Document Control

Project title	Whitestone Housem Whitestone Lane, London NW3 1EA	**Project ref**	J14136
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Issue No	**Status**	**Date**	**Approved for Issue**
1	DRAFT	20 October 2014	

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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 site investigation carried out by Geotechnical and Environmental Associates Limited (GEA), on the instructions of Conisbee, on behalf of Mr Graham Edwards, with respect to the construction of a single level basement, below the existing lower ground floor. The purpose of the investigation has been to research the history of the site, to determine the ground conditions, to identify the presence of contamination and to provide advice with respect to the design of suitable foundations and the basement structure. The report also includes a Basement Impact Assessment carried out in accordance with guidelines from London Borough of Camden in support of a planning application.

DESK STUDY FINDINGS

The earliest Ordnance Survey (OS) map studied, dated 1879, shows the site to be undeveloped and forming what appears to be the rear garden to a series of three properties in the approximate position of the current day Whitestone House, The Cottage and Gang Moor. According to online information, Whitestone House was originally constructed between 1811 and 1820 and therefore the easternmost of the three properties shown on the 1879 map is likely to be Whitestone House. Little change is shown on subsequent maps until 1934, by which time the three buildings present along the western boundary of the site, including Whitestone House, had been reconfigured to form just two buildings. The 1934 map also indicates that the existing Bell Moor, which includes a basement car park, had been constructed directly to the south of the site, on the opposite side of Whitestone Lane. Whitestone House is shown to have been reconfigured by the time of the aerial photograph dated 1946, which appears to show the site in the existing day layout. The map dated 1954 shows the site in more detail with Whitestone House clearly shown in its existing layout, along with the adjoining properties. Although the site is not shown to change on subsequent maps, it is understood that Whitestone House underwent extensive refurbishment work in 2003 and 2004, which included the excavation and construction of the existing lower ground floor level.

GROUND CONDITIONS

The investigation encountered the expected ground conditions in that, beneath a generally moderate thickness of made ground, the Bagshot Formation was encountered and proved to the maximum depth investigated. Made ground was encountered to depths of between 1.00 m and 2.00 m and generally comprised dark grey and greyish brown silty sandy clay with gravel and occasional brick fragments. In Borehole Nos 1 and 3, below the made ground, yellowish brown and dark brown clayey silty fine to coarse sand with fine to coarse subangular to well-rounded gravel was encountered to 3.00 m. It is thought that this horizon may represent made ground comprising the material used to backfill behind the existing retaining walls. Below the initial horizons, the Bagshot Formation generally comprised medium dense becoming dense and very dense yellowish brown and greyish brown, locally clayey, silty fine sand and was proved to the maximum depth investigated, of 20.00 m. A clay horizon was however encountered between 12.00 m and 15.50 m. Groundwater was encountered at a depth of 12.00 m, although a seepage of perched groundwater was also encountered at a depth of 3.00 m. The results of contamination testing have indicated elevated concentrations of lead in the made ground.

RECOMMENDATIONS

Excavations for the proposed basement structure will require temporary support to maintain stability and to prevent any excessive ground movements. Based on the groundwater observations to date, significant groundwater inflows are unlikely to be encountered within the basement excavation. On this basis it is thought that the best method of constructing the basement level will be through the use of localised traditional underpinning coupled with a bored pile retaining wall. On the basis that groundwater is unlikely to be encountered within the basement excavation, a contiguous bored piled wall may be the most suitable option, although the use of a secant bored pile wall generally provides an additional amount of stiffness, negates the requirement for any secondary groundwater control and also maximises the useable space within the basement structure. The investigation has determined that the proposed basement structured should not have an effect on the local hydrogeological and hydrological setting, or compromise the stability of neighbouring structures and existing slopes. Further testing will however be required in the areas that are to remain as soft landscaped gardens in order to determine the extent of the lead contamination.

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 Conisbee, on behalf of Mr Graham Edwards, to carry out a site investigation at the site of Whitestone House, Whitestone Lane, London NW3 1EA.

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 in support of a planning application.

1.1 Proposed Development

It is understood that it is proposed to extend the existing property to both the side and rear, in addition to excavating and constructing a new basement below the existing lower ground floor and out beneath part of the rear garden.

This report is specific to the proposed development and the advice herein should be reviewed once the development proposals have been finalised.

1.2 Purpose of Work

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

- to check the history of the site with respect to previous contaminative uses;
- to determine the ground conditions and their engineering properties;
- to assess the configuration of existing foundations;
- to assess the possible impact of the proposed development on the local hydrogeology and surrounding structures;
- to provide advice with respect to the design of suitable foundations and retaining walls;
- to provide an indication of the degree of soil contamination present; 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 desk study was carried out, followed by a ground investigation. The desk study comprised:

- a review of readily available geological and topographical maps;

- a review of historical Ordnance Survey (OS) maps and environmental searches sourced from the Envirocheck database;
- 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:

- three cable percussion boreholes, advanced to depths of 12.00 m and 20.00 m, by means of a dismantlable cable percussion drilling rig;
- standard penetration tests (SPTs), carried out at regular intervals in the borehole, to provide additional quantitative data on the strength of the soils;
- the installation of three groundwater monitoring standpipes to a depth of 8.00 m and three subsequent monitoring visits over a two month period;
- 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

The work carried out also includes a Hydrological and Hydrogeological Assessment and Land Stability Assessment (also referred to as Slope Stability 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 surface water, groundwater and land stability and in particular to assess whether the development will affect neighbouring properties or groundwater movements 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 assessment has been carried out by John Evans, MSc in Hydrogeology, Chartered Geologist (CGeol) and Fellow of the Geological Society of London (FGS). The surface water and flooding assessment has been carried out by Rupert Evans, a hydrologist with more than

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

ten years consultancy experience in flood risk assessment, surface water drainage schemes and hydrology / hydraulic modelling. Rupert Evans is a Chartered Environmentalist, Chartered Water and Environmental Manager and a Member of CIWEM.

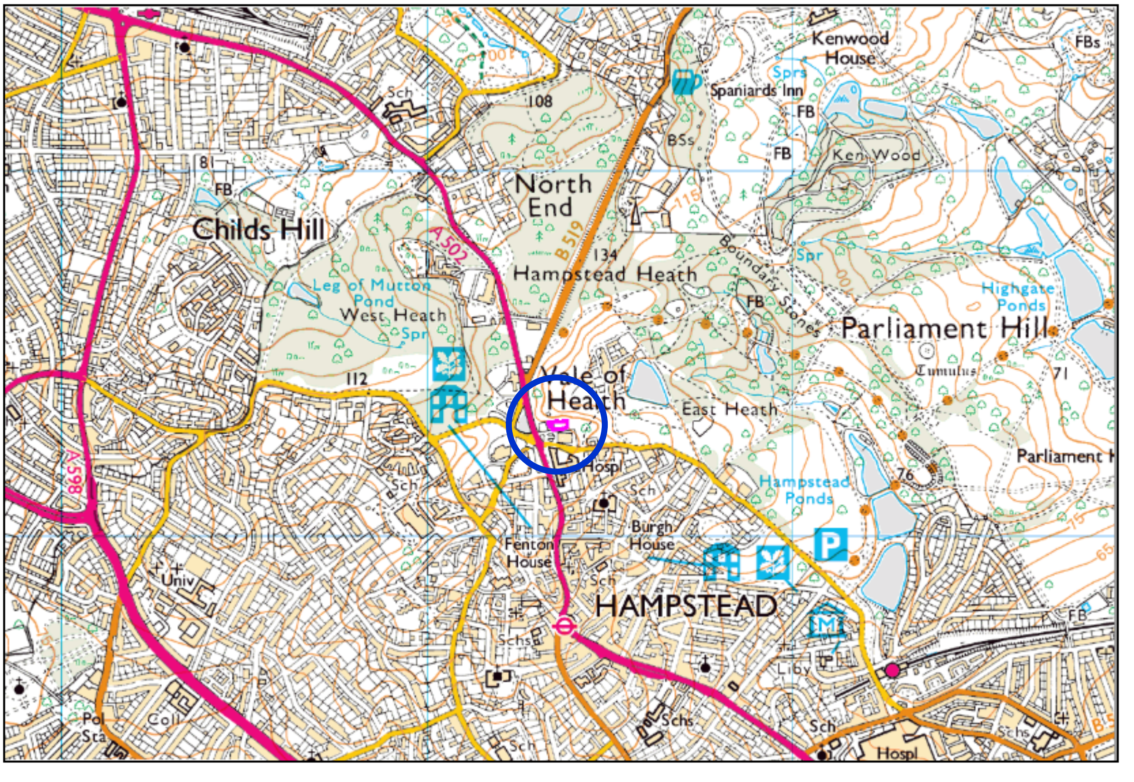
1.4 Limitations

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 in Hampstead, northwest London, approximately 500 m to the north of Hampstead London Underground station and may be additionally located by National Grid Reference 526342,186297 as shown on the map below.



The site covers a roughly rectangular shaped area with maximum dimensions of approximately 20 m north-south by 40 m east-west and is occupied by Whitestone House, a three-storey house with a lower ground floor level and associated private rear garden. It fronts onto and is accessed from Whitestone Lane to the south and is bordered by Hampstead Heath to the north and east and by two adjoining properties to the west.

The house is positioned in the western half of the site whilst the eastern half comprises the rear garden, which is mostly laid to lawn with planted borders, although the southern and eastern boundaries are quite densely vegetated with deciduous trees of up to 20 m in height. Species typically include London plane, sycamore and silver birch.

The site generally forms a level area, however it has been terraced to accommodate the lower ground floor level, which is at a level of approximately 2.90 m below ground floor level (approximately 129.00 m OD), although the existing swimming pool at the southern extent of the lower ground floor level is approximately 3.70 m below ground level (approximately 128.20 m OD). The garden level is also approximately 1.20 m below ground level, at a level of approximately 130.87 m OD. Beyond the northern boundary, the topography slopes down sharply to the north into the Vale of Heath and beyond the eastern boundary the topography also slopes down to the east.

2.2 Site History

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

The earliest Ordnance Survey (OS) map studied, dated 1879, shows the site to be undeveloped and forming what appears to be the rear garden to a series of three properties in the approximate position of the current day Whitestone House, The Cottage and Gang Moor. According to online information[4], Whitestone House was originally constructed in the Regency Era (1811 – 1820) and therefore the easternmost of the three properties shown on the 1879 map is likely to be Whitestone House. This map also indicates that a small outbuilding was present along the southern boundary of the site and that Whitestone Lane and the majority of the existing road network in the surrounding area was already established. A sand pit was also shown approximately 200 m to the west of the site.

By 1896 the sand pit is no longer shown and a cluster of small buildings that occupied the site directly to the south, on the opposite side of Whitestone Lane, had been demolished and replaced with a large building annotated as Bell Moor. Little change is shown on subsequent maps until 1934, by which time the three buildings present along the western boundary of the site, including Whitestone House, had been reconfigured to form just two buildings. This is confirmed by a review of further online information[5], which suggests that Whitestone House was redesigned in the 1930s by the renowned Architect Sir Clough Williams-Ellis. This information also indicates that the outbuilding, which had been demolished by this time, was used as a studio by various artists and painters including John Constable. The 1934 map also indicates that the original Bell Moor building to the south had been demolished and replaced with the existing building, also known as Bell Moor, which includes a basement car park.

Whitestone House is shown to have been reconfigured again by the time of the aerial photograph dated 1946, which appears to show the site in the existing day layout. The map dated 1954 shows the site in more detail with Whitestone House clearly shown in its existing layout, along with the adjoining properties, The Cottage and Gang Moor. The site is not shown to change on subsequent maps with the surrounding area also remaining essentially unchanged and occupied by mainly residential streets since the start of the 20th Century. It is however understood that Whitestone House underwent extensive refurbishment work in 2003 and 2004, which included the excavation and construction of the existing lower ground floor level.

4 http://www.glentree.co.uk/property_whitestone-house-nw3_384.html
5 http://www.primelocation.com/homes-news/hampstead-house-sold/

2.3 Other Information

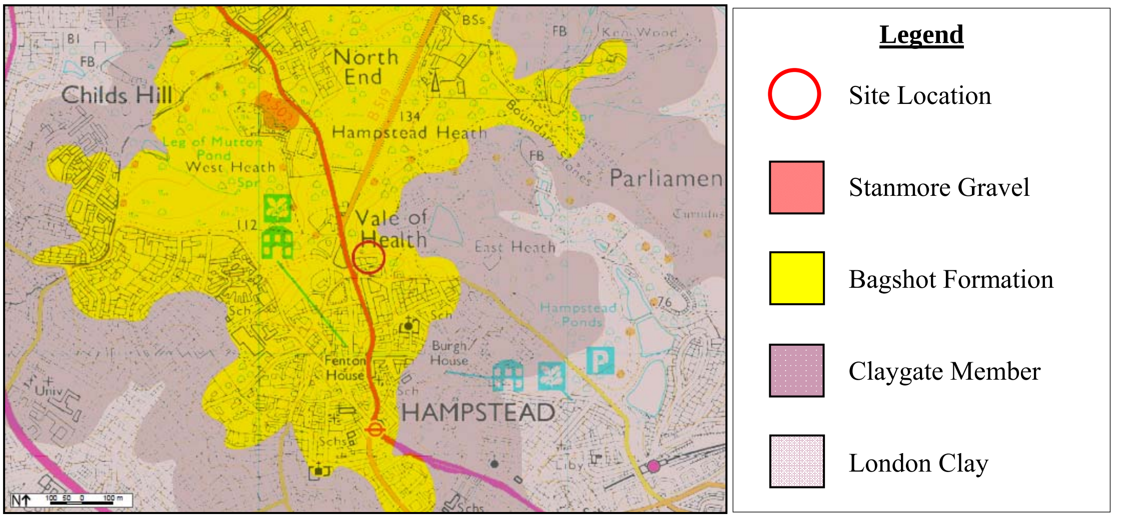
A search of public registers and databases has been made via the Envirocheck database and relevant extracts from the search are appended. Full results of the search can be provided if required.

The search has revealed that there are no landfills, waste management, transfer, treatment or disposal sites within 500 m of the site. There have also not been any recorded pollution incidents to controlled waters within 250 m of the site and there are no designated contaminated land sites within 500 m.

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.

2.4 Geology

The British Geological Survey (BGS) map of the area (sheet 256) indicates that the site is underlain by the Bagshot Formation, which is in turn underlain by the Claygate Member of the London Clay Formation, as shown by the digital geological map extract below.



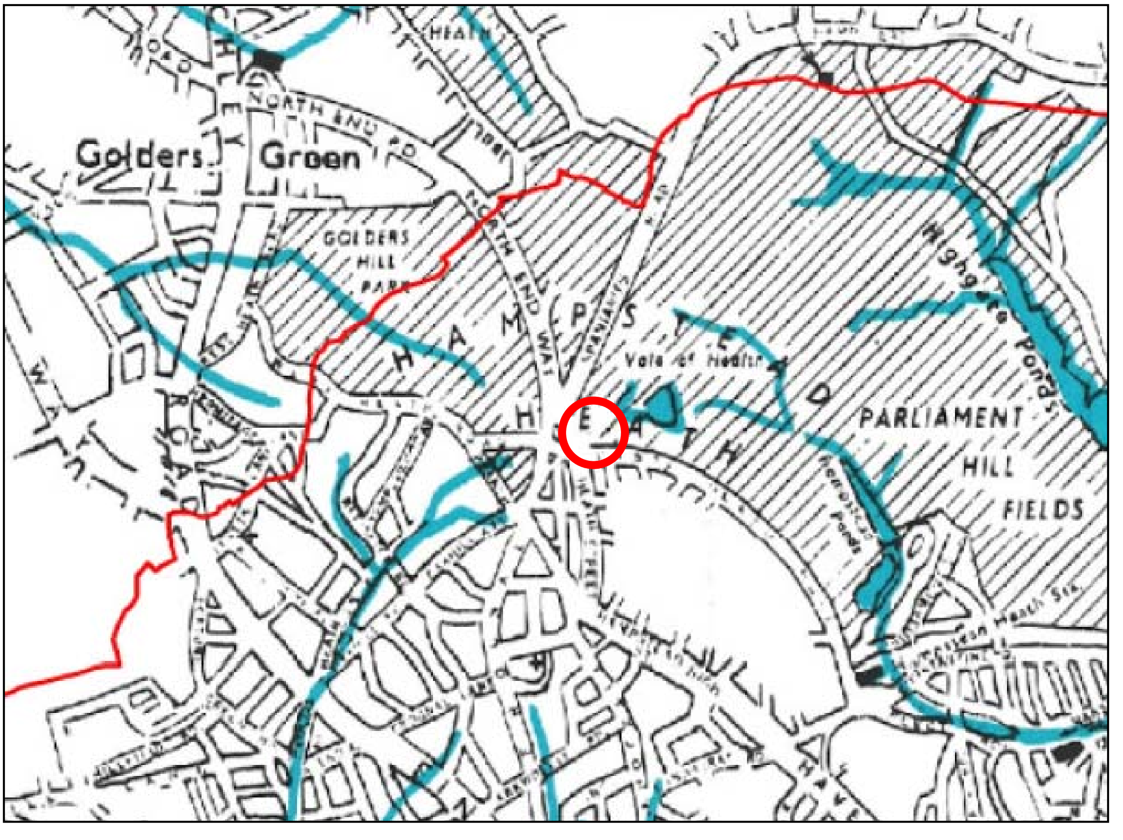
The geology in this area is generally horizontally bedded such that the boundary between the geological formations roughly follows the ground surface contour lines. The boundary between the Bagshot Formation and underlying Claygate Member is present approximately 150 m to the northeast of the site, at a level of approximately 115 m OD, approximately 18 m below the level of the site. The boundary between the Claygate Member and London Clay is at a level of approximately 85 m OD, around 50 m below the level of the site.

The above levels correspond relatively well to BGS archive borehole records of boreholes advanced close to the site. The BGS 'Hampstead Borehole' was advanced to the north of the site off of Spaniards Lane. The boundary between the Bagshot Formation and Claygate Member is shown to be at a level of 109 m OD, whilst another borehole advanced 100 m to the northwest of the site appears to show the boundary with the Claygate Member to be at a level of approximately 114 m OD. GEA have also carried out a number of investigations close to the site, which revealed the base of the Bagshot Formation to be between approximately 113 m OD and 115 m OD.

2.5 Hydrology and Hydrogeology

The Bagshot Beds and underlying Claygate Member are both classified as Secondary ‘A’ Aquifers, which refer to strata that contain permeable layers cable of supporting water supply at a local level and in some cases may form an important source of base flow for local rivers, as defined by the Environment Agency (EA).

The topographical maps show that the nearest surface water feature is a manmade pond, known as Whitestone Pond, located 60 m to the east of the site. The nearest natural surface water feature is a pond located within Hampstead Heath, approximately 230 m to the northeast of the site. This pond also marks the location of a former spring line, which formed the source of a tributary to one of London’s “lost” rivers, the Fleet, as shown by the extract of the Lost Rivers of London[6] map below. This particular tributary of the river flowed south from the spring through the Hampstead Ponds and on through Kentish Town and Camden Town before flowing through Clerkenwell and issuing into the Thames below Blackfriars Bridge.



In addition to the Fleet, spring lines to the former Westbourne River were present approximately 300 m to the southwest of the site, whilst a spring to the River Brent was present approximately 400 m to the northwest. The position of the spring to the Fleet corresponds with the boundary of the Bagshot Formation and the underlying Claygate Member. The Bagshot Formation predominantly comprises orange or pale yellow, fine grained sand and therefore has a relatively high permeability. The unit does however contain

6 Nicholas Barton (2000) *London’s Lost Rivers.* Historical Publications Ltd

localised thin beds of pale grey clay and it is therefore possible for perched groundwater to be present within the Formation. The underlying Claygate Member is predominantly cohesive in nature and therefore groundwater flow is likely to be relatively slow, although horizons of more sandy soils are present, resulting in the permeability ranging from "very low" to "high". It is for this reason that the former spring lines existed upon the interface of the Claygate Member below the Bagshot Formation.

Given the location of the former spring to the River Fleet, the position of the existing pond, the local topography and the fact that the site is within the catchment of the Hampstead Ponds, groundwater flow below the site is likely to be in a generally northeasterly direction. According to Figure 5 of the Arup report, the site is not located within an area with the potential to be at risk of surface water flooding and whilst Heath Street, approximately 60 m to the west of the site, suffered from surface water flooding in 1975, Whitestone Lane is not listed as having ever suffered from such an event. In addition, the site is not located in an area at risk of flooding, as defined by the EA.

2.6 Preliminary Contamination 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 residential properties throughout its developed history. There are thus no obvious likely sources of contamination on the site or in its immediate vicinity, including historical or existing landfill sites.

2.6.2 Receptor

The continued use of the property as a residential dwelling represents a relatively high sensitivity end-use. End users are considered to be sensitive receptors as is groundwater within the Secondary 'A' Aquifer of the Bagshot Formation. Site workers will come into contact with underlying soils during the construction phase, as will new buried services and both are therefore considered to be sensitive receptors. Neighbouring sites would also be considered to be moderately sensitive receptors.

2.6.3 Pathway

A pathway will exist in the private rear garden, although this pathway is already in existence. Any groundwater movements within the Bagshot Formation and/or perched water movements within any made ground are considered to be potential pathways by which any soluble contaminants may migrate off and onto to the site. The construction phase is considered to be a pathway by which site workers and new buried services may come in contact with any contamination.

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. Furthermore as there is no evidence of filled ground within the vicinity, there is not considered to be a significant potential for hazardous soil gas to be present on or migrating towards the site; there should thus be no need to consider soil gas exclusion systems.

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 Appendices E1, E2 and E3 which include a series of questions within screening flowcharts for surface flow and flooding, subterranean (groundwater) flow and land stability. The flowchart questions and responses to these questions are tabulated below.

3.1.1 Subterranean (groundwater) Screening Assessment

Question	Response for Whitestone House
1a. Is the site located directly above an aquifer?	Yes. The Bagshot Formation is a Secondary 'A' Aquifer
1b. Will the proposed basement extend beneath the water table surface?	Maybe.
2. Is the site within 100 m of a watercourse, well (used/ disused) or potential spring line?	No. The nearest spring line is over 200 m to the northeast of the site.
3. Is the site within the catchment of the pond chains on Hampstead Heath?	Yes the Hampstead Ponds
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	No it is proposed to keep the proportion of hardstanding the same
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. Run-off from hardstanding will drain to the sewer system, as it does currently
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 Bagshot Formation is classified as a Secondary 'A' Aquifer.
Q1b The proposed basement may extend beneath the water table.
Q3 The site is within the catchment of the Hampstead Ponds.

3.1.2 Stability Screening Assessment

Question	Response for Whitestone House
1. Does the existing site include slopes, natural or manmade, greater than 7°?	No. The site is slightly terraced but does not include slopes greater than 7°
2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7°?	No.

Question	Response for Whitestone House
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	Yes. The slope beyond the northern boundary slopes steeply down towards the Vale of Heath
4. Is the site within a wider hillside setting in which the general slope is greater than 7°?	Yes. As above
5. Is the London Clay the shallowest strata at the site?	No. Bagshot 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.
7. Is there a history of seasonal shrink-swell subsidence in the local area and / or evidence of such effects at the site?	No.
8. Is the site within 100 m of a watercourse or potential spring line?	No.
9. Is the site within an area of previously worked ground?	No.
10. Is the site within an aquifer?	Yes. The Bagshot Formation is a Secondary 'A' Aquifer
11. Is the site within 50 m of Hampstead Heath ponds?	No.
12. Is the site within 5 m of a highway or pedestrian right of way?	Yes. Whitestone Lane runs parallel to the southern boundary, although is not a public highway but a private road
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Yes.
14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	No.

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

Q3 A slope of greater than 7º is present directly to the north of the site.
Q4 The site forms part of Hampstead Heath, which includes slopes of greater than 7º
Q5 The site is located on the Secondary 'A' Aquifer of the Bagshot Formation.
Q12 The site is located within 5 m of Whitestone Lane.
Q13 The basement excavation 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 engineer experienced in carrying out surface water assessments.

Question	Response for Whitestone House
1. Is the site within the catchment of the pond chains on Hampstead Heath?	Yes.
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.

Question	Response for Whitestone House
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.
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 identified the following potential issues that need to be assessed:

Q5. The site is within the catchment of the Hampstead Ponds.

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 impacts are assessed for each of the identified potential impact factors.

4.1 Potential Impacts

The following potential impacts have been identified by the screening process

Potential Impact	Consequence
Is the site located directly above an aquifer?	The site is underlain by the Bagshot Formation, which is classified as a Secondary 'A' Aquifer. This has the potential of being able to support local water supplies as well as forming an important source of base flow for local rivers. There is the potential for the hydrogeological setting to be affected by a basement development.
Will the proposed basement extend beneath the water table surface?	As stated above, groundwater would be expected to be encountered within the Bagshot Formation and therefore it is possible that the basement excavation will extend below the water table. Should this happen, the basement structure is capable of diverting groundwater flow such that groundwater level is affected on both the up slope and down slope side of the basement structure. This in turn has the potential to affect the local hydrogeology and any adjacent structures.
Is the site within the catchment of the pond chains on Hampstead Heath?	The construction of a basement typically removes permeable shallow ground, which reduces the capacity of the ground to store rainfall, potentially leading to greater surface run-off and greater risk of flooding. There is currently a medium risk of flooding from the pond chains but if a development within the catchment were to result in an increase in surface run-off, this could potentially lead to an increased frequency of flooding. In addition heavy rainfall events have been noted to cause deterioration in the water quality of the bathing ponds as a result of increased overland flow. Therefore should a development increase the volume of water or alter the flow path of drainage and run-off from the site, this may increase overland flow and therefore contamination of the bathing ponds.

Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	The natural slope beyond the northern boundary is at an angle of greater than 7°. Such natural and manmade slopes are more prone to slope failure, however it should be noted that this is based on case studies of slopes within the Claygate Member and London Clay, which generally to be stable at angles of between 8° and 10°. It is possible for slopes in the Bagshot Formation to be stable at greater slope angles, however this will need to be confirmed.
Is the site within a wider hillside setting in which the general slope is greater than 7°?	As above, although it should be noted that the area of the site is not shown on Figure 17 in the Arup report to be in an area of significant landslide potential.
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?	Trees and other vegetation provide stability to slopes and if removed may play a factor in the future stability of slopes. In addition, where clay soils are present and trees are removed, heave of the shallow soils may take place, which can lead to movement and instability of nearby structures.
Is the site located within 5 m of a public highway or pedestrian right of way?	The public walkways of Whitestone Lane borders the site to the south, with the proposed basement structure being excavated close to this boundary. The proposed basement may cause instability of road structure, although the road is actually a private road and is owned by the current owner of the site.
Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	If not designed and constructed appropriately, the excavation of a basement may result in structural damage to neighbouring buildings and structures.

These potential impacts have been investigated through the site investigation, as detailed below.

4.2 Exploratory Work

In order to meet the objectives described in Section 1.2, three cable percussion boreholes were drilled, to depths of 12.00 m and 20.00 m, using a dismantlable cable percussion drilling rig. Standard penetration tests (SPTs) were carried out at regular intervals in the borehole and disturbed samples were recovered for subsequent laboratory examination and testing. Groundwater monitoring standpipes were installed in each of the boreholes to a depth of 8.00 m and have subsequently been monitored on two occasions over a one month period.

The borehole and trial pit records and results of the laboratory analyses are appended, together with a site plan indicating the exploratory positions. The Ordnance Datum (OD) levels shown on the borehole logs have been interpolated from spot heights shown on a site survey drawing (reference RGL-14-1968-01, dated July 2014), which was provided by Jonathan Freegard Architects.

4.3 Sampling Strategy

The borehole locations were agreed on site with the consulting engineers prior to the investigation in order to provide optimum coverage of the site, and were positioned on site by an engineer from GEA in order to avoid the areas of known buried services.

Four samples of made ground 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 sample was 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.

A number of disturbed samples recovered from the cable percussion boreholes were submitted to a geotechnical laboratory for a programme of testing that included moisture content and Atterberg limit tests, particle size distributions and soluble sulphate and pH level analysis.

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 encountered the expected ground conditions in that, below a moderate to significant thickness of made ground, the Bagshot Formation was encountered and proved to the maximum depth investigated.

5.1 Made Ground

Made ground was encountered to depths of between 1.00 m (130.70 m OD) and 2.00 m (128.88 m OD) and generally comprised dark grey and greyish brown silty sandy clay with gravel and occasional brick fragments. In Borehole Nos 1 and 2, advanced in the rear garden, the made ground was found to be capped with 300 mm thickness of topsoil, comprising dark grey sandy silt or clayey silty sand.

With the exception of notable fragments of extraneous material, no visual or olfactory evidence of significant contamination was observed within these soils, although four samples have been analysed for a range of contaminants and the results are summarised in Section 5.4.

5.2 Bagshot Formation

In Borehole Nos 1 and 3, this stratum was found to comprise an initial horizon of yellowish brown and dark brown clayey silty fine to coarse sand with fine to coarse subangular to well-rounded gravel, which extended to a depth of 3.00 m (127.88 m OD). Both these boreholes were advanced within close proximity of the existing lower ground floor, and it is thought that this horizon may represent made ground comprising the material used to backfill behind the existing retaining walls.

Below the above horizon and directly below the made ground in Borehole No 2, this stratum comprised medium dense and locally dense yellowish brown, locally clayey, silty fine sand, which extended to the maximum depth investigated in Borehole No 2, of 12.00 m (118.27 m OD), and to depths of 12.00 m (119.70 m OD) and 12.50 m (118.38 m OD) in the remaining other boreholes. Below these depths firm brown mottled grey and dark orange-brown silty sandy clay was encountered to depths of 15.00 m (115.88 m OD) and 15.50 m (116.20 m OD), whereupon dense locally very dense greyish brown mottled orange-brown and reddish brown, locally clayey, silty fine sand with occasional ironstone gravel was encountered and proved to the maximum depth investigated, of 20.00 m (110.88 m OD).

Atterberg limit tests have indicated the clay horizon to be of low shrinkability with plasticity indices ranging from 7% and 14% and the results of insitu SPTs have indicated the granular soils to have average internal angle of friction (Φ) of 33º at 3.00 m, increasing with depth to 36º by 12.00 m. Below the clay horizon, at a depth of 15.00 m, the internal angle of friction general increases from 36º to 43 º. Particle Size Distribution tests have also indicated the sand horizons to have a permeability of approximately 4 x 10^{-5}. These soils were observed to be free of any evidence of soil contamination.

5.3 Groundwater

Seepage of groundwater was encountered in Borehole No 3 at a depth of 3.00 m (128.70 m OD), whilst a deeper inflow was recorded in Borehole No 1 at a depth of 12.00 m (118.88 m OD). Borehole No 2 was found to be dry to 12.00 m (118.87 m OD). The basement excavation in the most part will extend to approximately 6.50 m (126.48 m OD) below ground level, although a small section for a new swimming pool will extend to a depth of 8.00 m (124.48 m OD) below ground level. On this basis groundwater monitoring standpipes were installed to 8.00 m (a maximum level of 122.88 m OD) in each of the boreholes and have been monitored on three occasions over a two month period. The table below provides the monitoring results.

Monitoring Date	Depth to groundwater (m OD)		
	BH 1	BH 2	BH 4
During drilling	12.00 m (118.88)	DRY	3.00 m (128.70)
27/06/14	DRY	DRY	4.30 m (127.40)
14/07/14	DRY	DRY	3.94 m (127.76)
14/08/14	DRY	DRY	4.10 m (127.60)

The water level encountered in Borehole No 4, is very different from that recorded in the other boreholes. During the drilling a seepage of water was encountered at a depth of 3.00 m, which coincided with the base of the suspected backfill material associated with the existing lower ground floor retaining wall. It is therefore thought that the water level measured in the standpipe is not indicative of the groundwater table, but rather perched water from within the fill material behind the existing retaining wall.

5.4 Soil Contamination

The table below sets out the values measured within four samples of made ground analysed; all concentrations are in mg/kg unless otherwise stated.

Determinant	BH1 – 0.3 m (mg/kg)	BH1 – 1.75 m (mg/kg)	BH2 – 0.3 m (mg/kg)	BH3 – 0.3 m (mg/kg)
pH	8.0	8.0	7.7	8.3
Arsenic	15	17	13	9.4
Cadmium	0.16	<0.10	0.19	<0.10
Chromium	19	29	21	11
Copper	29	16	35	20
Mercury	0.67	0.18	0.51	0.14
Nickel	13	11	13	7.5
Lead	**470**	120	**420**	160
Selenium	<0.20	<0.20	<0.20	<0.20

Determinant	BH1 – 0.3 m (mg/kg)	BH1 – 1.75 m (mg/kg)	BH2 – 0.3 m (mg/kg)	BH3 – 0.3 m (mg/kg)
Zinc	100	33	150	37
Total Cyanide	<0.5	<0.5	<0.5	<0.5
Total Phenols	<0.3	<0.3	<0.3	<0.3
Sulphide	3.5	0.90	1.9	5.4
Total TPH	<10	<10	14	160
Naphthalene	0.68	<0.1	0.56	0.72
Benzo(a)pyrene	0.59	<0.1	1.0	5.5
Total PAH	7.9	<2	14	72
Total organic carbon %	1.3	1.0	1.5	0.54
Note: Figure 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[7] 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 will not be a critical risk receptor;
- that the critical receptor for human health will be a young female child aged 0 to six years old;
- that young children will not have prolonged exposure to the site;
- 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 small terraced house

It is considered that these assumptions are acceptable for this generic first assessment of this site, although groundwater is considered to be a sensitive receptor at 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. The risk to groundwater is considered later in the report.

Where contaminant concentrations are measured at concentrations below the generic

7 *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.

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.

The results of the contamination testing have revealed elevated concentrations of lead within the samples of made ground recovered from Borehole Nos 1 and 2 at a depth of 0.30 m. 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 significance of the contamination results is considered further in Part 2 of the report.

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 with respect to foundation options and other aspects of the development.

6.0 INTRODUCTION

It is proposed to carry out refurbishment of the existing property which will include the construction of rear and side extensions and the construction of an additional basement level below the existing lower ground level. The new basement will extend in the most part to a depth of approximately 6.00 m below existing ground level (126.10 m OD), whilst the most eastern extent of the new basement will have a formation level of approximately 8.00 m below existing ground level (124.10 m OD), in order to house a new swimming pool.

7.0 GROUND MODEL

The desk study has revealed that the site has not had a potentially contaminative history, having apparently been occupied by Whitestone House since the early 1800s, although several phases of renovation and redevelopment of the house has taken place over recent years. On the basis of the fieldwork, the ground conditions at this site can be characterised as follows:

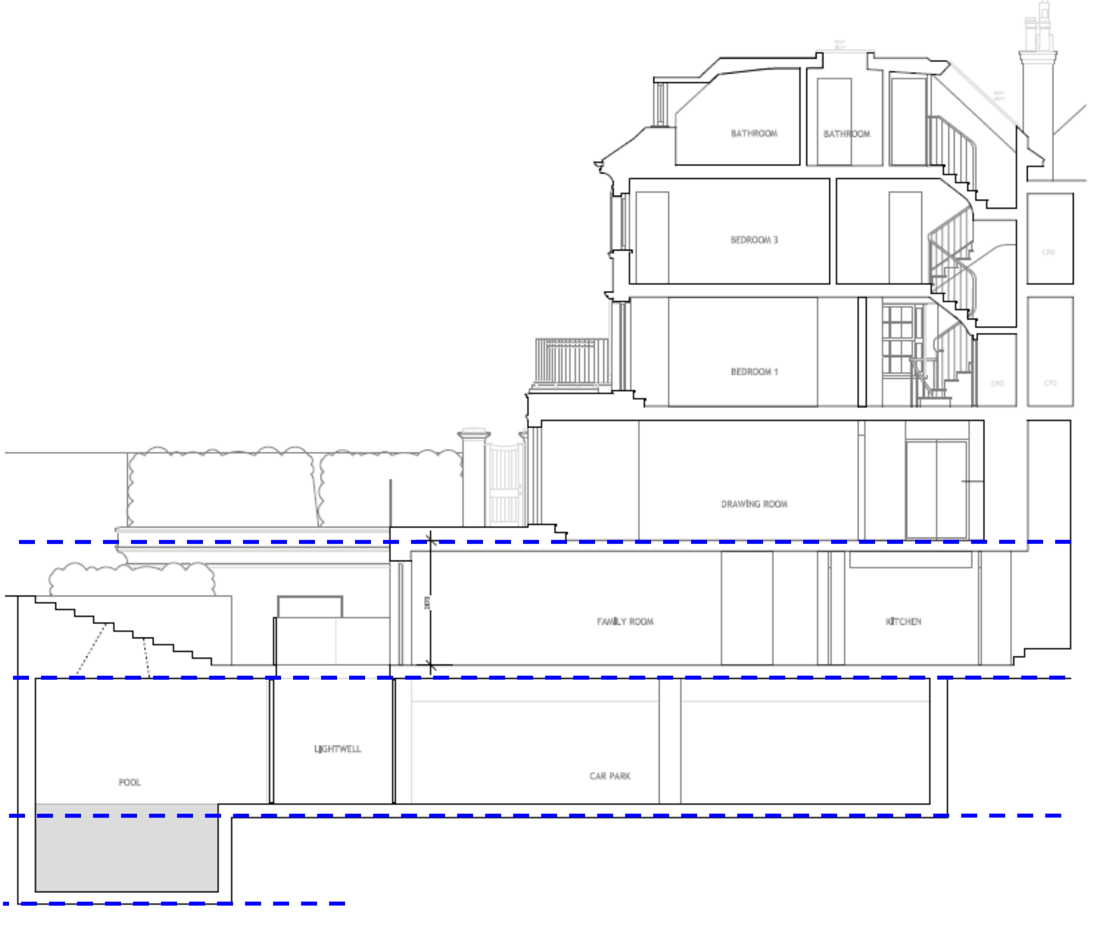
- Below a generally moderate thickness of made ground, the Bagshot Formation is present;
- made ground generally extends to depths of between 1.00 m (130.70 m OD) and 2.00 m (128.88 m OD), with the greater thicknesses encountered close to the existing house, and in particular, the retaining walls of the lower ground floor level;
- close to the existing lower ground floor, an horizon of clayey silty gravelly sand is present to a depth of 3.00 m (127.88 m OD), which is also thought to possibly be made ground from the backfilling behind the retaining walls;
- below the made ground, the Bagshot Formation predominantly comprises a yellowish brown becoming brownish grey mottled orange-brown, locally clayey silty fine sand;
- a horizon of firm brown mottled orange-brown silty sandy clay is present between 12.00 m (119.70 m OD) and 15.50 m (116.20 m OD);
- the density of the sand increases with depth from medium dense to dense and very dense below 15.00 m (115.88 m OD);
- perched groundwater was encountered close to the lower ground floor retaining walls at a depth of (128.70 m OD), whilst the groundwater table is present at a depth of 12.00 m (118.87 m OD); and
- the made ground contains elevated concentrations of lead.

8.0 ADVICE AND RECOMMENDATIONS

It is understood that the new basement will in general extend to a depth of approximately 6.00 m (126.48 m OD) below ground level although the eastern most part of the basement will extend to 8.00 m (124.48 m OD) in order to accommodate a new swimming pool. Significant groundwater inflows are unlikely to be encountered within the basement excavation, although perched groundwater may be encountered, particularly close to existing structures, as indicated by the monitoring carried out to date. On the basis of all of the above, it is considered that the use of a contiguous bored pile wall, coupled with localised underpinning, is likely to be the most suitable means of constructing the basement retaining walls.

8.1 Basement Excavation

The formation level for the basement will be within the medium dense sand of the Bagshot Formation at a general depth of 6.00 m below existing ground level (126.48 m OD), although an 8.00 m (124.48 m OD) deep section is proposed for a new swimming pool. Due to the existing levels of the site, this is likely to lead to a maximum excavation of 6.50 m. A cross section of the proposed basement is shown below.



The groundwater table was encountered at a depth of 12.00 m (118.88 m OD) during the drilling of the boreholes, although a shallower seepage of perched groundwater was encountered in Borehole No 3 at a depth of 3.00 m (128.70 m OD). Groundwater monitoring standpipes were installed to 8.00 m in the boreholes, a maximum level of 122.88 m OD, approximately 2.00 m below the maximum proposed depth of the new basement level. Whilst groundwater was encountered in Borehole No 3 at depth of 3.94 m (127.76 m OD), the standpipes installed in both Borehole Nos 1 and 2, were recorded to be dry on each occasion. It is therefore apparent that the groundwater level encountered in Borehole No 3 does not represent the groundwater table but rather perched groundwater, which is likely to be associated with the existing lower ground floor retaining wall, to which Borehole No 3 was advanced in close proximity to.

Whilst significant groundwater inflows are not expected to be encountered within the basement excavation, similar perched groundwater inflows to that encountered Borehole No 3 maybe encountered. These inflows are unlikely to be prolonged and should be adequately dealt with using sump pumping. As with any basement project, it would be prudent to continue to monitor the standpipes to check for any seasonal variations in groundwater levels, and to ensure that the water levels in the standpipes have reached equilibrium with the groundwater level in the soil. It would also be prudent to carry out a number of trial excavations in order to confirm the absence of any significant inflows.

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 wall 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. In this respect the stability of the adjacent buildings and surrounding road structures, will be paramount.

It is considered likely that the best method of constructing the new basement level will be through a combination of underpinning and a bored pile retaining wall. Underpinning of the existing party wall foundations will be required along the western extent of the new basement level. The use of conventional underpinning using a ‘hit and miss’ approach will however require the soils being underpinned to stand unsupported and difficulties may be encountered with unsupported excavations in the made ground and underlying sand of the Bagshot Formation, particularly if groundwater is encountered. It may be possible to control groundwater inflows with sump pumping; however careful control of pumping will be required to ensure that it does not lead to undermining and settlement of the adjacent buildings. If the adopted method of temporary support during excavations is not watertight, it would be prudent for the chosen contractor to have a contingency plan in place to deal with more significant inflows as a precautionary measure.

Ideally a number of trial excavations should be carried out, to depths as close to the depth of the basement in order to check the stability of the soil and to provide an indication of the extent to which the basement excavation may be affected by any groundwater inflows. If trial excavations indicate traditional underpinning to be impractical, jet grouting or permeation grouting below the existing foundations to form retaining walls may alternatively be considered, although issues regarding the use of grouting with respect to party wall matters will need to be addressed. Alternatively consideration could be given to the use of piled retaining walls, which in any case will be required for the portion of basement that extends out into the existing rear garden.

On the basis that significant groundwater inflows are unlikely to be encountered within the basement excavation, a contiguous bored piled wall may be the most suitable option with localised grouting between piles to prevent any groundwater inflows, although the use of a secant bored pile wall generally provides an additional amount of stiffness, negates the requirement for any secondary groundwater control and also maximises the useable space within the basement structure. The use of sheet piles is not considered to be a viable option due to the noise and vibrations associated with their installation.

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 and the timing of the provision of support to the wall will have an important effect on movements.

8.1.1 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	1700	Zero	27
Bagshot Formation (sand)	1850	Zero	36
Bagshot Formation (clay)	1900	Zero	25

Although the general groundwater table is considered to be below the proposed basement excavation, perched groundwater inflows maybe encountered within the basement excavation, particularly close to existing structures. Whilst it is always prudent to continue to monitor the standpipes, given the risk of groundwater and surface water collecting behind the retaining walls, it is recommended that a design water level of 1 m below ground level be adopted in the design of new retaining walls. Consideration could however be given to the use of a fully effective drainage system around the outside of the wall to prevent such inflows from collecting behind the walls. The advice in BS8102:2009[8] should be followed in the design of the basement retaining walls and with regard to waterproofing requirements.

8.1.2 Basement Heave

The 6.50 m deep excavation of the basement will result in a net unloading of around 120 kN/m^2. Given the remaining thickness of granular soils below the basement, heave is not expected to be an issue. There could potentially be some heave from the clay horizon encountered at 15.00 m, however given the fact that this horizon is limited in thickness and taking into consideration the applied loads from the existing house, which is to be retained, excess heave movements are not considered likely to occur due to the basement excavation.

8.2 Piled Foundations

For the ground conditions at this site some form of driving pile would be ideal and would utilise the high bearing capacities of the sand of Bagshot Formation. However, given the setting of the site, particularly with regard to the close proximity of the adjacent properties and the slope to the north, the noise and vibrations associated with this piling technique is likely to render their use unacceptable. Therefore some form of bored pile is likely to be the most appropriate type. A conventional rotary augered pile may be appropriate, with

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

temporary casing installed to maintain stability and prevent groundwater inflows, or alternatively the use of bored piles installed using continuous flight auger (cfa) techniques, which would not require the provision of casing, would also be an appropriate choice of pile.

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

Ultimate Skin Friction		**kN/m^2**
Made Ground and Bagshot Formation	All soil above 124.39 m OD	Ignore (basement)
Bagshot Formation (sand – $\Phi = 36$ Ks = 0.7)	124.39 m OD to 118.38 m OD	18
Bagshot Formation (clay - $\alpha = 0.6$)	118.38 m OD to 115.38 m OD	Increasing linearly from 65 to 85
Bagshot Formation (sand – $\Phi = 39$ Ks = 0.7)	115.38 m OD to 110.38 m OD	Increasing linearly from 75 to 125

Ultimate End Bearing		**kN/m^2**
Bagshot Formation (clay)	118.38 m OD	990
Bagshot Formation (sand)	115.38 m OD to 110.38 m OD	10,500 (limited)

On the basis of the above coefficients and a factor of safety of 3, it has been estimated that a 300 mm diameter pile founding at a depth of 13.00 m below existing ground level, a toe level of 118.38 m OD should provide a safe working load of about 50 kN, whilst the same diameter pile founding at 16.00 m, a toe level of 115.38 m OD should provide 340 kN. A 300 mm diameter pile founding at 21.00 m, 110.38 m OD, should provide a safe working load of about 500 kN.

The above examples are not intended to constitute any form of recommendation with regard to pile size or type, but merely serve to illustrate the use of the above coefficients. Specialist piling contractors should be consulted with regard to the design of a suitable piling scheme for this site and their attention should be drawn to the possibility of groundwater inflows from within the Bagshot Formation.

8.3 Shallow Excavations

It is not wholly possible to make an assessment of the stability of the shallows from the investigation techniques used, although it is considered likely that it will be feasible to form relatively shallow excavations that extend through the made ground and terminate within the underlying Bagshot Formation without the requirement for lateral support, although localised instabilities may occur from within the made ground. Where personnel are required to enter excavations, a risk assessment should be carried out and temporary lateral support or battering of the excavation sides will be required in order to comply with normal safety requirements.

Inflows of groundwater into shallow excavations are not generally anticipated, although seepages may be encountered from perched water tables within the made ground, particularly within the vicinity of existing foundations, although such inflows should be suitably controlled by sump pumping.

8.4 Basement Slab

Following the excavation of the basement, it should be possible to adopt a ground bearing slab, subject to a proof rolling exercise and the infilling of any soft spots with suitably compacted granular fill. Consideration will however need to be given to designing the slab to accommodate the pressures associated with the adopted design water level.

8.5 Effect of Sulphates

Low concentrations of total sulphate have been measured in selected soil samples and therefore indicate that buried concrete could be designed in accordance with Class DS-1 conditions of Table C2 of BRE Special Digest 1: SD1 Third Edition (2005). The measured pH conditions are mildly acidic and therefore on the basis of mobile groundwater conditions being assumed for buried concrete an ACEC classification of AC-2z may be adopted.

The guidelines contained in the above digest should be followed in the design of foundation concrete.

8.6 Site Specific Risk Assessment

The chemical analyses have revealed elevated concentrations of lead in two samples of made ground tested. No other elevated concentrations of the contaminants tested were identified. Furthermore, the desk study has indicated that the site has not had a contaminative history and therefore there is not considered to be a risk of significant contamination being present at the site. The exact source of the contamination is unknown, although the made ground was noted to contain variable inclusions of extraneous material. The contamination is however not considered to be in a soluble form as the samples were recovered from areas currently laid to lawn and therefore the soils have been subjected to years of surface and rainwater infiltration, which would have leached down any soluble contaminants. The measured concentrations are only slightly elevated above the generic guideline value and as any made ground in the area of the proposed basement will be removed, there is generally considered to be a low risk posed to end users. End users however could conceivably come into contact with the contamination in the remaining areas of soft landscaping. Should modifications occur to the existing rear garden area, then it is recommended that further testing of shallow samples is carried out, in order to determine the extent of any lead contamination and the requirement for any remediation.

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[9], 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 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

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

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[10], would qualify for the 'lower rate' of landfill tax.

Based upon on the technical guidance provided by the Environment Agency[11] 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[12] 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" on site by sufficiently characterising the soils insitu 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.

10 *Landfill Tax (Qualifying Material) Order 2011*

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

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

9.0 BASEMENT IMPACT ASSESSMENT

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
Is the site located directly above an aquifer?	The investigation has confirmed that the site is underlain by the Bagshot Formation, which is classified as a Secondary 'A' Aquifer.
Will the proposed basement extend beneath the water table surface?	Whilst perched groundwater was encountered close to the existing retaining structures, the groundwater table was encountered at a depth of 12.00 m (118.88 m OD) and subsequent monitoring has indicated that groundwater has been consistently below the maximum level of the basement excavation, of 124.48 m OD. The proposed basement will therefore not extend below the groundwater table and groundwater levels are therefore not expected to be affected
Is the site within the catchment of the pond chains on Hampstead Heath?	The current proposals will not significantly increase the proportion of hard surfaced areas on the site and therefore the volume of surface water inflow from surface run-off is unlikely to change due to the proposed development. Therefore, despite being in the catchment of the pond chains, the development is not considered to cause an increase of overland flow and therefore the risk of flooding or increased contamination of the pond chains.
Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	The site is located at the top of a natural slope that slopes down to the north away from the northern boundary and into the Vale of Heath at an angle of approximately 26º. The slope is very well-vegetated and no signs of historic or recent slope movement was noted during the site walkover. Furthermore the proposed basement excavation will not alter the profile of the slope or add any additional loading to the crest of the slope. Due to the basement excavation loads will actually be transferred down to a depth that is almost the equivalent of the level of the toe of the slope and is therefore likely to aid the long-term slope stability.
Is the site within a wider hillside setting in which the general slope is greater than 7°?	As above, although it should also be noted that the area of the site is not shown on Figure 17 in the Arup report to be in an area of significant landslide potential.
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?	A number of trees will be felled along the southern boundary. However on the basis that the shallow ground conditions comprise sand of the Bagshot Formation, there is not considered to be a risk of heave associated with removal of the trees. In addition, in line with that discussed in the preceding two points above, the trees are not considered to provide critical stability to the existing slope along the northern boundary. Therefore the removal of the trees are not considered to pose a risk of instability of existing structures and the natural slope.
Is the site within 5 m of a public highway or pedestrian right of way?	The investigation has not indicated any specific problems, such as weak or unstable ground, voids or a high water table that would make working within 5 m of public infrastructure particularly problematic at this site.

Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	As above and provided that the new retaining walls are adequately designed and / or the neighbouring foundations are unpinned, there is no need for the basement to cause instability of the adjoining properties.

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 extending below groundwater

The current development proposal includes the excavation of a basement to a maximum level of 124.88 m OD. For the majority of the basement, formation level of the final basement will be in the sand of the Bagshot Formation, approximately 6.00 m below ground level and 3.20 m below lower ground floor, although the swimming pool section, along the eastern extent of the basement, will be founding in the Bagshot Formation at a depth of approximately 8.00 m, below ground level and 5.20 m below lower ground floor.

Where the construction of a basement intercepts the groundwater table, groundwater will be diverted around the basement structure. The effect that this will have on groundwater flow will be largely governed by several factors, including the gradient of the local topography and thus the groundwater level contours, the permeability of the underlying geology and the shape and orientation of the basement structure compared to the local topography and groundwater flow direction. These factors may lead to a rise in the upstream groundwater level and reduction in downstream groundwater level, which has the potential to affect the local hydrogeology and sensitive features, such as springs and wells. The increase in hydraulic gradient as result of these groundwater level fluctuations, may also give rise to higher flow velocities at the sides of the basement structure, which could result in the subsurface erosion or piping of loose sandy material. This could cause a loss of material from around and below foundations of adjacent properties and therefore cause instability. All of these factors should be considered in assessing the likely effect of the proposed basement structure on the hydrogeological setting.

Groundwater was encountered at a level 118.88 m OD, approximately 6.00 m below proposed formation level. Groundwater monitoring standpipes were installed to a maximum level of 122.88 m OD and have been recorded to be dry during each monitoring visit. On this basis the basement excavation will not encounter the groundwater table. However, seasonal variations in groundwater level do occur and therefore it is recommended that further monitoring is carried out in order to establish equilibrium levels. Groundwater level would however not be expected to rise significantly. In the aforementioned Guidance for Subterranean Development prepared by Arup on behalf of the London Borough of Camden, it is noted that groundwater table variations in the area are generally only in the order of a few tens of centimetres throughout the year. This has been confirmed by GEA investigations in the Hampstead area, in which groundwater monitoring has been carried out between 2011 and 2013. Although 2011 was a notably very dry year, whilst, the summer of 2012 and the early months of 2013 were one of the wettest summers and winters respectively on record, and the monitoring showed a maximum variation in groundwater level of 19 cm over the three years. On the basis of all the above, groundwater would be expected to remain well below the level of the basement.

In addition to the above, consideration should be given to the position of the site in relation to the surrounding hillside setting. The site is located at the crest of the hill and as indicated by the desk study research into the hydrogeological setting, groundwater flow is likely to be in a generally northerly / northeasterly direction towards the areas of greater catchment, which are marked by the Highgate and Hampstead Ponds. In addition, a former spring line that is marked by a pond, approximately 200 m to the northeast of the site, provides further evidence of the depth to the groundwater table, which is well below the depth of the proposed basement. On this basis the proposed structure will not affect the local hydrogeological setting, such that it will not cause an increase in groundwater levels on the upstream side and should have no effect on neighbouring properties.

It is however recommended that suitable measures are incorporated to deal with any surface run-off. Such measures would in any case form part of the design of the basement in order to maintain required conditions, as detailed in BS 8102:2009.

The site is located in the catchment of the pond chains on Hampstead Heath

The current proposals will not significantly increase the proportion of hard surfaced areas on the site from the existing condition and therefore the volume of surface water inflow from surface run-off is unlikely to change due to the proposed development, such that it will increase the risk of flooding of the ponds or increased contamination from overland flow. The desk study research has indicated that the site is not within close proximity of the pond chains and nor is it located in close proximity to an existing or historical water course. Therefore the site is not considered to be at risk from flooding and is any case not noted to be an area considered to be at risk of surface water flooding, as indicated by Figure 5 of the Arup report.

The site neighbours a slope of greater than 7° is in a wider hillside setting with slopes of greater than 7°

Beyond the northern boundary of the site, a natural slope slopes down to the north at an angle of approximately 26°. The site also forms part of the Hampstead Heath which is a wider hillside setting that includes natural slopes of greater than 7°. Slopes of such gradients may be susceptible to natural slope failure or induced slope failure, due to increased loading, modification or de-vegetating of the slope. It should however be noted that 7° is considered to be the approximate critical slope angle for slopes within the London Clay Formation, including the overlying Claygate Member. Slopes within the sands of the Bagshot Formation are generally considered to be cable of remaining stable at greater slope angles. The density and the inferred angle of friction for these soils can provide an initial indication of suitable slope angles with the investigation indicating that the initial 12.00 m of the Bagshot Formation has an average angle of friction of 35°, significantly greater than the existing slope angle.

The slope is very well-vegetated and no signs of historic or recent slope movement was noted during the site walkover. Furthermore the proposed basement excavation will not alter the profile of the slope or add any additional loading to the crest of the slope. Due to the basement excavation, loads will actually be transferred down to a depth that is almost the equivalent of the level of the toe of the slope and is therefore likely to aid the long-term slope stability. On the basis of the all the above, and the fact the site is not shown to be in area of significant landslide potential on Figure 17 of the Arup report, a full slope stability analysis is not considered to be required.

A number of trees will be felled during the development

A number of trees will be felled along the southern boundary. However on the basis that the shallow ground conditions comprise sand of the Bagshot Formation, there is not considered to be a risk of heave associated with removal of the trees. In addition, in line with that discussed in the preceding two points above, the trees are not considered to provide critical stability to the existing slope along the northern boundary. Therefore the removal of the trees are not considered to pose a risk of instability of existing structures and the natural slope.

Location of public highway

The basement excavation is within 5 m of Whitestone Lane to the south, which although is actually a private road, is used by neighbouring vehicles. The lower ground floor however already extends below the lane, which is retained by an existing retaining wall that was constructed some time between 2003 and 2004. This has not given rise to any notable or reported instability along Whitestone Lane or the surrounding structures. 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, with this investigation fully identifying the ground model at this site, such that new retaining walls can be adequately designed.

Founding depths relative to neighbours

The proposed basement structure will require a number of the existing foundations of the lower ground floor to be underpinned down to the proposed depth of the new basement level. However, these foundations, particularly those along the western elevation, are also party walls and therefore the neighbouring foundations will also be underpinned in the process. This will prevent the creation of differential foundation depths between the existing property and the neighbouring properties and provided that good workmanship is applied and the work carried out by a suitably qualified contractor, there is no need for the stability of the adjacent properties to be compromised. The underpinning the foundations down to more dense and therefore competent soils, will in any case only aid the stability of the existing structures. Furthermore, these foundations have already been underpinned during the construction of the existing lower ground floor, which, as far as known, did not cause any instability of the neighbouring structures.

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 may 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.

Continued monitoring of the standpipes installed in the boreholes is essential to allow equilibrium groundwater levels to be established and the magnitude of any seasonal variations in level to be determined. As stated within this report, it would also be prudent to carry out a number of trial excavations in order to determine the stability of the underlying soils and the presence of any shallow perched water inflows, particularly if traditional underpinning methods are considered.

These limited areas of risk should be drawn to the attention of prospective contractors and sufficient contingency should be provided to cover the outstanding risk.

APPENDIX

Borehole Records

SPT Summary Sheet

Geotechnical Test Results

SPT & Cohesion/ Level Graph

Chemical Analyses (Soil)

Generic Risk Based Screening Values

Envirocheck Extracts

Historical Maps

Site Plan

Geotechnical & Environmental Associates

Tyttenhanger House
Coursers Road
St Albans
AL4 0PG

Site	Borehole Number
Whitestone House, Whitestone Lane, London NW3 1EA	BH1

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 13.00m		Mr Graham Edwards	J14136
	Location	**Dates**	**Engineer**	**Sheet**
		27/05/2014-28/05/2014	Conisbee	1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
						(0.30) 0.30	Topsoil (dark grey sandy silt)			
0.30	D1						Made Ground (dark grey silty sandy clay with gravel and occasional brick fragments)			
						(1.70)				
1.20-1.65	CPT N=4		DRY	1,1/1,1,1,1						
1.20-1.65	B1									
1.75	D2									
						2.00	Medium dense dark brown silty fine to coarse SAND and fine to coarse subangular to well-rounded GRAVEL - Possible made ground			
2.00-2.45	CPT N=10	2.00	DRY	1,2/2,2,3,3						
2.00-2.45	B2									
						(1.00)				
2.75	D3									
						3.00	Medium dense yellowish brown, locally clayey, silty fine SAND			
3.00-3.45	CPT N=12	3.00	DRY	1,2/2,2,3,5						
3.00-3.45	B3									
3.75	D4									
4.00-4.45	CPT N=14	4.00	DRY	1,2/3,3,4,4						
4.00-4.45	B4									
4.75	D5									
5.00-5.45	CPT N=21	5.00	DRY	3,3/4,5,6,6						
5.00-5.45	B5									
6.00	D6									
6.50-6.95	CPT N=17	6.00	DRY	1,2/3,4,4,6						
6.50	B6									
7.50	D7						decayed root at 7.5 m			
						(9.50)				
8.00-8.45	CPT N=22	7.00	DRY	2,3/5,5,6,6						
8.00-8.45	B7									
9.00	D8									
9.50-9.95	CPT N=25	9.00	9.00	3,4/5,6,6,8						
9.50-9.95	B8									

Remarks
4 hrs spent manhandling rig and tools into position.
Excavating services inspection pit from GL to 1.2 m for 1 hr.
Water added to assist drilling between 3.0 m and 12.0 m.
Groundwater monitoring standpipe installed in borehole to a depth of 8.00 m.
1 hr spent clearing the drilling area.
Groundwater monitoring visit on 27/06/14 recorded the standpipe to be dry.
Groundwater monitoring visit on 14/07/14 recorded the standpipe to be dry.

Scale (approx)	Logged By
1:50	ML
Figure No.	
J14136.BH1	

GEA Geotechnical & Environmental Associates	Tyttenhanger House, Coursers Road, St Albans, AL4 0PG	**Site** Whitestone House, Whitestone Lane, London NW3 1EA		**Borehole Number** BH1
Boring Method Cable Percussion	**Casing Diameter** 150mm cased to 13.00m	**Ground Level (mOD)**	**Client** Mr Graham Edwards	**Job Number** J14136
	Location	**Dates** 27/05/2014-28/05/2014	**Engineer** Conisbee	**Sheet** 2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
10.50	D9									
11.00-11.45 11.00-11.45	CPT N=28 B9	11.00	9.00	3,4/6,6,8,8						
						(9.50)				
12.00	D10			Slow(1) at 12.00m, sealed at 13.00m. 27/05/2014:9.00m					∇1	
						12.50	Firm brown mottled grey and dark orange-brown silty sandy CLAY			
12.50 12.50-12.95	D11 CPT N=18	12.00	11.00	28/05/2014:11.00m 1,2/4,4,5,5						
						(2.50)				
14.00-14.45 14.00	CPT N=24 D13	13.00	DRY	2,3/4,6,6,8						
						15.00	Dense becoming very dense greyish brown mottled orange-brown and reddish brown clayey silty fine SAND with occasional ironstone gravel			
15.00	D14									
15.50-15.95 15.50-15.95	CPT N=33 B10	13.00	DRY	5,5/8,8,8,9						
16.50 16.50	D15 D12									
17.00-17.45 17.00-17.45	CPT N=48 B11	13.00	DRY	5,8/8,11,11,18						
						(5.00)				
18.00-18.45 18.00	SPT N=52 D16	13.00	DRY	5,8/8,14,15,15						
19.25	D17									
19.55-20.00 19.55	SPT N=65 D18	13.00	DRY	9,11/12,17,17,19 28/05/2014:DRY						
						20.00				

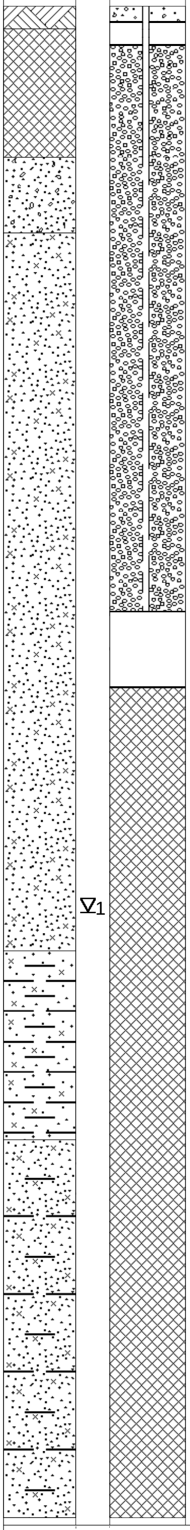
Remarks	**Scale (approx)** 1:50	**Logged By** ML
	Figure No. J14136.BH1	

GEA Geotechnical & Environmental Associates

Tyttenhanger House
Coursers Road
St Albans
AL4 0PG

Site	Borehole Number
Whitestone House, Whitestone Lane, London NW3 1EA	BH1

Installation Type	Dimensions		Client	Job Number
			Mr Graham Edwards	J14136
	Location	**Ground Level (mOD)**	**Engineer**	**Sheet**
			Conisbee	1/1



Legend	Water	Instr (A)	Level (mOD)	Depth (m)	Description
				0.20	Concrete
				0.50	Bentonite Seal
					Gravel Filter
				2.00	
					Slotted Standpipe
				8.00	
					Bentonite Seal
				9.00	
	∇1				
					General Backfill
				20.00	

Groundwater Strikes During Drilling

Date	Time	Depth Struck (m)	Casing Depth (m)	Inflow Rate	Readings 5 min	10 min	15 min	20 min	Depth Sealed (m)
		12.00	11.50	Slow					13.00

Groundwater Observations During Drilling

Date	Start of Shift Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)	End of Shift Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)
27/05/14	11:00			DRY		16:00	12.00	11.50	9.00	
28/05/14	9:00	12.00	11.50	11.00		12:00	20.00	13.00	DRY	

Instrument Groundwater Observations

Inst. [A] Type :

Date	Instrument [A] Time	Depth (m)	Level (mOD)	Remarks
27/06/14		DRY		
14/07/14		DRY		

Remarks

GEA Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans AL4 0PG	**Site** Whitestone House, Whitestone Lane, London NW3 1EA	**Borehole Number** **BH2**

Boring Method	**Casing Diameter**	**Ground Level (mOD)**	**Client**	**Job Number**
Cable Percussion	150mm cased to 5.00m		Mr Graham Edwards	J14136
	Location	**Dates** 28/05/2014- 29/05/2014	**Engineer** Conisbee	**Sheet** 1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
						(0.30)	Topsoil (dark grey clayey silty sand)			
0.30	D1					0.30	Made Ground (dark grey silty sandy clay with gravel and occasional brick fragments)			
0.50	B1									
						(1.45)				
1.20-1.65 1.20-1.65	CPT N=9 B2	1.00	DRY	1,2/1,3,2,3						
1.75	D2					1.75	Medium dense, locally dense, yellowish brown, locally clayey, silty fine SAND			
2.00-2.45 2.00-2.45	CPT N=22 B3	2.00	DRY	3,3/5,5,6,6						
2.75	D3									
3.00-3.45 3.00-3.45	CPT N=27 B4	3.00	DRY	5,6/6,6,7,8						
3.75	D4									
4.00-4.45 4.00-4.45	CPT N=28 B5	4.00	DRY	3,5/6,6,8,8						
4.75	D5									
5.00-5.45 5.00-5.45	CPT N=30 B6	5.00	DRY	6,6/7,7,7,9						
6.00	D6			28/05/2014:DRY						
				29/05/2014:DRY						
6.50-6.95 6.50-6.95	CPT N=30 B7	5.00	DRY	6,6/7,7,8,8						
						(10.25)				
7.50	D7									
8.00-8.45 8.00-8.45	CPT N=35 B8	5.00	DRY	5,6/7,7,9,12						
9.00	D8									
9.50-9.95 9.50-9.95	SPT N=27 D9	5.00	DRY	5,6/6,7,7,7						

Remarks
2 hrs spent moving rig from BH1 to BH2
Excavating services inspection pit from GL to 1.2 m.
Groundwater not encountered.
Groundwater monitoring standpipe installed in Borehole to a depth of 8.0 m.
Groundwater monitoring visit on 27/06/14 recorded the standpipe to be dry.
Groundwater monitoring visit on 14/07/14 recorded the standpipe to be dry.

Scale (approx)	**Logged By**
1:50	ML
Figure No. J14136.BH2	

Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans AL4 0PG	Site Whitestone House, Whitestone Lane, London NW3 1EA	Borehole Number **BH2**
Boring Method Cable Percussion	**Casing Diameter** 150mm cased to 5.00m	**Ground Level (mOD)**	**Client** Mr Graham Edwards	**Job Number** J14136
	Location	**Dates** 28/05/2014- 29/05/2014	**Engineer** Conisbee	**Sheet** 2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
10.50	D10									
						(10.25)				
11.55-12.00 11.55	SPT N=27 D11	5.00	DRY	4,5/6,6,7,8						
				29/05/2014:DRY		12.00				
							Complete at 12.00m			

Remarks	Scale (approx)	Logged By
	1:50	ML
	Figure No. J14136.BH2	

GEA Geotechnical & Environmental Associates

Tyttenhanger House
Coursers Road
St Albans
AL4 0PG

Site	Borehole Number
Whitestone House, Whitestone Lane, London NW3 1EA	BH2

Installation Type	Dimensions		Client	Job Number
			Mr Graham Edwards	J14136
	Location	**Ground Level (mOD)**	**Engineer**	**Sheet**
			Conisbee	1/1

Legend	Water	Instr (A)	Level (mOD)	Depth (m)	Description
				0.20	Concrete
				0.50	Bentonite Seal
					Gravel Filter
				1.50	
					Slotted Standpipe
				8.00	
					Bentonite Seal
				9.00	
					General Backfill
				12.00	

Groundwater Strikes During Drilling

Date	Time	Depth Struck (m)	Casing Depth (m)	Inflow Rate	Readings 5 min	10 min	15 min	20 min	Depth Sealed (m)

Groundwater Observations During Drilling

Date	Start of Shift Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)	End of Shift Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)
28/05/14	14:00			DRY		16:00	6.00	5.00	DRY	
29/05/14	9:00	6.00	5.00	DRY		11:00	12.00	5.00	DRY	

Instrument Groundwater Observations

Inst. [A] Type :

Date	Instrument [A] Time	Depth (m)	Level (mOD)	Remarks
27/06/14		DRY		
14/07/14		DRY		

Remarks

Geotechnical & Environmental Associates

Tyttenhanger House
Coursers Road
St Albans
AL4 0PG

Site	Borehole Number
Whitestone House, Whitestone Lane, London NW3 1EA	BH3

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 13.00m		Mr Graham Edwards	J14136
	Location	**Dates**	**Engineer**	**Sheet**
		29/05/2014-30/05/2014	Conisbee	1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
						(0.30) 0.30	Made Ground (loose shingle surfacing over compacted dark grey silty sand)			
0.30	D1									
0.50	D2					(0.70)	Made Ground (dark greyish brown silty sandy clay with gravel and occasional brick fragments)			
0.75	D3									
						1.00	Yellowish brown clayey silty fine SAND with occasional fine to medium rounded gravel - possible made ground			
1.20-1.65	CPT N=18	1.00	DRY	2,3/4,5,4,5						
1.20-1.62	B1									
1.75	D4									
2.00-2.45	CPT N=21	2.00	DRY	2,3/4,6,6,5		(2.00)				
2.00-2.45	B2									
2.75	D5									
3.00-3.45	B3			Seepage(1) at 3.00m.		3.00	Medium dense becoming dense yellowish brown silty fine SAND		∇1	
3.00-3.45	CPT N=27	3.00	DRY	3,4/5,6,8,8						
3.75	D6									
4.00-4.45	CPT N=32	4.00	DRY	4,4/7,7,7,11						
4.00-4.45	B4									
4.75	D7									
5.00-5.45	CPT N=34	5.00	DRY	6,6/7,8,8,11						
5.00-5.45	B5									
6.00	D8									
6.50-6.95	CPT N=36	6.50	DRY	5,6/7,7,10,12						
6.50-6.95	B6									
7.50	D9					(9.00)				
8.00-8.45	CPT N=39	8.00	DRY	6,7/8,9,10,12						
8.00-8.45	B7									
9.00	D10									
9.50-9.95	CPT N=39	9.50	DRY	6,7/8,9,10,12						
9.50	D11									

Remarks
2 hrs spent moving rig from BH2 to BH3.
Excavating services inspection pit from GL to 1.2 m for 1 hr.
Groundwater montioring standpipe installed in borehole to a depth of 8.00 m.
2 hrs spent clearing borehole positions and dismantling rig.
Groundwater monitoring visit on 27/06/14 recorded groundwater at 4.30 m.
Groundwater monitoring visit on 14/07/14 recorded groundwater at 3.94 m.

Scale (approx)	Logged By
1:50	ML

Figure No. J14136.BH3

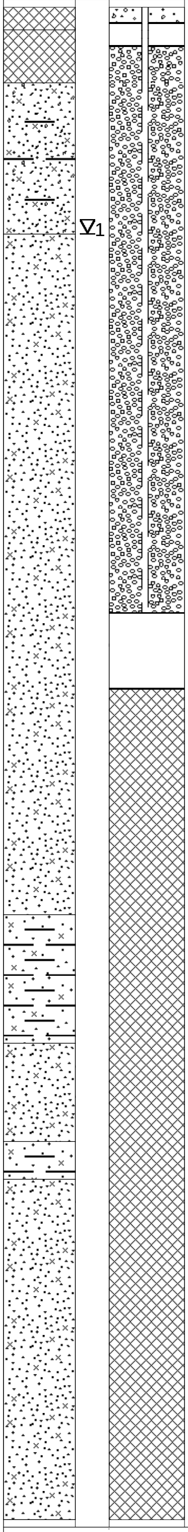
GEA Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans AL4 0PG	**Site** Whitestone House, Whitestone Lane, London NW3 1EA	**Borehole Number** **BH3**
Boring Method Cable Percussion	**Casing Diameter** 150mm cased to 13.00m **Location**	**Ground Level (mOD)** **Dates** 29/05/2014- 30/05/2014	**Client** Mr Graham Edwards **Engineer** Conisbee	**Job Number** J14136 **Sheet** 2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
10.50	D12									
11.00-11.45 11.00	SPT N=30 D13	11.00	DRY	5,6/6,7,8,9		(9.00)				
12.00	D14					12.00	Firm brown mottled orange-brown and brownish grey silty sandy CLAY			
12.50-12.95 12.50	CPT N=28 D15	12.00	DRY	4,5/6,6,8,8		(1.70)				
13.50	D16					13.70	Very dense brown and brownish grey silty fine SAND with dark orange-brown specks			
14.00-14.45 14.00	SPT N=39 D17	13.00	DRY	5,9/8,9,9,13		(1.30)				
15.00	D18					15.00 (0.50)	Firm brownish grey silty very sandy CLAY			
15.50-15.95 15.50	SPT N=71 D19	13.00	DRY	8,12/15,21,35		15.50	Dense locally very dense greyish brown mottled orange-brown and reddish brown, locally clayey, silty fine sand with occasional ironstone gravel			
16.50	D20									
17.00-17.45 17.00	CPT N=45 D21	13.00	DRY	6,8/9,11,12,13						
						(4.50)				
18.00	D22									
18.50-18.95 18.50	CPT N=45 D23	13.00	DRY	5,8/9,10,12,14						
19.25	D24									
19.55-20.00 19.55	CPT N=64 D25	13.00	DRY	8,12/15,15,17,17 30/05/2001:DRY 29/05/2014:DRY		20.00				

Remarks	**Scale (approx)** 1:50	**Logged By** ML
	Figure No. J14136.BH3	

Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans AL4 0PG	**Site** Whitestone House, Whitestone Lane, London NW3 1EA		**Borehole Number** **BH3**
Installation Type	**Dimensions**	**Client** Mr Graham Edwards		**Job Number** J14136
	Location	**Ground Level (mOD)**	**Engineer** Conisbee	**Sheet** 1/1

Legend	Water	Instr (A)	Level (mOD)	Depth (m)	Description
				0.20	Concrete
				0.50	Bentonite Seal
				1.00	Gravel Filter
	∇1				
					Slotted Standpipe
				8.00	Bentonite Seal
				9.00	
					General Backfill
				20.00	



Groundwater Strikes During Drilling

Date	Time	Depth Struck (m)	Casing Depth (m)	Inflow Rate	Readings 5 min	10 min	15 min	20 min	Depth Sealed (m)
		3.00	2.00	Seepage					

Groundwater Observations During Drilling

Date	Start of Shift Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)	End of Shift Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)
30/05/01	9:00	13.75	13.00	DRY		13:00	20.00	13.00	DRY	
29/05/14	13:00			DRY		17:00	13.75	13.00	DRY	

Instrument Groundwater Observations

Inst. [A] Type :

Date	Instrument [A] Time	Depth (m)	Level (mOD)	Remarks
27/06/14		4.30		
14/07/14		3.94		

Remarks

Geotechnical & Environmental Associates

Tyttenhanger House
Coursers Road
St Albans
Herts AL4 0PG

Site Plan

Site	Whitestone House, Whitestone Lane, London NW3 1EA	**Job Number**	J14136
Client	Mr Graham Edwards	**Sheet**	1 / 1
Engineer	Conisbee