other Information

A search of public registers and databases has been made via the Envirocheck database and relevant extracts from the search are appended. Full results of the search are included in the appendix.

The search has revealed that there are no registered landfills, historic landfills, registered waste transfer sites, or waste management facilities within 500 m of the site and there are no contaminated land register entries or notices within 1 km of the site.

The search has indicated that the site is located in an area where less than 1% of homes are affected by radon emissions; which is the lowest classification given by the Health Protection Agency (HPA) and therefore no radon protective measures will be necessary.

2.6 Preliminary Risk Assessment

Part IIA of the Environmental Protection Act 1990, which was inserted into that Act by Section 57 of the Environment Act 1995, provides the main regulatory regime for the identification and remediation of contaminated land. The determination of contaminated sites is based on a “suitable for use” approach which involves managing the risks posed by contaminated land by making risk-based decisions. This risk assessment is carried out on the basis of a source-pathway-receptor approach.

2.6.1 Source

The historical usage of the site that has been established by the desk study and the site walkover indicates that the site does not have a potentially contaminative history by virtue of it having been occupied by housing for the entire developed history. There are thus no obvious likely sources of contamination on the site or in its immediate vicinity.

There are no historical or existing landfill sites within 500 m of the site and therefore there is not a risk to the site from migrating landfill gas.

2.6.2 Receptor

Consideration is being given to the construction of a new basement beneath the existing house and rear patio area. The site will continue to have a residential end use and no new receptors will result. However, the residential end use is considered a high sensitivity end-use. Being underlain by the Claygate Member, classified as a Secondary 'A' Aquifer, groundwater is considered to be a moderately sensitive target. Buried services are likely to come into contact with any contaminants present within the soils through which they pass and site workers are likely to come into direct contact with any contaminants present in the soil during basement excavation and construction.

2.6.3 Pathway

Within the site, end users will be isolated from direct contact with any contaminants present within the near surface soils by the presence of the building and any areas of hardstanding, thus limiting potential contaminant exposure pathways, whilst a potential for direct contact will exist in the rear garden area and any other areas of soft landscaping, although this pathway is already in existence. Any soluble contaminants within the made ground could potentially migrate onto adjacent sites as a result of infiltration of surface run-off, although this pathway is also already in existence. The presence of negligibly permeable clay of the London Clay Formation underlying the permeable silty very sandy clay of the Claygate Member will limit the potential for groundwater percolation to a sensitive aquifer at depth, and thus a pathway is not considered likely to exist to a Principal Aquifer. Buried services may be exposed to any contaminants present within the soil through direct contact and site workers will come into contact with the soils during construction works. There is thus considered to be a low potential for a contaminant pathway to be present between any potential contaminant source and a target for the particular contaminant.

2.6.4 Preliminary Risk Appraisal

On the basis of the above it is considered that there is a VERY LOW risk of there being a significant contaminant linkage at this site which would result in a requirement for major remediation work.

3.0 SCREENING

The LBC guidance suggests that any development proposal that includes a subterranean basement should be screened to determine whether or not a full BIA is required.

3.1 Screening Assessment

A number of screening tools are included in the Arup document and for the purposes of this report reference has been made to Appendix E which includes a series of questions within a screening flowchart for three categories; groundwater flow; land stability; and surface water flow. Responses to the questions are tabulated below.

3.1.1 Subterranean (groundwater) Screening Assessment

Question	Response for 2 Oakhill Avenue
1a. Is the site located directly above an aquifer?	Yes - the site is directly underlain by the Claygate Member, which is classified as a Secondary 'A' Aquifer.
1b. Will the proposed basement extend beneath the water table surface?	Unlikely – the proposed basement extends to a level of 96.4 m OD and groundwater has been in the standpipes at levels of 95.03 m OD and 93.76 m OD.

Question	Response for 2 Oakhill Avenue
2. Is the site within 100 m of a watercourse, well (used/ disused) or potential spring line?	Yes - historically, a source of the River Westbourne arose roughly 25 m to the north of the site and flowed north-northwest before joining other tributaries and flowing in a generally southerly direction.
3. Is the site within the catchment of the pond chains on Hampstead Heath?	No.
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	No.
5. As part of the site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or SUDS)?	No.
6. Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to or lower than, the mean water level in any local pond or spring line?	No.

The above assessment has identified the following potential issues that need to be assessed:

Q1a The site is located directly above an aquifer.
Q2 The site is within 100 m of a potential spring line.

3.1.2 Stability Screening Assessment

Question	Response for 2 Oakhill Avenue
1. Does the existing site include slopes, natural or manmade, greater than 7°?	No - the site is terraced with low vertical retaining walls; however the overall slope angle of the site is less than 7°.
2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7°?	No.
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	Yes - the Camden Geological, Hydrogeological and Hydrological Study Slope Angle Map shows the area of land to the rear of the site, that is currently occupied by houses fronting onto Heath Drive, has a slope angle greater than 7°.
4. Is the site within a wider hillside setting in which the general slope is greater than 7°?	No.
5. Is the London Clay the shallowest strata at the site?	Yes - The site is underlain the Claygate Member of the London Clay Formation.
6. Will any trees be felled as part of the proposed development and / or are any works proposed within any tree protection zones where trees are to be retained?	Yes - One or more of the existing trees on the site are likely to be felled.
7. Is there a history of seasonal shrink-swell subsidence in the local area and / or evidence of such effects at the site?	Yes - There is a moderate potential for shrinking or swelling clay ground stability hazards. However no structures on the site showed any signs of movement that may relate to shrink - swell problems.
8. Is the site within 100 m of a watercourse or potential spring line?	Yes - historically a source of the River Westbourne arose roughly 25 m to the north of the site.
9. Is the site within an area of previously worked ground?	No.
10. Is the site within an aquifer? If so will the proposed basement extend beneath the water table such that dewatering may be required during construction?	Yes - the site is directly underlain by a Secondary 'A' Aquifer. Unknown - given the local geology, topography and groundwater levels from monitoring in the local area, the proposed basement may extend beneath the water table surface.
11. Is the site within 50 m of Hampstead Heath ponds?	No.

Question	Response for 2 Oakhill Avenue
12. Is the site within 5 m of a highway or pedestrian right of way?	Yes - the site fronts onto Oakhill Avenue to the southeast.
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Yes - the depth of adjacent foundations is unknown but it is likely that the development will increase the foundation depths relative to the neighbouring properties to a relatively significant extent.
14. Is the site over (or within the exclusion zone of) any tunnels, eg railway lines?	No.

The above assessment has identified the following potential issues that need to be assessed:

Q3 The development neighbours land with a slope greater than 7°.
Q5 The Claygate Member of the London Clay Formation is the shallowest strata at the site.
Q6 One or more existing trees on the site are to be felled.
Q7 There is a history of seasonal shrink-swell subsidence in the local area.
Q8 The site is within 100 m of a watercourse or potential spring line.
Q10 The site is underlain by an aquifer and the proposed basement may extend beneath the water table such that dewatering may be required during construction.
Q12 The site is within 5 m of a public highway.
Q13 The proposed basement is likely to increase the differential depth of foundations relative to neighbouring properties.

3.1.3 Surface Flow and Flooding Screening Assessment

This element of the BIA is provided for guidance only and should be confirmed by a suitably qualified hydrologist experienced in carrying out surface water assessments.

Question	Response for 2 Oakhill Avenue
1. Is the site within the catchment of the pond chains on Hampstead Heath?	No.
2. As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route?	No.
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	No.
4. Will the proposed basement development result in changes to the profile of the inflows (instantaneous and long term) of surface water being received by adjacent properties or downstream watercourses?	No.
5. Will the proposed basement result in changes to the quantity of surface water being received by adjacent properties or downstream watercourses?	No - the proposed basement is very unlikely to result in any changes to the quality of surface water being received by adjacent properties or downstream watercourses.
6. Is the site in an area known to be at risk from surface water flooding such as South Hampstead, West Hampstead, Gospel Oak and Kings Cross, or is it at risk of flooding because the proposed basement is below the static water level of a nearby surface water feature?	No.

The above assessment has not identified any potential issues that need to be assessed.

4.0 SCOPING AND SITE INVESTIGATION

The purpose of scoping is to assess in more detail the factors to be investigated in the impact assessment. Potential consequences are assessed for each of the identified potential impact factors.

4.1 Potential Impacts

The following potential impacts have been identified.

Potential Impact	Possible Consequence
The site is located directly above an aquifer.	The basement may affect the groundwater flow regime. This could potentially impact on baseflow to watercourses or local private water supplies.
The site is within 100 m of a watercourse or potential spring line.	The basement may alter the groundwater flow regime supporting the watercourse or potential spring line and diverting the groundwater flow route may cause new springs to form or the reactivation of old springs. Seasonal spring lines and changes in groundwater may also affect slope stability.
The development neighbours land with a slope greater than 7°.	Local instability within the site and adjoining sites may occur.
The Claygate Member is the shallowest strata at the site and as such may be subject to seasonal shrink-swell.	Seasonal shrink swell can result in foundation movements and in particular if a new basement is dug to below the depth likely to be affected by tree roots this could lead to damaging differential movement between the subject site and adjoining properties.
Existing trees on the site are to be felled.	The removal of trees can lead to loss of the binding effect of tree roots and can lead to the subsequent instability of slopes. Heave of clay soils related to the removal of trees can lead to structural damage.
Site within 5 m of a highway or pedestrian right of way.	Excavation of a basement may result in structural damage to the road or public footpath.
The development is likely to increase the differential depth of foundations relative to neighbouring properties.	Excavation of a basement may result in structural damage to neighbouring properties if there is a significant differential depth between adjacent foundations.

These potential impacts have been further assessed through the ground investigation, as detailed below.

4.2 Exploratory Work

In order to meet the objectives described in Section 1.2, a single cable percussion borehole was advanced to a depth of 15.0 m (84.13 m OD) on the front driveway. In addition three window sampler boreholes were advanced to a depth of 7.0 m (to depths of between 89.60 m OD and 92.27 m OD) to provide further coverage of the site. Standard Penetration Tests (SPTs) were carried out at regular intervals in the cable percussion borehole to provide quantitative data on the strength of soils encountered. Groundwater monitoring standpipes were installed in Borehole Nos 1, 2 and 4 to depths of 4.00 m (92.88 m OD), 5.00 m (91.60 m OD) and 8.20 m (90.93 m OD) respectively, and have been monitored on three occasions to date, over a period of roughly four weeks.

In addition to the boreholes, two trial pits were manually excavated to depths of 1.3 m and 1.8 m to investigate the configuration of the foundations of the existing house.

All of the above work was carried out under the supervision of a geotechnical engineer from GEA.

A selection of disturbed and undisturbed samples recovered from the boreholes has been submitted to a soil mechanics laboratory for a programme of geotechnical testing and an analytical laboratory for a programme of contamination testing.

The borehole records and the results of the laboratory analyses are appended together with a site plan, which indicates the exploratory locations. The levels shown on the borehole records have been interpolated from temporary benchmark levels (shown on Drawing Ref 1182LS, dated July 2011, provided by the consulting engineers) that have been correlated using a digital altimeter with a known OD level spot height.

4.3 Sampling Strategy

The borehole locations were specified by the consulting engineers and positioned on site by GEA to provide optimum coverage of the site with due regard to the proposed development, whilst avoiding the areas of known services.

Laboratory geotechnical classification tests were undertaken on samples of the natural soil.

Two samples of made ground and a single sample of topsoil were subjected to analysis for a range of common industrial contaminants and contamination indicative parameters. For this investigation the analytical suite for the soil included a range of metals, speciation of total petroleum hydrocarbons (TPH), polycyclic aromatic hydrocarbons (PAH), total cyanide and monohydric phenols. The soil samples were selected to provide a general view of the chemical conditions of the soils that are likely to be involved in a human exposure or groundwater pathway and to provide advice in respect of re-use or for waste disposal classification.

The contamination analyses were carried out at an MCERTs accredited laboratory with the majority of the testing suite accredited to MCERTS standards. Details of the MCERTs accreditation and test methods are included in the Appendix together with the analytical results.

5.0 GROUND CONDITIONS

The investigation has confirmed the expected ground conditions in that, below a nominal to moderate thickness of topsoil / made ground, the Claygate Member was encountered and proved to the maximum depth investigated, of 15.0 m.

5.1 Topsoil / Made Ground

A nominal thickness of topsoil was encountered in all of the boreholes advanced in the rear garden area. The topsoil generally comprised dark brown clayey sandy silt with roots and rare gravel and extended to depths of between 0.10 m (96.78 m OD) and 0.40 m (96.07 m OD). Made ground was encountered beneath the topsoil in Boreholes Nos 2 and 3 and from ground level in Borehole No 4. The made ground typically comprised brown silty sandy clay with occasional fragments of brick, concrete charcoal and ash and extended to depths of between 0.40 m (96.48 m OD) and 1.10 m (98.17 m OD).

No visual or olfactory evidence of contamination was noted during the fieldwork; however, two samples of made ground and a single sample of topsoil have been selected and sent for contamination analysis and the results are summarised in Section 4.4.

5.2 Claygate Member

The Claygate Member initially comprised soft becoming firm orange-brown silty very sandy clay with occasional pockets of fine sand and extended to depths of between 4.30 m (92.58 m OD) and 6.20 m (93.07 m OD), whereupon firm becoming stiff grey silty sandy clay with occasional pockets of grey silty fine sand was encountered and proved to the maximum depth investigated, of 15.00 m (84.13 m OD).

Roots were noted in all of the boreholes and were found to extend to depths of between about 1.2 m and 2.0 m. The Claygate Member was noted to be desiccated to a maximum depth of 2.0 m in Borehole No 3, which was advanced in the rear garden area, in close proximity to a 10 m high deciduous tree. Desiccation was not noted in any of the other boreholes.

Atterberg limit laboratory tests have indicated the Claygate Member to be of moderate volume change potential. The results of the laboratory undrained triaxial compression tests carried out on seven undisturbed samples of clay from Borehole No 4 indicate the Claygate Member to be of medium to very high strength with undrained shear strengths ranging from 76 kN/m^2 to 206 kN/m^2 at depths of between 1.20 m and 13.50 m.

These soils were observed to be free of any visual or olfactory evidence of contamination.

5.3 Groundwater

Groundwater was not encountered during excavation of the trial pits, which extended to depths of 1.3 m and 1.8 m.

Groundwater was encountered during drilling within all four boreholes at depths of between 1.80 m (95.08 m OD) and 7.40 m (91.73 m OD) from within the Claygate Member. Groundwater monitoring standpipes were installed in Borehole Nos 1, 2 and 4 at depths of 4.00 m, 5.00 m and 8.20 m. Groundwater monitoring has subsequently been carried out on three occasions to date over a period of roughly four weeks and the findings are presented in the table below.

Date	Borehole No	Depth to water (m) [Level (m OD)]
16/04/2013	1	1.60 [95.00]
	2	1.85 [95.03]
	4	5.20 [93.93]
24/04/2013	1	2.00 [94.60]
	2	2.40 [94.48]
	4	5.26 [93.87]
13/05/2013	1	2.21 [94.39]
	2	2.60 [94.28]
	4	5.37 [93.76]

Monitoring of the standpipes should be continued in order to establish equilibrium levels and to determine the extent of any seasonal fluctuations.

5.4 Soil Contamination

The table below sets out the values measured within two samples of made ground and a single sample of topsoil analysed; all concentrations are in mg/kg unless otherwise stated.

Determinant	BH1 0.3 m	BH2 0.2 m	BH3 0.5 m
pH	6.6	7.9	7.3
Arsenic	**37**	29	19
Cadmium	0.30	0.16	0.33
Chromium	<0.50	8.3	<0.50
Copper	48	48	55
Mercury	0.48	0.48	1.30
Nickel	5.3	<5.0	<5.0
Lead	300	680	500
Selenium	<0.20	<0.20	<0.20
Zinc	160	210	130
Total Cyanide	<0.50	<0.50	<0.50
Total Phenols	<0.30	<0.30	<0.30
Sulphide	1.30	0.91	1.40
TPH	18	57	76
Total PAH	**9.1**	**8.0**	**22.0**
Benzo(a)pyrene	0.86	0.74	**2.2**
Naphthalene	0.52	<0.10	0.48
Total organic carbon %	6.9	2.3	4.8
Note: Figures in bold indicates concentration in excess of risk-based soil guideline values, as discussed below			

5.4.1 Generic Quantitative Risk Assessment

The use of a risk-based approach has been adopted to provide an initial screening of the test results to assess the need for subsequent site-specific risk assessments. To this end the contaminants of concern are those that have values in excess of a generic human health risk based guideline values which are either that of the CLEA[4] Soil Guideline Value where available, or is a Generic Guideline Value calculated using the CLEA UK Version 1.06 software assuming a residential end use.

The key generic assumptions for this end use are as follows:

- that groundwater is not a critical risk receptor;
- that the critical receptor for human health will be young female child (aged zero to six years old);

4 *Updated Technical Background to the CLEA Model (Science Report SC050021/SR3) Jan 2009* and Soil Guideline Value reports for specific contaminants; all DEFRA and Environment Agency.

- that the exposure duration will be six years;
- that the critical exposure pathways will be direct soil and indoor dust ingestion, consumption of homegrown produce, consumption of soil adhering to homegrown produce, skin contact with soils and dust, and inhalation of dust and vapours; and
- that the building type equates to a two-storey terraced house.

It is considered that these assumptions are acceptable for this generic assessment of this site. The tables of generic screening values derived by GEA and an explanation of how each value has been derived are included in the Appendix.

Where contaminant concentrations are measured at concentrations below the generic screening value it is considered that they pose an acceptable level of risk and thus further consideration of these contaminant concentrations is not required. However, where concentrations are measured in excess of these generic screening values there is considered to be a potential that they could pose an unacceptable risk and thus further action will be required which could include;

- additional testing to zone the extent of the contaminated material and thus reduce the uncertainty with regard to its potential risk;
- site specific risk assessment to refine the assessment criteria and allow an assessment to be made as to whether the concentration present would pose an unacceptable risk at this site; or
- soil remediation or risk management to mitigate the risk posed by the contaminant to a degree that it poses an acceptable risk.

This assessment is based upon the potential for risk to human health, which at this site is considered to be the critical risk receptor. The results of the chemical analysis have revealed an elevated concentration of arsenic, of 37 mg/kg, in a single sample of topsoil taken at a depth of 0.30 m from Borehole No 1, located in the rear garden area and elevated concentrations of total PAHs in all three samples of topsoil / made ground, including an elevated benzo(a)pyrene of 2.2 mg/kg from the sample of made ground taken at a depth of 0.50 m from Borehole No 3.

The significance of these results is considered further in Part 2 of the report.

5.5 Existing Foundations

Trial Pit No 1 was excavated in the patio area to the rear of the house, adjacent to the northwestern external wall. It revealed a brick wall extending to a depth of 0.55 m, with two brick corbels and a concrete footing extending to a depth of 1.18 m, bearing on the firm orange-brown sandy clay of the Claygate Member. Trial Pit No 2 was advanced in the area of hardstanding to the rear of the garage, adjacent to the southwestern external wall. It revealed a brick wall extending to a depth of 1.00 m, whereupon a concrete obstruction was encountered such that the extent of the footing could not be proved. Probing down between the concrete obstruction and brick wall suggests that the top of the footing is at a depth of about 1.80 m.

Copies of the trial pit records are included in the appendix.

Part 2: DESIGN BASIS REPORT

This section of the report provides an interpretation of the findings detailed in Part 1, in the form of a ground model, and then provides advice and recommendations for foundations and other aspects of the development.

6.0 INTRODUCTION

It is understood that it is proposed to construct a basement beneath the existing house and rear patio area as part of a programme of refurbishment. Foundation loads are not known, but are expected to be light to moderate and thus typical for this type of development.

7.0 GROUND MODEL

The desk study has indicated that the site has been occupied by housing for its entire known developed history. On the basis of the investigation, the ground conditions at this site can be characterised as follows:

- a nominal to moderate thickness of topsoil / made ground overlies the Claygate Member of the London Clay Formation;
- the made ground / topsoil extends to depths of between 0.40 m and 1.10 m;
- the Claygate Member, initially comprises soft becoming firm orange-brown mottled brown and grey silty very sandy clay to depths of between 4.30 m and 6.20 m, whereupon firm becoming stiff grey silty sandy clay with occasional pockets of grey silty fine sand extends to a depth of 15.00 m.
- the Claygate Member was noted to be desiccated to a maximum depth of 2.0 m in Borehole No 3, located in close proximity to a 10 m high tree;
- groundwater is present at depths of between 1.60 m (95.03 m OD) and 5.37 m (93.76 m OD) from within the Claygate Member; and
- the chemical analysis identified elevated concentrations of arsenic and total PAH, including benzo (a) pyrene, within samples tested.

8.0 ADVICE AND RECOMMENDATIONS

Formation level for the approximately 3.0 m deep basement (96.4 m OD) will be within the Claygate Member. On the basis of the groundwater monitoring results to date, groundwater is unlikely to be encountered during basement excavation.

Excavations for the proposed basement structure will require temporary support to maintain stability of the excavation and surrounding structures at all times. It will be necessary to underpin the existing foundations of the existing house and neighbouring structures or to design the new retaining walls to accommodate the load from the existing structures.

8.1 Basement Excavation

8.1.1 Basement Construction

The investigation has indicated that the formation level of the proposed basement will be within the Claygate Member, at a level of about 96.4 m OD. On the basis of the groundwater monitoring to date, which indicates a groundwater level of between 95.03 m OD and 93.76 m OD, groundwater is unlikely to be encountered during the basement excavation, although it would be prudent to continue monitoring in order to establish equilibrium levels and the extent of any seasonal fluctuations.

Shallow inflows of perched water may also be encountered from within the made ground, particularly within the vicinity of existing foundations although these should be adequately dealt with through sump pumping.

It would be prudent to carry out a number of trial excavations, to depths as close to the full basement depth as possible, to provide an indication of the likely groundwater conditions, and to provide an indication of excavation stability. It is important to bear in mind that inflows may result from the presence of inter-connected pockets of water within the sand and silt pockets of the Claygate Member, which were not encountered during the investigation.

There are a number of methods by which the sides of the basement excavation could be supported in the temporary and permanent conditions. The choice of support may be governed to a large extent by whether it is to be incorporated into the permanent works and have a load bearing function. The final choice will depend to a large extent on the need to protect nearby structures from movements, the required overall stiffness of the support system, and the need to control groundwater movement through the wall in the temporary condition.

The most suitable method of support will probably therefore be to form the retaining walls by mass concrete underpinning of the existing foundations, using a traditional ‘hit and miss’ approach. Careful workmanship will be required to ensure that movement of the surrounding structures does not arise. Alternatively consideration could be given to the use of a bored pile wall, which could have the advantage of being incorporated into the permanent works and will be able to provide support for structural loads. The monitoring carried out to date would suggest that groundwater is unlikely to be encountered within the excavation and therefore it should be possible to adopt a contiguous bored pile wall with the use of localised grouting and sump pumping if necessary in order to deal with any groundwater inflows. However, if trial excavations indicate significant inflows of groundwater into the basement excavation a secant wall may be required to provide the necessary water-tightness.

The ground movements associated with the basement excavation will depend on the method of excavation and support and the overall stiffness of the basement structure in the temporary condition. Thus, a suitable amount of propping will be required to provide the necessary rigidity. In this respect the timing of the provision of support to the wall will have an important effect on movements. The stability of the existing foundations and surrounding structures will need to be ensured at all times and the retaining walls will need to be designed to accommodate the loads from these foundations unless they are underpinned.

8.1.2 Basement Retaining Walls

The following parameters are suggested for the design of the permanent basement retaining walls.

Stratum	Bulk Density (kg/m^3)	Effective Cohesion (c' – kN/m^2)	Effective Friction Angle (Φ' – degrees)
Made ground	1800	Zero	27
Claygate Member	2000	Zero	25

Groundwater has been measured at depths of between 1.60 m (95.03 m OD) and 5.37 m (93.76 m OD) and is unlikely to be encountered during basement excavation although monitoring should be continued to confirm this view.

At this stage, it is recommended that the basement is designed with a water level assumed to be two-thirds of the basement depth, unless a fully effective drainage system can be ensured. It may however be possible to review this requirement following additional investigation by means of trial excavations and further monitoring and the advice in BS8102:2009[5] should be followed in this respect.

8.1.3 Basement Heave

The excavation of the proposed basement is likely to result in heave of the underlying Claygate Member, which will comprise an "immediate" elastic component that may be expected to occur within the construction period, together with long term swelling movement that would theoretically occur over a period of many years. The effects are likely to be mitigated to some extent by the loads applied by the existing and proposed structures. However, a more detailed analysis of the possible heave should be carried out once the basement design has been finalised.

8.1.4 Basement Floor Slabs

It should be possible to adopt a light to moderately loaded ground bearing floor slab bearing on the Claygate Member. Consideration may need to be given to designing the slab to accommodate heave movements and this should be considered in more detail once the proposed loads and levels are known.

8.2 Spread Foundations

Moderate width pad or strip foundations, bearing in the firm orange-brown silty sandy clay of the Claygate Member may be designed to apply a net allowable bearing pressure of 125 kN/m^2 below the level of proposed basement. This value provides an adequate factor of safety against bearing capacity failure and should ensure that settlement remains within normal tolerable limits.

Possible desiccation was noted in Borehole No 3 to a depth of 2.00 m, located in close proximity to mature trees in the rear garden. Once the final levels are known, the depth of founding should be checked to ensure that it provides sufficient protection against tree root growth and it is recommended that the basement excavation is inspected by a qualified and experienced geotechnical engineer.

If proposed loads are high or groundwater is encountered close to the base of the foundations such that spread foundations become unfeasible, piled foundations would provide a suitable solution.

5 BS8102 (2009) *Code of practice for protection of below ground structures against water from the ground*

8.3 Piled Foundations

For the ground conditions encountered at the site, some form of bored pile is likely to be the most suitable. A conventional rotary augered pile would be appropriate but given the available space is unlikely to be suitable. Alternatively, consideration could be given to the use of bored piles installed using continuous flight auger (cfa) techniques, which would not require the provision of casing. The final choice of pile type will be largely governed by the access restrictions and working area.

The following table of ultimate coefficients may be used for the preliminary design of bored piles, which have been based on the SPT & Cohesion / depth graph in the appendix.

Ultimate Skin Friction		**kN/m^2**
Made ground and Claygate Member	GL to 3.0 m	Ignore (basement excavation)
Claygate Member	3.0 m to 15.0 m	Increasing linearly from 20 to 75
Ultimate End Bearing		**kN/m^2**
Claygate Member	12.5 m to 15.0 m	Increasing linearly from 1170 to 1400

On the basis of the above coefficients it has been estimated that a 450 mm diameter pile, founding within the Claygate Member at a depth of 15 m, or approximately 12 m below the level of the proposed basement, should provide a safe working load of about 400 kN, based on an overall factor of safety of 2.6. Alternatively a 600 mm diameter pile, founding within the Claygate Member at a depth of 12.5 m, or approximately 9.5 m below basement level should provide a safe working load of about 415 kN.

The above examples are not intended to constitute any form of recommendation with respect to pile size or type and the advice of specialist piling contractors should be consulted in this respect.

8.4 Shallow Excavations

On the basis of the borehole and trial pit findings it is considered likely that it will be generally feasible to form relatively shallow excavations terminating within the made ground or firm silty clay of the Claygate Member without the requirement for lateral support, although localised instabilities may occur. Inflows of groundwater are unlikely to be encountered in shallow excavations although perched water may be present within the made ground, particularly in the vicinity of existing foundations and any such inflows should be controllable with sump pumping. However, should deeper excavations be considered or if excavations are to remain open for prolonged periods it is recommended that provision be made for battered side slopes or lateral support. Where personnel are required to enter excavations, a risk assessment should be carried out and temporary lateral support or battering of the excavation sides is considered necessary in order to comply with normal safety requirements.

8.5 Effect of Sulphates

Chemical analyses have revealed a moderately low concentration of soluble sulphate and mildly alkaline pH in accordance with Class DS-1 and DS-2 conditions of Table C2 of BRE Special

Digest 1 Part C (2005). The measured pH values of the samples show that an ACEC class of AC-2 would be appropriate for the site, assuming a worst case scenario and a mobile water condition at the site. The guidelines contained in the above digest should be followed in the design of foundation concrete.

8.6 Site Specific Risk Assessment

The site is not considered to have had a contaminative history, by virtue of it having been occupied by houses since prior to 1915. The desk study identified a very low risk of there being a significant pollution linkage present at this site. However, the chemical analyses have revealed an elevated concentration of arsenic in a single sample of topsoil and elevated concentrations total PAHs in all three samples of topsoil / made ground, including benzo (a) pyrene in the sample of made ground from Borehole No 3.

Although the total PAH is elevated, the constituent PAH compounds were not elevated above the respective guideline values in Borehole Nos 1 and 2 and as such, the measured total PAH is not of concern in these areas. The elevated benzo (a) pyrene taken from a sample of made ground from Borehole No 3 and arsenic from a sample of topsoil from Borehole No 1 could pose a potentially unacceptable risk to human health through direct contact, accidental ingestion or inhalation of soil or soil derived dust. However, the basement is proposed to extend beneath the rear patio and as such the excavation will remove the made ground from the area around Borehole 3, and hence remove the potential risk to end users in this area. Further consideration should however be given to the risks to end users posed by the elevated concentration of arsenic and the risks to site workers. Further testing should be carried to zone the extent of contamination in the rear garden area and on any soil that is proposed to be reused in the reinstatement of the garden above the basement level.

8.6.1 End Users

The basement excavation will remove the made ground and potential contamination at this site although a single elevated concentration of arsenic was identified at a depth of 0.3 m from Borehole No 1, outside the proposed excavation area. The slightly elevated concentration of arsenic, of 37 mg/kg is not considered to pose a significant risk to human health on the basis that no new receptors or exposure pathways will be introduced by the proposed development. However, only a limited number of samples were tested to provide an initial assessment of the presence of contamination and it is recommended that further testing is carried out to determine the extent of arsenic contamination across the rest of the garden.

8.6.1 Site Workers

Site workers should be made aware of the contamination and a programme of working should be identified to protect workers handling any soil. The method of site working should be in accordance with guidelines set out by HSE[6] and CIRIA[7] and the requirements of the Local Authority Environmental Health Officer.

8.7 Waste Disposal

Any spoil arising from excavations or landscaping works, which is not to be re-used in accordance with the CL:AIRE guidance[8], will need to be disposed of to a licensed tip. Under the European Waste Directive, waste is classified as being either Hazardous or Non-Hazardous and

6 HSE (1992) HS(G)66 *Protection of workers and the general public during the development of contaminated land* HMSO

7 CIRIA (1996) *A guide for safe working on contaminated sites* Report 132, Construction Industry Research and Information Association

8 CL:AIRE (2011) *The Definition of Waste: Development Industry Code of Practice* Version 2, March 2011

landfills receiving waste are classified as accepting hazardous or non-hazardous wastes or the non-hazardous sub-category of inert waste in accordance with the Waste Directive. Waste going to landfill is subject to landfill tax at either the standard rate of £64 per tonne (about £120 per m^3) or at the lower rate of £2.50 per tonne (roughly £5 per m^3). However, the classifications for tax purposes and disposal purposes differ and currently all made ground and topsoil is taxable at the 'standard' rate and only naturally occurring rocks and soils, which are accurately described as such in terms of the 2011 Order[9], would qualify for the 'lower rate' of landfill tax.

Based upon on the technical guidance provided by the Environment Agency[10] it is considered likely that the made ground from this site, as represented by the four chemical analyses carried out, would be classified as NON-HAZARDOUS waste under the waste code 17 05 04 (soils and stones not containing dangerous substances) and would be taxable at the standard rate. It is likely that the natural soils, if separated out, could be classified as an INERT waste also under the waste code 17 05 04. This material would be taxable at the lower rate, if accurately described as naturally occurring clay in terms of the 2011 Order on the waste transfer note. As the site has never been developed or used for the storage of potentially hazardous materials, it is likely that WAC leaching tests would not be required for such inert waste going to landfill. This would however need to be confirmed by the receiving landfill site.

Under the requirements of the European Waste Directive all waste needs to be pre-treated prior to disposal. The pre-treatment process must be physical, thermal, chemical or biological, including sorting. It must change the characteristics of the waste in order to reduce its volume, hazardous nature, facilitate handling or enhance recovery. The waste producer can carry out the treatment but they will need to provide documentation to prove that this has been carried out. Alternatively, the treatment can be carried out by an approved contractor. The Environment Agency has issued a position paper[11] which states that in certain circumstances, segregation at source may be considered as pre-treatment and thus excavated material may not have to be treated prior to landfilling if the soils can be segregated onsite prior to excavation by sufficiently characterising the soils in-situ prior to excavation.

The above opinion with regard to the classification of the excavated soils and its likely landfill taxable rate is provided for guidance only and should be confirmed by the receiving landfill once the soils to be discarded have been identified.

The local waste regulation department of the Environment Agency (EA) should be contacted to obtain details of tips that are licensed to accept the soil represented by the test results. The tips will be able to provide costs for disposing of this material but may require further testing.

If consideration were to be given to the re-use of the soil as a structural fill on this or another site, in accordance with the Code of Practice for the definition of waste, it would be necessary to confirm its suitability for use, its certainty of use and to confirm that only as much material is to be used as is required for the specific purpose for which it was being used. A materials management plan could then be formulated and a tracking system put in place such that once placed the material would no longer be regarded as being a waste and thus waste management licensing and landfill tax would not apply.

9 *Landfill Tax (Qualifying Material) Order 2011*

10 Environment Agency (2008) *Hazardous Waste: Interpretation of the definition and classification of hazardous waste. Technical Guidance* WM2 Second Edition Version 2.2, May 2008

11 Regulatory Position Statement (2007) *Treating non-hazardous waste for landfill - Enforcing the new requirement* Environment Agency 23 Oct 2007

9.0 BASEMENT IMPACT ASSESSMENT

Consideration is being given to the construction of a 3.0 m deep basement beneath the existing house. The proposed basement is unlikely to have any significant effect on groundwater levels as it is wholly within the Claygate Member so does not provide any form of cut-off into less permeable strata.

The screening identified a number of potential impacts. The desk study and ground investigation information has been used below to review the potential impacts, to assess the likelihood of them occurring and the scope for reasonable engineering mitigation.

The table below summarises the previously identified potential impacts and the additional information that is now available from the site investigation in consideration of each impact.

Potential Impact	Site Investigation Conclusions
The site is underlain by an aquifer and the basement could interfere with the groundwater flow regime.	Groundwater monitoring to date has found that the water table is present at a level of between 95.03 m and 93.76 m OD. The proposed 3.0 m deep basement, extending to a level of about 96.4 m OD, should not therefore extend beneath the water table and hence will not affect the groundwater flow regime, although groundwater monitoring should be continued to establish equilibrium levels and to determine the extent of any seasonal fluctuations in order to confirm this view. Dewatering during construction is unlikely to be required and will not therefore impact on the stability of adjacent structures, although it would be prudent to carry out trial excavations in order to provide a better indication of the likely groundwater conditions.
The site is within 100 m of a watercourse or potential spring line and the basement may alter the groundwater flow regime supporting these features causing new springs to form or reactivating old springs.	Groundwater is present about 1.5 m below formation level of the proposed basement and as such the basement will not extend beneath the water table surface and therefore will not cause any change in the groundwater flow regime. Further to this, although the Claygate Member is classified as a Secondary 'A' Aquifer, the classification is based on the presence of continuous saturated sand bed horizons within the Claygate Member and the ground investigation found that the Claygate Member beneath the site is predominantly clay and hence of relatively low permeability. However; groundwater monitoring should be continued in order to establish equilibrium levels and to determine the extent of any seasonal fluctuations.
One or more existing trees on the site are to be felled; which can lead to slope instability due to the loss of the binding effect of tree roots and heave of the clay soils which can result in damage to nearby structures. The development neighbours land which has a slope angle greater than 7° The Claygate Member is the shallowest strata at the site and as such may be subject to seasonal shrink-swell.	The site is terraced with low retaining walls, however, the overall slope angle of the site is less than 7° and therefore slope stability should not be an issue. The proposed re-profiling will also include low retaining walls. The depth of the proposed basement excavation is below the depth that desiccation was found to extend and therefore structural damage caused by shrinking and swelling of the clay is unlikely to be an issue; reference should also be made to NHBC guidelines in this respect.
The site is within 5 m of a highway or pedestrian right of way and excavation of a basement may result in structural damage to these structures.	Although the site is within 5 m of a public highway, the basement will be located in the central part of the site, away from these structures; however, consideration should still be given to its stability and limiting any ground movements due to other neighbouring structures.
The development is likely to increase the differential depth of foundations relative to neighbouring properties which may result in structural damage.	The existing foundations will need to be underpinned to form the basement and these underpins will need to be designed to minimise movement of the adjacent structures.

The results of the site investigation have therefore been used below to review the remaining potential impacts, to assess the likelihood of them occurring and the scope for reasonable engineering mitigation.

The site is underlain by an aquifer and the basement could interfere with the groundwater flow regime

Groundwater monitoring to date has found that the water table is present at a level of between 95.03 m OD and 93.76 m OD. The basement is proposed to extend to a depth of about 3.0 m below the existing ground floor level of the house or to a level of about 96.4 m OD and therefore will not extend beneath the water table surface and hence will not affect the groundwater flow regime. However, groundwater monitoring should be continued to establish equilibrium levels and to determine the extent of any seasonal fluctuations in order to confirm this view.

Location of public highway

The basement is located in the central part of the site, away from the public highway and in any case, the proposed development will include retaining walls that will be designed to maintain the stability of the surrounding ground, thus protecting the adjacent road and public footpath. There is nothing unusual or exceptional in the proposed development or the findings of the investigation that give rise to any concerns with regard to stability over and above any development of this nature.

Increase in the differential depth of neighbouring foundations

The stability of neighbouring structures will be ensured at all times through underpinning or the construction of new retaining walls.

10.0 OUTSTANDING RISKS AND ISSUES

This section of the report aims to highlight areas where further work is required as a result of limitations on the scope of this investigation, or where issues have been identified by this investigation that warrant further consideration. The scope of risks and issues discussed in this section is by no means exhaustive, but covers the main areas where additional work is considered to be required.

The ground is a heterogeneous natural material and variations will inevitably arise between the locations at which it is investigated. This report provides an assessment of the ground conditions based on the discrete points at which the ground was sampled, but the ground conditions should be subject to review as the work proceeds to ensure that any variations from the Ground Model are properly assessed by a suitably qualified person.

Further groundwater monitoring should be carried out to establish equilibrium levels and the extent of any seasonal fluctuations and it would be prudent to carry out trial excavations to the dull depth of the proposed basement to assess the extent of any groundwater inflows.

It is recommended that heave movements are checked by further analysis once the loadings and final levels are known.

Possible desiccation was noted in Borehole No 3 to a depth of 2.00 m, located in close proximity to mature trees in the rear garden. Once the final levels are known, the depth of founding should be checked to ensure that it provides sufficient protection against tree root growth and it is recommended that the basement excavation is inspected by a qualified and experienced geotechnical engineer.

A single elevated concentration of arsenic was identified at a depth of 0.3 m from Borehole No 1 and although this is not considered to pose a significant risk to human health only a limited number of samples were tested in order to provide an initial assessment of the presence of contamination. It is therefore recommended that further testing is carried out to determine the extent of arsenic contamination across the rest of the garden, particularly in any areas outside of the proposed excavation area.

If during ground works any visual or olfactory evidence of contamination is identified it is recommended that further investigation be carried out and that the risk assessment is reviewed. These areas of doubt should be drawn to the attention of prospective contractors and further investigation will be required or sufficient contingency should be provided to cover the outstanding risk.

APPENDIX

Borehole Records

SPT Results

Trial Pit Records

Laboratory Geotechnical Test Results

SPT & Cohesion / Depth Graph

Chemical Analyses

Generic Risk-Based Guideline Values

Environment Report and Extracts

Historical Maps

Site Plan

Geotechnical & Environmental Associates

Tyttenhanger House
Coursers Road
St Albans
AL4 0PG

Site	Number
2 Oakhill Avenue, London, NW3 7RE	BH1

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler		96.60	Mr Abhay Ruparell	J13073
	Location	**Dates**	**Engineer**	**Sheet**
		25/03/2013	Price and Myers	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.40)	Topsoil (dark brown clayey sandy silt with roots ash and rare brick fragments)		
0.30	D1			96.20	0.40			
0.50	D2				(0.60)	Soft orange-brown silty very sandy CLAY with fine roots and occasional fine to coarse sub-angular to rounded flint gravel		
1.00	D3			95.60	1.00	Firm orange-brown mottled grey and locally reddish brown at 1.3 m and between 2.8 m and 3.0 m silty very sandy CLAY with roots to 1.5 m and occasional pockets of fine sand		
1.50	D4							
2.00	D5		SLOW(1) at 2.00m.					∇1
2.50	D6				(2.50)			
3.00	D7							
3.50	D8			93.10	3.50	Firm grey mottled orange-brown and reddish brown silty very sandy CLAY		
4.00	D9				(1.10)			
4.50	D10			92.00	4.60	Firm grey silty sandy CLAY		
5.00	D11							
5.50	D12							
6.00	D13				(2.40)			
6.50	D14							
7.00	D15			89.60	7.00	Complete at 7.00m		

Remarks
Groundwater monitoring standpipe installed to 5.0 m
Groundwater encountered at 2.0 m during drilling.

Scale (approx)	Logged By
1:50	DA

Figure No. J13073.BH1

GEA Geotechnical & Environmental Associates Tyttenhanger House, Coursers Road, St Albans, AL4 0PG	**Site** 2 Oakhill Avenue, London, NW3 7RE	**Number** **BH2**

Excavation Method	**Dimensions**	**Ground Level (mOD)**	**Client**	**Job Number**
Drive-in Window Sampler		96.88	Mr Abhay Ruparell	J13073
	Location	**Dates**	**Engineer**	**Sheet**
		25/03/2013	Price and Myers	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
				96.78	(0.10) 0.10	Topsoil (brown clayey sandy silt with roots)		
0.20	D1			96.48	(0.30) 0.40	Made Ground (brown clayey sandy silt with freqent fine sub-angular to sub-rounded flint gravel, brick fragments and rare ash)		
0.80	D2				(1.90)	Soft orange-brown with occasional grey markings sity very sandy CLAY with roots to 1.8 m		
1.80	D3		SLOW(1) at 1.80m.					∇1
2.80	D4			94.58	2.30 (1.10)	Soft orange-brown mottled grey silty sandy CLAY with occasional pockets of orange-brown and grey very sandy clay and a pocket of dark brown and black organic matter at 2.9 m		
3.80	D5			93.48	3.40 (0.90)	Firm grey mottled orange-brown silty sandy CLAY with pockets of grey very sandy clay		
4.80	D6			92.58	4.30 (2.70)	Firm grey silty sandy CLAY with pockets of grey silty fine sand		
6.50	D7							
				89.88	7.00	Complete at 7.00m		

Remarks	**Scale (approx)**	**Logged By**
Groundwater encountered at 1.8 m during drilling. Groundwater monitoring standpipe installed to 4.0 m.	1:50	DA
	Figure No.	
	J13073.BH2	

Geotechnical & Environmental Associates	Tyttenhanger House, Coursers Road, St Albans, AL4 0PG	**Site** 2 Oakhill Avenue, London, NW3 7RE	**Number** BH3
Excavation Method Drive-in Window Sampler	**Dimensions** / **Location**	**Ground Level (mOD)** 99.27 / **Dates** 25/03/2013	**Client** Mr Abhay Ruparell / **Engineer** Price and Myers	**Job Number** J13073 / **Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
				98.97	(0.30) 0.30	Topsoil (dark brown clayey silty sand with roots and occasional fine gravel)		
0.50	D1					Made Ground (brown silty sandy clay with roots, occasional ash and charcoal and fragments of brick and concrete at 0.5 m)		
0.80	D2			98.17	(0.80) 1.10			
1.00	D3					Stiff brown mottled orange-brown silty sandy CLAY with occasional pockets of brown and orange-brown silty very sandy clay. (Desiccated Soil)		
1.50	D4			97.27	(0.90) 2.00			
2.00	D5					Firm orange-brown with occasional grey mottling silty very sandy CLAY with a pocket of orange-brown silty fine sand at 1.7 m and a pocket of dark brown and black organic matter at 4.8 m		
2.50	D6							
3.00	D7							
3.50	D8							
			SLOW(1) at 3.80m.		(3.70)			∇1
4.00	D9							
4.50	D10							
5.00	D11							
5.50	D12			93.57	5.70			
					(0.50)	Firm grey mottled orange-brown and reddish brown silty sandy CLAY		
6.00	D13			93.07	6.20			
6.50	D14				(0.80)	Firm grey silty sandy CLAY with occasional pockets of grey silty fine sand.		
7.00	D15			92.27	7.00	Complete at 7.00m		

Remarks
Groundwater encountered at 3.8 m during drilling.

Scale (approx)	Logged By
1:50	DA

Figure No. J13073.BH3

Geotechnical & Environmental Associates	Tyttenhanger House, Coursers Road, St Albans, AL4 0PG	Site: 2 Oakhill Avenue, London, NW3 7RE	Borehole Number: BH4

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 1.50m	99.13	Mr Abhay Ruparell	J13073
	Location	**Dates** 28/03/2013	**Engineer** Price and Myers	**Sheet** 1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					99.08	(0.05) 0.05	Tarmac		
						(0.45)	Made Ground (brick rubble with concrete fragments)		
0.40	D1				98.63	0.50	Soft becoming firm brown mottled orange-brown and reddish brown silty sandy CLAY with roots to 1.2 m		
0.80	D2								
1.20	U1								
1.70	D3								
1.90	D4								
2.00-2.45	SPT N=15	1.50	DRY	2,2/3,3,4,5					
2.00	D5								
2.70	D6								
3.00	U2					(5.60)			
3.50	D7								
3.80	D8								
4.00-4.45	SPT N=17	1.50	DRY	1,3/3,4,5,5					
4.00	D9								
4.70	D10								
5.00	U3								
5.50	D11								
6.00-6.45	SPT N=9	1.50	DRY	2,2/2,2,2,3	93.03	6.10	Stiff grey silty sandy CLAY with occasional partings and pockets of pale brown fine silty sand		
6.00	D12								
7.00	D13								
				Slow(1) at 7.40m.					∇1
7.50	U4								
8.00	D14								
9.00-9.45	SPT N=14	1.50	8.70	2,3/3,3,4,4					
9.00	D15								

Remarks
Groundwater monitoring standpipe installed to 8.20 m
Groundwater encountered at 7.4 m
Chiselling from 0.00m to 0.20m for 1.15 hours.

Scale (approx)	Logged By
1:50	ME

Figure No. J13073.BH4

GEA Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans AL4 0PG	Site 2 Oakhill Avenue, London, NW3 7RE	Borehole Number BH4

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 1.50m	99.13	Mr Abhay Ruparell	J13073
	Location	**Dates** 28/03/2013	**Engineer** Price and Myers	**Sheet** 2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
10.50	U5								
11.00	D16								
12.00	U6								
12.50	D17					(8.90)			
13.50	U7								
14.00	D18								
14.50-14.95	SPT N=26	1.50	12.60	4,4/5,6,7,8					
14.50	D19								
					84.13	15.00			
							Complete at 15.00m		

Remarks	Scale (approx)	Logged By
	1:50	ME
	Figure No. J13073.BH4	

Geotechnical & Environmental Associates

Tyttenhanger House
Coursers Road
St Albans
AL4 0PG

Standard Penetration Test Results

Site : 2 Oakhill Avenue, London, NW3 7RE

Client : Mr Abhay Ruparell

Engineer : Price and Myers

Job Number J13073

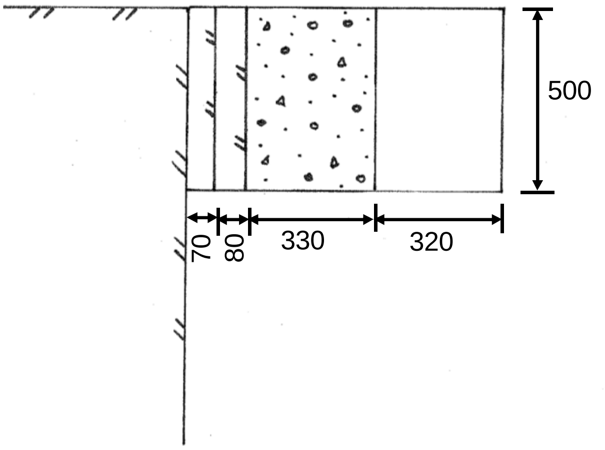
Sheet 1 / 1

Borehole Number	Base of Borehole (m)	End of Seating Drive (m)	End of Test Drive (m)	Test Type	Seating Blows per 75mm		Blows for each 75mm penetration				Result	Comments
					1	2	1	2	3	4		
BH4	2.00	2.15	2.45	SPT	2	2	3	3	4	5	N=15	
BH4	4.00	4.15	4.45	SPT	1	3	3	4	5	5	N=17	
BH4	6.00	6.15	6.45	SPT	2	2	2	2	2	3	N=9	
BH4	9.00	9.15	9.45	SPT	2	3	3	3	4	4	N=14	
BH4	14.50	14.65	14.95	SPT	4	4	5	6	7	8	N=26	

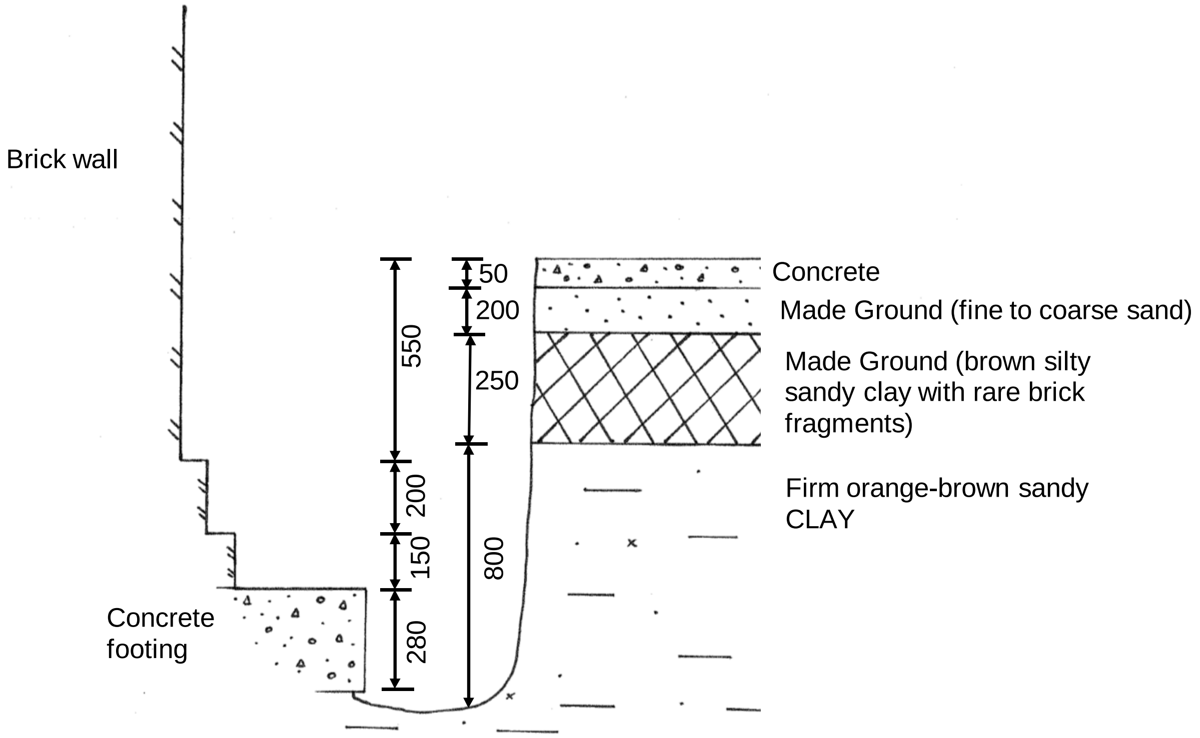
GEA Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans Herts AL4 0PG	**Site** 2 Oakhill Avenue, London, NW3 7RE	**Trial Pit Number** **1**

Excavation Method	**Dimensions**	**Ground Level (mOD)**	**Client**	**Job Number**
Manual	500 x 900 x 1300	98.25	Mr Abhay Ruparell	J13073
	Location	**Dates**	**Engineer**	**Sheet**
		25/03/2013	Price & Myers	1 / 1

Plan



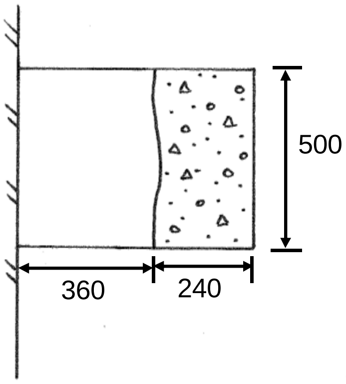
Section A - A'



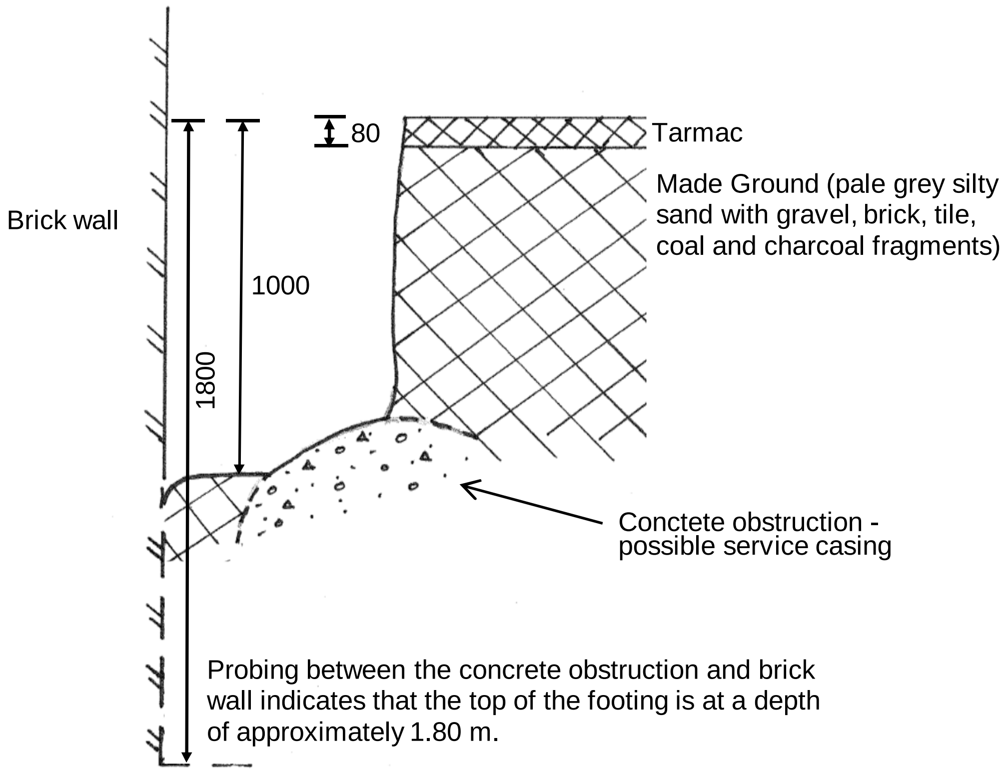
Remarks:	Scale:
All dimensions in millimetres	1:20
Sides of trial pit remained stable during excavation	Logged by:
Groundwater: Not encountered	DA

GEA Geotechnical & Environmental Associates Tyttenhanger House Coursers Road St Albans Herts AL4 0PG			**Site** 2 Oakhill Avenue, London, NW3 7RE	**Trial Pit Number** **2**
Excavation Method Manual	**Dimensions** 500 x 600 x 1800	**Ground Level (mOD)** 99.32	**Client** Mr Abhay Ruparell	**Job Number** J13073
	Location	**Dates** 25/03/2013	**Engineer** Price & Myers	**Sheet** 1 / 1

Plan



Section A - A'



Remarks:	Scale: 1:20
Extent of footing not proved due to concrete obstruction (possible service casing)	
All dimensions in millimetres	
Sides of trial pit remained stable during excavation	Logged by:
Groundwater: Not encountered	DA

PROJECT NAME	**OAK HILL AVENUE**	Date	16/04/2013
	Project Number: J13073	Approved	Simon Burke
PROJECT NO:	**GEO / 19502**	Page	1 of 1

Sample details					Classification Tests					Density Tests		Undrained Triaxial Compression Tests			Chemical Tests			
Borehole No.	Depth (m)	No.	Type	Description	MC (%)	LL (%)	PL (%)	PI (%)	<425 mic (%)	Bulk (Mg/m³)	Dry (Mg/m³)	Cell Pressure (kPa)	Deviator Stress (kPa)	Shear Stress (kPa)	pH	2:1 W/S SO4 (g/l)	Ground Water SO4 (g/l)	Other tests and comments
2	1.80	-	D	Orange mottled grey very fine sandy silty CLAY with rare rootlets	34	43	22	21	100						5.1	0.069		
3	4.00	-	D	Dark orange brown and rare grey fine sandy silty CLAY	26	41	20	21	100									
3	6.00	-	D	Mottled dark orange brown and grey slightly fine sandy silty CLAY	27	47	22	25	100						5.0	0.34		
4	1.20	1	U	Firm orange brown fine sandy CLAY	28					1.97	1.54	25	152	76				
4	3.00	2	U	Medium dense orange brown clayey fine SAND	19					1.93	1.62	60	130	65				
4	5.00	3	U	Firm orange brown fine sandy CLAY	28					2.27	1.78	100	104	52				
4	7.50	4	U	Stiff grey silty CLAY	24	50	20	30	100	2.06	1.65	150	244	122				
4	10.50	5	U	Stiff dark brown fine sandy CLAY	26					2.06	1.64	210	285	142	7.1	0.71		
4	12.00	6	U	Stiff dark grey CLAY	24					2.03	1.64	240	262	131				
4	13.50	7	U	Very stiff fissured dark brown silty CLAY	22					1.95	1.60	270	413	206				

SUMMARY OF GEOTECHNICAL TESTING

GEOLABS®