

Document Control

Project title		39 College Crescent, London NW3 5LD		Project ref	J12079
Report prepared by		Rosemary Rafferty BSc MSc DIC FGS			
With input from		Martin Cooper BEng CEng MICE FGS		John Evans MSc FGS CGeol	
Report checked and approved for issue by		Steve Branch BSc MSc CGeol FGS FRGS MIEnvSc			
Issue No	Status		Date		Approved for Issue
1	Draft		29 May 2012		

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



Hertfordshire

tel 01727 824666

mail@gea-ltd.co.uk



Nottinghamshire

tel 01509 674888

midlands@gea-ltd.co.uk

Geotechnical & Environmental Associates Limited (GEA) disclaims any responsibility to the Client and others in respect of any matters outside the scope of this work. This report has been prepared with reasonable skill, care and diligence within the terms of the contract with the Client and taking account of the manpower, resources, investigation and testing devoted to it in agreement with the Client. This report is confidential to the Client and GEA accepts no responsibility of whatsoever nature to third parties to whom this report or any part thereof is made known, unless formally agreed beforehand. Any such party relies upon the report at their own risk. This report may provide advice based on an interpretation of legislation, guidance notes and codes of practice. GEA does not however provide legal advice and if specific legal advice is required a lawyer should be consulted.

© Geotechnical & Environmental Associates Limited 2012

CONTENTS

EXECUTIVE SUMMARY

Part 1: INVESTIGATION REPORT

1.0	INTRODUCTION	1
1.1	Proposed Development	1
1.2	Purpose of Work	1
1.3	Scope of Work	2
1.4	Qualifications	3
1.5	Limitations	3
2.0	THE SITE	3
2.1	Site Description	3
2.2	Site History	5
2.3	Other Information	6
2.4	Geology	6
2.5	Hydrology and Hydrogeology	6
2.6	Preliminary Risk Assessment	7
3.0	SCREENING	8
3.1	Slope Stability Screening Assessment	8
3.2	Subterranean (Groundwater) Flow Screening Assessment	9
3.3	Surface Flow and Flooding Screening Assessment	10
4.0	SCOPING AND SITE INVESTIGATION	11
4.1	Potential Impacts	11
4.2	Exploratory Work	12
5.0	GROUND CONDITIONS	13
5.1	Made Ground	13
5.2	London Clay	13
5.3	Groundwater	14
5.4	Soil Contamination	14
5.5	Existing Foundations	16

Part 2: DESIGN BASIS REPORT

6.0	INTRODUCTION	17
7.0	GROUND MODEL	17
8.0	ADVICE AND RECOMMENDATIONS	18
8.1	Basement Excavation	18
8.2	Spread Foundations	20
8.3	Piled Foundations	20
8.4	Shallow Excavations	21
8.5	Basement Floor Slab	21
8.6	Effect of Sulphates	21
8.7	Site Specific Risk Assessment	22
8.8	Waste Disposal	22
9.0	BASEMENT IMPACT ASSESSMENT	23
9.1	Slope Stability Impact Assessment	23
9.2	Subterranean (Groundwater) Flow Impact Assessment	24
10.0	OUTSTANDING RISKS AND ISSUES	25
	APPENDIX	

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 and Basement Impact Assessment (BIA) carried out by Geotechnical and Environmental Associates Ltd (GEA), on the instructions of Paul Carpenter Associates, on behalf of Thameside Construction Co Ltd, with respect to the redevelopment of this site through construction of seven new properties, to include basement accommodation and parking. The purpose of the investigation has been to research the history of the site, to assess the potential for contamination, to determine the soil and hydrogeological conditions, and to provide information to assist with the design of the basement and suitable foundations for the proposed development. The report also includes a Land Stability Impact Assessment and Subterranean Flow Assessment, which form part of the Basement Impact Assessment procedure in accordance with guidelines from London Borough of Camden in support of a planning application. An initial Surface Flow and Flooding Screening Assessment has also been completed, although a full surface flow and flooding risk assessment did not form part of the brief for this project.

DESK STUDY FINDINGS

A building, presumably the existing building which was in the process of being demolished at the time of the ground investigation, was constructed within the northern end of the site some time between 1871 and 1895. The historical maps do not indicate any significant changes to have occurred within the site since that time. The River Tyburn historically flowed in a roughly southwards direction towards the River Thames, approximately 50 m east of the site. The Envirocheck report does not list any landfills within 500 m of the site and there are no contaminated land register entries or notices or pollution incidents recorded within 1 km of the site. The London Underground Metropolitan Line tunnel runs beneath Finchley Road, roughly 20 m southwest of the site.

GROUND CONDITIONS

The investigation encountered a moderate thickness of made ground overlying London Clay. The made ground comprised brown clayey gravelly sand with fragments of brick and concrete, and extended to depths of between 0.5 m and 1.4 m. The underlying London Clay initially comprises firm fissured brown mottled orange-brown and grey silty clay, becoming stiff from depths of between 2.0 m and 4.0 m and brownish grey from depths of between 10.1 m and 11.2 m, with selenite crystals and occasional claystones and pockets or partings of silt or fine sand. Roots were recorded to a maximum depth of 4.5 m and the clay was found to be desiccated to a depth of 1.5 m in a single location. Groundwater seepages were encountered within the London Clay at depths of 1.8 m (60.25 m OD) in Borehole No 3 and associated with claystones at depths of 12.4 m and 18.7 m (48.20 m OD and 43.35 m OD) in Borehole Nos 1 and 3; subsequent monitoring of the standpipes has measured groundwater level at depths of between 0.2 m and 4.6 m (61.85 m OD and 56.20 m OD). The chemical analyses have indicated the made ground to be generally free from significant contaminant concentrations, although a single concentration of total PAH was measured at a concentration that may pose a risk to human health.

RECOMENDATIONS

The formation level for the new basement will extend into the London Clay. Foundations will need to be deepened in the vicinity of trees to bypass any desiccated soil and it is likely that piles will be appropriate for the support of the basement excavation and to provide structural support. Groundwater is likely to be encountered within the basement excavation and it would be prudent to carry out trial excavations to the full basement depth to assess the likely volumes of inflows. Following completion of the proposed development, limited pathways will exist to expose end users to any contaminants remaining within the soil. A cover thickness of clean soil will be required in any areas of soft landscaping. Consideration will also need to be given to the protection of site workers and buried services.

BASEMENT IMPACT ASSESSMENT

A land stability assessment and subterranean flow assessment have been carried out following the information and guidance published by the London Borough of Camden. It is concluded that the proposed development is unlikely to result in any specific land or slope stability issues, or cause harm to neighbouring properties or result in flooding. It will be necessary to liaise with London Underground Ltd to ensure the safety of their assets during proposed works at this site. The surface water and flooding screening assessment has identified a requirement for a full surface water and flooding assessment.

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 Ltd (GEA) has been commissioned by Paul Carpenter Associates, on behalf of Thameside Construction Co Ltd, to carry out a desk study and ground investigation at 39 College Crescent, London NW3 5LD.

This report also forms the slope stability and subterranean (groundwater) flow parts of a Basement Impact Assessment (BIA), which has been carried out in accordance with guidelines from the London Borough of Camden (LBC). A Surface Water Screening Assessment has also been completed, but a full flood risk assessment did not form part of the brief for this project.

1.1 Proposed Development

Consideration is being given to the redevelopment of this site through the construction of seven new three-storey residential properties with basements, to include basement accommodation and parking. It is understood that the proposed basements will extend to depths of up to 3.0 m to 3.5 m below existing ground level, whilst the upper ground floor will be approximately at street level.

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

1.2 Purpose of Work

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

- ❑ to determine the history of the site and surrounding area, particularly with respect to any previous or present potentially contaminative uses;
- ❑ to research the geology and hydrogeology of the site;
- ❑ to check records of data on groundwater, surface water and other publicly available environmental data;
- ❑ to use the information obtained in the above searches to carry out a qualitative risk assessment with respect to subsurface contamination;
- ❑ to provide preliminary advice with respect to the design of suitable foundations and retaining walls;
- ❑ to provide an assessment of the impact of the proposed development on land stability and local hydrogeology; and
- ❑ to provide a preliminary assessment of the impact of the proposed development on surface water and flooding.

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 the following activities:

- ❑ a review of readily available geological maps;
- ❑ a review of publicly available environmental data sourced from the Landmark Envirocheck database;
- ❑ a review of historical Ordnance Survey (OS) maps supplied by Landmark;
- ❑ a review of bomb damage maps available at the London Metropolitan Archives; and
- ❑ a walkover survey of the site carried out in conjunction with the fieldwork.

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

- ❑ three cable percussion boreholes, advanced to depths of 20.0 m, by means of a cable percussion drilling rig;
- ❑ standard penetration tests (SPTs), carried out at regular intervals in the cable percussion boreholes, to provide additional quantitative data on the strength of the soils;
- ❑ the installation of groundwater monitoring standpipes into the three boreholes and two monitoring visits after a period of approximately two weeks and four weeks;
- ❑ inspection of a single trial pit excavated by others to investigate the configuration of the existing foundations;
- ❑ 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) 11¹ 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 Basement Impact Assessment (BIA) comprises a subterranean (groundwater) flow assessment and a land stability assessment (also referred to as slope stability assessment) which has been prepared by GEA and is reported, and a surface water and flooding risk assessment, which has not been carried out in full although the results of the initial screening have been prepared by GEA and are reported. These assessments form part of the Basement

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

Impact Assessment (BIA) procedure specified in the London Borough of Camden Planning Guidance CPG4² and their Guidance for Subterranean Development³ prepared by Arup.

The aim of the assessment is to provide information on land stability and in particular to assess whether the development will affect the stability of neighbouring properties. In addition, the assessment will identify potential groundwater impacts that the development may have and how any identified impacts can be appropriately mitigated by the design of the development.

1.4 Qualifications

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

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

1.5 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

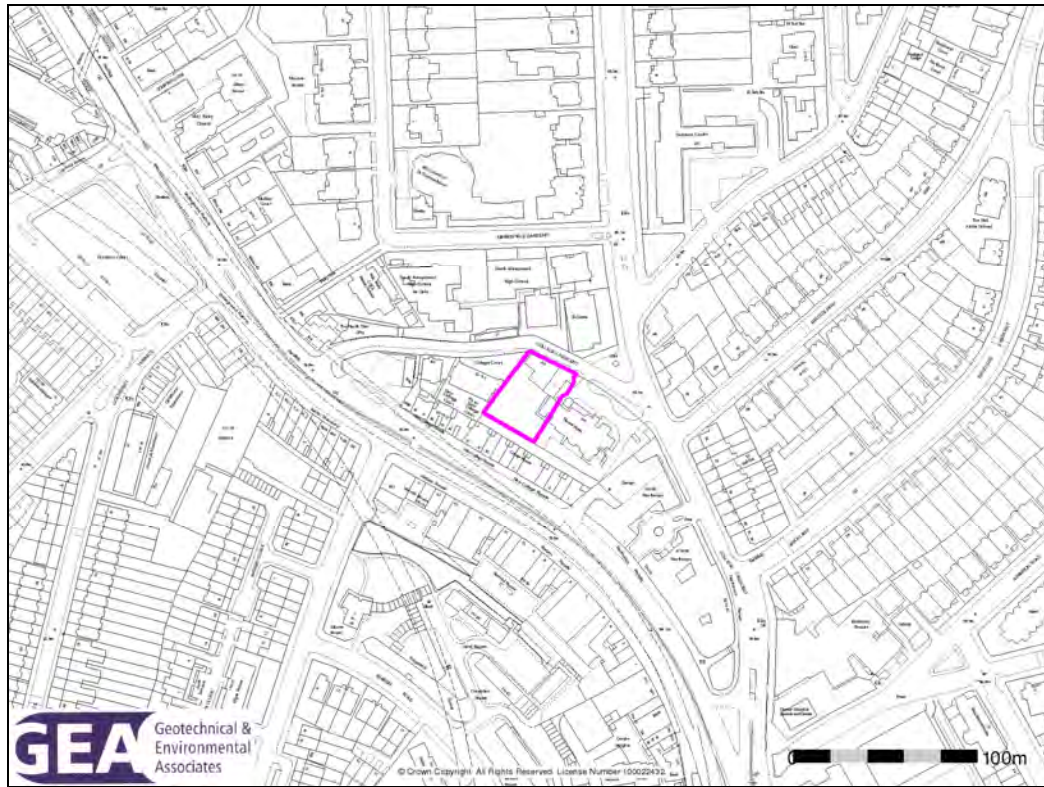
The site is located in the London Borough of Camden, approximately 1.5 km southwest of Hampstead Heath, 250 m southeast of Finchley Road London Underground Station and 230 m northwest of Swiss Cottage London Underground Station. The site is roughly rectangular in shape, measuring approximately 30 m northwest to southeast by 45 m northeast to southwest. It fronts onto College Crescent to the northeast and is bounded to the southeast by a three-storey nurses home, with a two-storey component extending within the site, to the

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

northwest by College Court, a three-storey building with a basement, and to the southwest by the rear of commercial buildings that front onto Finchley Road to the southwest.

The site is shown on the map below and may be additionally located by National Grid Reference 526540, 184540.



A walkover survey of the site was carried out by a geotechnical engineer from GEA, in conjunction with the ground investigation, on 12 April 2012 and some photographs are presented below. At the time of the ground investigation a two-storey brick-built house, which was in the process of being demolished, was present in the northwestern corner of the site, and a two-storey brick-built building was located in the east of the site, adjoined to the neighbouring nurses home building, which it is understood is due to be demolished. The remainder of the site was mostly unsurfaced, with a concrete platform in the north.



Northwestern corner of site



East of site, looking southwards



Southwestern corner of site



Northern end of site



Southeast of site, looking northwards

Two approximately 28 m high London plane trees are present in the southwestern corner of the site and a 17 m high ash tree is located just outside the site boundary adjacent to the northeastern corner. A tree stump was present to the south of the house in the northwest of the site and creeper vegetation covered much of the southern face of the house. The site was otherwise devoid of vegetation at the time of the site walkover, although the topographic survey provided by the consulting engineer and dated February 2012 indicates much of the site to have been recently covered by undergrowth.

The site lies at an elevation of approximately 62 m OD and slopes down southwestwards, from front to rear, such that the southwestern boundary is roughly 2 m below the northeastern boundary, resulting in an average slope angle of less than 3° across the site. There is a strip of land along the northwestern side of the site at an elevation approximately 1 m to 1.5 m above the adjacent ground, edged with a steep slope, and an approximately 1 m high retaining wall is present along a break in slope towards the northeastern end of the site, at the edge of the concrete platform. The surrounding area generally slopes down towards the southwest. The Slope Angle Map provided in the Arup Report (Figure 16 of the Camden Geological, Hydrogeological and Hydrological Study) shows the site to be within an area where the general slope angle is less than 7°.

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 map studied, dated 1850, shows Finchley Road in its existing location, approximately 30 m southwest of the site and a road in the location of the existing College Crescent immediately northeast of the site, which at that time ended adjacent to the northern corner of the site and extended southeastwards to Finchley Road. The next map, dated 1871, shows College Crescent to have extended westwards beyond the site to Finchley Road and a building within the northwestern corner of the site. The remainder of the site appeared to be a garden at that time. Buildings were present to the northwest and southeast of the site; the building to the southeast was labelled as Abbey Farm Lodge. A building labelled as New College was present beyond Abbey Farm Lodge to the southeast.

Abbey Farm Lodge was either extended or replaced by a new building some time between 1871 and 1895, which extended slightly into the east of the site, and it was named Northcourt at that time. Within the site, a small building had been constructed towards the northern end of the northwestern boundary and College Crescent was known as College Villas Road. Some time between 1896 and 1915 the building within the north of the site extended southeastwards, to adjoin the Northcourt building to the southeast. The buildings to the southwest of the site, fronting onto Finchley Road, were constructed some time between 1906 and 1915.

By 1935 the western end of the building east of the site, which extended into the site, appears to be as the existing building on site and at that time was labelled as a children's hospital.

The bomb damage maps viewed at London Metropolitan Archives show there to have been no damage within the site from bombing during World War 2. A clearance area is shown roughly 70 m west of the site, in the location of the existing petrol filling station at the western end of College Crescent.

The children's hospital to the east of the site became a preliminary training school for nurses some time between 1939 and 1954 and from 1967 it was labelled as a nurses' home. The maps do not show any further significant changes within or adjacent to the site.

2.3 Other Information

The Envirocheck report does not list any historical or current landfills within 500 m of the site. A single historical landfill site is listed within 1 km; at a distance of 597 m northwest of the site at Canfield Place. A registered waste transfer sites is listed 400 m northwest of the site, relating to a goods yard, which is now listed as cancelled.

There are no contaminated land register entries or notices listed and no pollution incidents have been recorded within 1 km of the site.

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.

The site is not within any environmentally sensitive areas, such as sites of special scientific interest.

The London Underground Ltd (LUL) Metropolitan Line runs approximately beneath Finchley Road, roughly 20 m southwest of the site. An enquiry has been made to LUL regarding the location of their assets close to the site and their response is included in the appendix. LUL must be consulted prior to undertaking any works at this site, in order to ensure the safety of the railway.

2.4 Geology

The British Geological Survey (BGS) map of the area (Sheet 256) indicates that the site is underlain by London Clay from the surface, which overlies a downwards sequence of Lambeth Group overlying Thanet Sand in turn overlying chalk. A cross section on the geological map indicates the London Clay to be approximately 65 m thick beneath the site.

2.5 Hydrology and Hydrogeology

The nearest surface water feature is listed in the Envirocheck Report as 300 m southeast of the site.

The site is not located within a Flood Zone as defined by the Environment Agency, and College Crescent has not been identified as a street at risk of surface water flooding within the London Borough of Camden. The Camden Geological, Hydrogeological and Hydrological Study Flood Map (Figure 15 in the Arup Report) does not show the site to be within an area with the potential to be at risk of surface water flooding.

Investigations carried out around the area of Hampstead Heath indicate that spring lines are present at the interface of the Bagshot Beds and the Claygate Member and, at a lower level, near the boundary between the Claygate Member and the underlying essentially impermeable London Clay. These springs have been the source of a number of London's "lost" rivers, including the Tyburn which rose roughly 1 km north of the site and flowed southwards, passing approximately 50 m east of the site before continuing south-southeastwards towards Regents Park.

The Environment Agency classifies the London Clay as Unproductive Strata (formerly Non Aquifer), i.e. not capable of providing useable quantities of water; however this classification may not take into account local geological variations within the sandier upper unit of the London Clay Formation. The Cretaceous Chalk is classified as a Principal (formerly Major) Aquifer although it is highly confined beneath over 60 m of London Clay. The site does not lie within a Source Protection Zone as designated by the Environment Agency.

A figure provided in the BGS memoir showing groundwater contours in 1965 indicates groundwater beneath the site to be at a level of -60 m OD (i.e. approximately 120 m below ground level). This reflects the level of groundwater within the chalk aquifer at depth; the London Clay effectively acts as a barrier to flow between the lower (chalk) aquifer and superficial groundwater. A more recent contour map of groundwater levels provided by the Environment Agency⁴ indicates that by 2009, groundwater in the London area had risen by approximately 40 m and is more likely to be at around -20 m OD, currently 80 m below ground level.

Groundwater within the London Clay beneath the site is considered to be dominated by fissure flow. Due to the very low permeability of the London Clay, any groundwater flow will be at very low rates. Published data for the permeability of the London Clay indicates the horizontal permeability to generally range between 1×10^{-10} m/s and 1×10^{-8} m/s, with an even lower vertical permeability. Without evidence to the contrary, groundwater flow beneath the site is anticipated to follow topographic contours toward the south.

2.6 Preliminary Risk Assessment

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

2.6.1 Source

The historical usage of the site that has been established by the desk study and the site walkover indicates that the site does not have a potentially contaminative history by virtue of it having been occupied by the existing property for its entire developed history. There are thus no obvious likely sources of contamination on the site or in its immediate vicinity and no potential sources of soil gas have been identified in the vicinity of the site. However, as with any previously developed site, there may be areas where spillages or dumping of material have resulted in isolated contaminant sources, although it is likely that the excavation of the proposed basements would result in the removal of most shallow potential sources.

2.6.2 Receptor

Residents of the proposed new building represent sensitive receptors. The London Clay

4 Environment Agency Status Report (2009) *Management of the London Basin Chalk Aquifer*

beneath the site is a non aquifer and, therefore, near-surface groundwater is not considered to be a sensitive receptor, whilst groundwater at depth within the Chalk is considered to be a sensitive receptor. Site workers, who will come into contact with any contaminated soils during the ground work and plastic services, which will come into contact with any contaminants within the soil in which they are laid, are also potential sensitive receptors.

2.6.3 Pathway

The site will be mostly covered by the proposed building and basement excavation, forming a barrier between the end users and soil. Only in any areas of planting or soft landscaping will there be a potential contaminant exposure pathway to end users of the site. The London Clay essentially forms a barrier to groundwater flow into the underlying chalk. Therefore there will be very limited potential contaminant exposure pathways to the end users of the site or groundwater in the Pricipal Aquifer at depth below the site. Site workers may come into direct contact with any contaminated soils during ground works and services will come into contact with any contaminants present in soils through which they are laid.

2.6.4 Preliminary Risk Appraisal

On the basis of the above it is considered that there is a low risk of there being a 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 of the site and no landfill sites, 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. A number of screening tools are included in the Arup document and for the purposes of this report reference has been made to Appendix E.

3.1 Slope Stability Screening Assessment

Reference has been made to Appendix E of the Arup document, which includes 14 questions within a slope stability screening flowchart. Responses to the questions are tabulated below.

Question	Response for 39 College Crescent
1. Does the existing site include slopes, natural or manmade, greater than 7°?	<i>Yes. Although the average slope of the site is less than 7°, localised breaks in slope are present up to approximately 1.5 m high.</i>
2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7°?	<i>No.</i>
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	<i>No.</i>
4. Is the site within a wider hillside setting in which the general slope is greater than 7°?	<i>No. The slope angle map provided in the Arup Report (Figure 16) shows the site to be in an area where the slope is less than 7°.</i>
5. Is the London Clay the shallowest strata at the site?	<i>Yes.</i>

Question	Response for 39 College Crescent
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?	<i>Yes. It is understood that no trees will be felled, but there is a tree in the west of the site that will be retained, close to the proposed new building, so works are likely to be within the tree protection zone.</i>
7. Is there a history of seasonal shrink-swell subsidence in the local area and / or evidence of such effects at the site?	<i>Yes. The area is prone to these effects as a result of the presence of London Clay with high volume change potential.</i>
8. Is the site within 100 m of a watercourse or potential spring line?	<i>Yes. The former course of the River Tyburn flowed roughly 50 m east of the site, although the closest existing surface water feature is over 100 m from the site.</i>
9. Is the site within an area of previously worked ground?	<i>No.</i>
10. Is the site within an aquifer?	<i>No. The site is underlain by the London Clay which is designated as Unproductive Strata by the Environment Agency and cannot store and transmit usable amounts of water.</i>
11. Is the site within 50 m of Hampstead Heath ponds?	<i>No. The site is approximately 1.5 km from Hampstead Heath.</i>
12. Is the site within 5 m of a highway or pedestrian right of way?	<i>Yes. The site fronts onto College Crescent, a public road.</i>
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	<i>No. The basement is proposed to a maximum depth of 3.5 m, which will only moderately increase the differential depth of foundations relative to neighbouring properties.</i>
14. Is the site over (or within the exclusion zone of) any tunnels, eg railway lines?	<i>Yes. The site is close to the Metropolitan London Underground line.</i>

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

- Q1 The site has localised slopes greater than 7° up to approximately 1.5 m high.
- Q5 The London Clay is the shallowest stratum at the site.
- Q6 Some works are proposed within tree root protection zones.
- Q7 The site is underlain by London Clay, which is prone to shrink-swell subsidence.
- Q8 The former course of the River Tyburn passed roughly 50 m east of the site.
- Q12 The site is within 5 m of a public highway.
- Q14 The site is close to the Metropolitan London Underground line.

The potential issues that need to be assessed are discussed further in Part 2 of this report.

3.2 Subterranean (Groundwater) Flow Screening Assessment

Reference has been made to Appendix E of the Arup document, which includes 6 questions within a subterranean (groundwater) flow screening flowchart. Responses to the questions are tabulated below.

Question	Response for 39 College Crescent
1a. Is the site located directly above an aquifer?	<i>No. The site is underlain by the London Clay which is designated as Unproductive Strata by the Environment Agency and cannot store and transmit usable amounts of water.</i>
1b. Will the proposed basement extend beneath the water table surface?	<i>Unknown. Ground investigation required to confirm the presence of groundwater.</i>
2. Is the site within 100m of a watercourse, well (used/disused) or potential spring line?	<i>Yes. The former course of the River Tyburn flowed roughly 50 m east of the site, although the closest existing surface water feature is over 100 m from the site.</i>

Question	Response for 39 College Crescent
3. Is the site within the catchment of the pond chains on Hampstead Heath?	<i>No. The site is located approximately 1.5 km southwest of Hampstead Heath.</i>
4. Will the proposed development result in a change in the proportion of hard surfaced / paved area?	<i>Yes. There will be significant increase in the proportion of hard surfaced / paved area.</i>
5. As part of the site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to ground (e.g. via soakaways and/or SUDS)?	<i>No. The low permeability of the London Clay makes it unsuitable for receiving discharge to the ground.</i>
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 (not just the pond chains on Hampstead Heath) or spring line?	<i>No. There are no ponds or spring lines in the vicinity of the site.</i>

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

- Q1b It is unlikely that the proposed basement structure will extend below the water table, but a ground investigation is required to confirm the groundwater conditions.
- Q2 The former course of the River Tyburn passed roughly 50 m east of the site.
- Q4 There will be a significant increase in the proportion of hard surfaced and paved areas following the construction of the proposed development.

The potential issues that need to be assessed are discussed further in Part 2 of this report.

3.3 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.

Reference has been made to Appendix E of the Arup document, which includes six questions within a surface flow and flooding screening flowchart. Responses to the questions are tabulated below.

Question	Response for 39 College Crescent
1. Is the site within the catchment of the pond chains on Hampstead Heath?	<i>No. The site is located approximately 1.5 km southwest of Hampstead Heath.</i>
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?	<i>Unknown</i>
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	<i>Yes. There will be significant increase in the proportion of hard surfaced / paved area.</i>
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?	<i>Unknown</i>
5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	<i>Unknown</i>
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?	<i>No.</i>

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

- Q3 The proposed development will result in a change in the proportion of hard surfaced / paved areas.

The potential issues that need to be assessed are discussed further in Part 2 of this report.

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

4.1.1 Slope Stability Scoping Assessment

The following potential impacts have been identified that may have an impact on slope stability.

Screening Issue	Potential Impact
Site includes slopes greater than 7°	Local instability within the site and adjoining sites may occur
London Clay is the shallowest strata at the site	London Clay is prone to seasonal shrink-swell (subsidence and heave)
Works are to be carried out within tree root protection zones	Seasonal shrink-swell due to the presence of tree roots affecting the soil moisture content / loss of stability from binding by tree roots
The site is underlain by clay prone to shrink-swell	Seasonal shrink-swell can result in foundation movements and in particular if a new basement is dug to below the depth likely to be affected by tree roots this could lead to damaging differential movement between the subject site and adjoining properties
The former course of the River Tyburn passed roughly 50 m east of the site	Changes in groundwater regimes within slopes can affect slope stability
The site is within 5 m of a public highway	Excavation of a basement may result in structural damage to the road or footway.
Site close to London Underground Metropolitan line	Excavation for a basement and associated foundations may result in damage to the tunnel

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

4.1.2 Subterranean (Groundwater) Flow Scoping Assessment

The following potential impacts have been identified that may have an impact on subterranean flow.

Screening Issue	Potential Impact
The basement structure may extend into saturated ground	The groundwater flow regime may be altered by the proposed basement. Changes in flow regime could potentially cause the groundwater level within the zone encompassed by the new flow route to increase or decrease locally. For existing nearby structures the degree of dampness or seepage may potentially increase as a result of changes in groundwater level.

Screening Issue	Potential Impact
The former course of the River Tyburn passed roughly 50 m east of the site	The flow from a watercourse may increase or decrease if the groundwater flow regime which supports that water feature is affected by a proposed basement. If the flow is diverted, it may result in the groundwater flow finding another location to issue from with new springs forming or old springs being reactivated. There may also be an impact on water quality.
There will be a significant increase in the proportion of hard surfaced and paved areas following the construction of the proposed development	The sealing of the ground surface to rainfall, by increasing the building area, will result in decreased recharge to the underlying ground. In areas underlain by an aquifer, this may impact on groundwater flow or levels.

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

4.1.3 Surface Flow and Flooding Scoping Assessment

The following potential impacts have been identified that may have an impact on surface flow.

Screening Issue	Potential Impact
There will be a significant increase in the proportion of hard surfaced and paved areas following the construction of the proposed development	A change in the proportion of hard surfaced or paved areas of a property will affect the way in which rainfall and surface water are transmitted away from a property. This includes changes to the surface water received by the underlying aquifers, adjacent properties and nearby watercourses. Changes could result in decreased flow, which may affect ecosystems or reduce amenity, or increased flow which may additionally increase the risk of flooding.

These potential impacts need to be assessed through a full surface flow and flooding risk assessment, which falls outside the scope of this report.

4.2 Exploratory Work

In order to meet the objectives described in Section 1.2, three boreholes were advanced to depths of 20.0 m using a cable percussion rig. Standard Penetration Tests (SPTs) were carried out at regular intervals in the boreholes. Groundwater monitoring standpipes were installed in the boreholes and two monitoring visits were undertaken, roughly two weeks and four weeks following installation. Additionally, a single trial pit excavated by others was inspected to determine the configuration of the existing foundations of the neighbouring building.

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

The borehole records and results of the laboratory analyses are appended, together with a site plan indicating the exploratory positions. The ordnance datum (OD) levels shown on the records are based upon interpolation from spot levels provided on a topographic drawing by Omega Geomatics, referenced 12-0058 and dated February 2012, provided by the consulting engineer.

4.2.1 Sampling Strategy

The boreholes were positioned to provide optimum coverage of the site whilst avoiding the areas of known services.

Five samples recovered from the 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 samples were selected to provide a general overview of the chemical conditions of the soils that are likely to be involved in a human exposure or groundwater pathway and to provide advice in respect of re-use or for waste disposal classification. The samples are considered to represent the general fill material that may be encountered across the site. 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 confirmed the expected ground conditions in that, beneath a moderate thickness of made ground, London Clay was encountered and proved to the full depth of the investigation of 20.0 m (40.6 m OD).

5.1 Made Ground

Made ground was found to extend to depths of between 0.5 m and 1.4 m (61.45 m OD and 59.20 m OD) and typically comprised brown slightly clayey gravelly sand with fragments of brick and concrete.

No visual or olfactory evidence of contamination was reported within these soils. Samples of the made ground were analysed for a range of contaminants and the results are summarised in Section 5.4.

5.2 London Clay

The London Clay initially comprised firm fissured brown mottled orange-brown and grey silty clay, becoming stiff from depths of between 2.0 m and 4.0 m (58.8 m OD and 57.6 m OD) and brownish grey from depths of between 10.1 m and 11.2 m (51.95 m OD and 49.40 m OD). Selenite crystals and occasional claystones and pockets or partings of orange-brown silt or fine sand were noted within the clay.

Roots were recorded within the clay to depths of between 2.0 m and 4.5 m (60.06 m OD and 56.1 m OD) and the clay in Borehole No 2 was initially noted to be “stiff” to a depth of 1.5 m (59.3 m OD), indicating this soil to be desiccated. This desiccation was confirmed by the results of the laboratory classification tests. Laboratory Atterberg limit tests carried out on samples of the clay indicate it to be of high volume change potential.

Quick unconsolidated undrained triaxial tests undertaken on undisturbed samples of the clay indicated its undrained shear strength to generally increase with depth, from 70 kN/m² at a depth of 1.2 m (60.85 m OD) to 190 kN/m² at a depth of 19.5 m (42.55 m OD), indicating the strength of the clay to increase from medium to very high strength.

These soils were observed to be free of any evidence of soil contamination.

5.3 Groundwater

Groundwater seepages were encountered within the London Clay at a depth of 1.8 m (60.25 m OD) in Borehole No 3 and associated with claystones at depths of 12.4 m (48.20 m OD) in Borehole No 1 and 18.7 m (43.35 m OD) in Borehole No 3. Groundwater was not encountered in Borehole No 2 during drilling.

Standpipes were installed into the London Clay to depths of 5.0 m in all three boreholes. The results from two subsequent monitoring visits, carried out roughly two weeks and four weeks after installation, are presented in the table below.

Date	Depth To Groundwater					
	BH1		BH2		BH3	
	m bgl	m OD	m bgl	m OD	m bgl	m OD
2 May 12	2.33	58.27	4.60	56.20	1.10	60.95
16 May 12	1.65	58.95	4.20	56.60	0.20	61.85

Groundwater flow within the London Clay is likely to be very slow and in a generally southwards direction, downslope. On the basis of the monitoring results, groundwater flow would appear to be towards the south/southwest. However, this assumes that the water measured in the three standpipes is interconnected, whilst it may be from separate discrete pockets or layers which are not all necessarily intercepted by all three standpipes across the site.

5.4 Soil Contamination

The use of a risk-based approach, which is presented in Part 2 of this report, means that it is not appropriate to determine the significance of contamination test results by simply comparing individual contaminant concentrations to a single “trigger” or “target” concentration. The significance of the results is therefore considered in more detail in Part 2, whilst the table below sets out the range of values measured within nine samples analysed and indicates the statistically weighted average concentrations; all concentrations are in mg/kg unless otherwise stated.

Determinant	Maximum concentration recorded (mg/kg)	Minimum concentration recorded (mg/kg)	Number of samples below detection limit	Normalised upper bound US ₉₅
Arsenic	15	8.7	None	15.4
Cadmium	0.2	<0.1	4	0.16
Chromium	26	16	None	25
Lead	450	210	None	443
Mercury	0.65	0.25	None	0.59
Selenium	0.29	<0.2	2	0.28
Copper	46	20	None	41
Nickel	26	16	None	23
Zinc	250	74	None	190
Total Cyanide	<0.5	<0.5	All	-

Determinant	Maximum concentration recorded (mg/kg)	Minimum concentration recorded (mg/kg)	Number of samples below detection limit	Normalised upper bound US ₉₅
Total Phenols	<0.3	<0.3	All	-
PAH	7.5	<2	3	6.5
Naphthalene	<0.1	<0.1	All	-
Benzo(a)pyrene	0.84	<0.1	3	0.58
Sulphide	4.3	1.6	None	4.0
TPH	21	<10	3	17.6
Total organic carbon %	2.6	0.47	None	2.7
<p><i>Note:</i> The use of the normalised upper bound for 95th percentile confidence aims to remove some of the uncertainty associated with calculation of an arithmetic sample mean of a relatively small number of samples. The US₉₅ value is the upper bound of the range within which it can be stated with 95% confidence that the true mean concentration of the data set will fall.</p> <p>Figure in bold indicates concentration in excess of risk-based soil guideline values, on the basis of a residential end use, as discussed in Part 2 of this report</p>				

The chemical analyses did not generally indicate any significantly elevated concentrations of contaminants. However, the concentration of total PAH has been measured in a single sample of made ground, from a depth of 0.5 m in Trial Pit No 2, at a concentration in excess of the risk-based soil guideline value. A comparison of the measured concentrations of individual PAH species against their respective guideline values has revealed only a single concentration of dibenzo[a,h]anthracene, in a sample of made ground from a depth of 0.3 m in Borehole No 2, to be in excess of its guideline value, indicating a potential risk to human health.

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 table below indicates those contaminants of concern that have values in excess of a generic human health risk based guideline values which are either that of the CLEA⁵ 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 a residential end use are as follows:

- that groundwater will not be a critical risk receptor;
- that the critical receptor for human health will be young female children aged zero to six years old;
- 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 indoor dust, and inhalation of indoor and outdoor dust and vapours; and
- that the building type equates to a two-storey small terraced house.

⁵ 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.

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

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

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

The concentration ranges of the contaminants of concern highlighted by a comparison of the measured concentrations against the generic screening values are tabulated below. This assessment is based upon the potential for risk to human health, which at this site that is underlain by a non aquifer is considered to be the critical risk receptor.

Contaminant of Concern	Maximum concentration recorded (mg/kg)	Minimum concentration recorded (mg/kg)	US ₉₅ Value	Generic Risk-Based Screening Value
Total PAH	7.5	<2	6.5	6.3
Dibenzo[a,h]anthracene	1.2	<0.1	0.8	0.86

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

5.5 Existing Foundations

Trial Pit No 2, excavated against the neighbouring building on the northwestern side of the site, encountered a concrete footing bearing on London Clay at a depth of 3.5 m. The trial pit record and photograph are provided in the appendix.

Part 2: DESIGN BASIS REPORT

This section of the report provides an interpretation of the findings detailed in Part 1, in the form of a ground model, and then provides advice and recommendations with respect to foundation options and other aspects of the development.

6.0 INTRODUCTION

Consideration is being given to the redevelopment of this site through the construction of seven new three-storey properties with basements, to include basement accommodation and parking. It is understood that the proposed basements will extend to maximum depths of 3.0 m to 3.5 m below existing ground level (approximately 59 m OD).

The proposed loads are not known at this stage. However, on the basis of the nature of the development, the foundation loads for the proposed building are anticipated to be moderate.

7.0 GROUND MODEL

The desk study has revealed that the site has not had a potentially contaminative history, having apparently been occupied by the existing property for the entirety of its developed history. On the basis of the fieldwork, the ground conditions at this site can be characterised as follows.

- ❑ Beneath a moderate thickness of made ground, London Clay was proved to the maximum depth investigated of 20.0 m (40.6 m OD);
- ❑ made ground, comprising brown clayey gravelly sand with fragments of brick and concrete, extends to depths of between 0.5 m and 1.4 m (61.45 m OD and 59.20 m OD);
- ❑ the underlying London Clay initially comprises firm fissured brown mottled orange-brown and grey silty clay, becoming stiff from depths of between 2.0 m and 4.0 m (58.8 m OD and 57.6 m OD) and brownish grey from depths of between 10.1 m and 11.2 m (51.95 m OD and 49.40 m OD), with selenite crystals and occasional claystones and pockets or partings of silt or fine sand;
- ❑ roots were noted within the clay to depths of up to 4.5 m (56.1 m OD) and the clay in a single borehole was found to be desiccated to a depth of 1.5 m (59.3 m OD);
- ❑ groundwater seepages were encountered within the London Clay at depths of 1.8 m (60.25 m OD) in Borehole No 3 and associated with claystones at depths of 12.4 m and 18.7 m (48.2 m OD and 43.35 m OD) in Borehole Nos 1 and 3 and was not encountered in Borehole No 2 during drilling. Groundwater was measured in all three boreholes at depths of between 0.2 m and 4.6 m (61.85 m OD and 56.2 m OD) on subsequent monitoring visits; and
- ❑ the chemical analyses have indicated the made ground to be generally free from significant contaminant concentrations, although a single concentration of total PAH was measured at a concentration that may pose a risk to human health.

8.0 ADVICE AND RECOMMENDATIONS

Excavations for the proposed basement structure will require temporary support to prevent any excessive ground movements and it is unlikely to be feasible to construct the new basement without the requirement for some level of groundwater control. It would be prudent to carry out further investigation to assess the volume of water likely to flow into the basement excavation.

Formation level for the proposed up to 3.5 m deep basement is likely to be within the firm clay of the London Clay, which should provide an eminently suitable bearing stratum for spread foundations although consideration should be given to the likely presence of groundwater at this depth and piled foundations would provide a suitable alternative solution.

8.1 Basement Excavation

The investigation has indicated that groundwater may be encountered within the 3 m to 3.5 m deep basement excavation. Water was encountered in a single borehole at a depth of 1.8 m (60.25 m OD) during drilling and has subsequently been measured at depths of between 0.2 m (61.85 m OD) and 4.6 m (56.2 m OD) in the three standpipes. This suggests that the clay is of low permeability or that the measured water levels are not representative. The permeability of the London Clay is likely to be very low, with horizontal permeability ranging between 1×10^{-10} m/s and 1×10^{-8} m/s and an even lower vertical permeability. On this basis, if water is encountered inflow rates into the excavation are expected to be slow. However, it is possible that larger pockets or inter-connected layers of groundwater could be encountered, within fissures in the clay or layers of sand. 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. It is not possible to draw meaningful conclusions from the measurements made in the standpipes, as the level of the water table is not as significant as the volume of water that may flow into the excavation. For example, a high level of water measured in a standpipe may not be significant if this represents only a small volume of water. It would therefore be prudent to carry out a number of trial excavations, to depths as close to the full basement depth as possible, to provide an indication of the likely ground water conditions.

The design of basement support in the temporary and permanent conditions needs to take account of the need to maintain the stability of the excavation and surrounding structures and to protect against groundwater inflows.

A bored pile wall may be the most reliable method of supporting the basement excavation, and would have the benefit of providing support for structural loads in the permanent condition. On the basis of the groundwater monitoring observations to date a secant piled wall may be required; however, the groundwater observations made during drilling indicate that the clay is of low permeability such that although there is a relatively high water table the rate of inflow into excavations may depend to a large extent on the presence of pockets or layers of sand in the clay. Alternatively, a sheet piled wall could be used as a temporary measure, prior to the construction of a permanent structure following the completion of the basement excavations. It is recommended that the advice of a specialist piling contractor should be sought in this respect and consideration should also be given to the noise and vibrations associated with the installation of sheet piles, unless a “silent” installation method is adopted. Care would need to be taken if water jetting of sheet piles is adopted, in view of the risk of causing settlement of the adjacent buildings and structures.

The ground movements associated with the basement excavation will depend on the method of excavation and support and the overall stiffness of the basement structure in the temporary condition. Thus, a suitable amount of propping will be required to provide the necessary

rigidity. In this respect the timing of the provision of support to the wall will have an important effect on movements. Consideration will need to be given to a retention system that maintains the stability at all times of neighbouring properties. Excavation of a 3 m to 3.5 m deep basement will result in settlement and lateral displacement behind the basement wall; the stability of the adjacent buildings will need to be ensured at all times and the retaining walls will need to be designed to accommodate the loads from these foundations unless they are underpinned.

The design of basement support in the temporary and permanent conditions needs to take account of the need to maintain the stability of the excavation, the existing slope, the surrounding structures, namely the neighbouring properties, and to protect against groundwater inflows.

8.1.1 Slope Stability

The site slopes gently down southwards, at an average angle of less than 3°, although the drop in elevation is largely accommodated at present by a vertical retaining wall around 1 m high. It is understood that the proposed development will not involve any steepening of the existing slope or introduce any new slopes. Additionally, the proposed development, which will include the construction of new retaining walls as part of the basement structure, will provide additional support to that already in place. It is recommended that there should not be any unsupported excavations and that the basement retaining walls are suitably designed to maintain the stability of the existing slope. Further assessment is not deemed necessary at this stage.

8.1.2 Basement Retaining Walls

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

Stratum	Bulk Density (kg/m ³)	Effective Cohesion (c' – kN/m ²)	Effective Friction Angle (φ' – degrees)
Made Ground	1700	Zero	27
London Clay	1900	Zero	25

The investigation has indicated that groundwater is likely to be encountered within the basement excavation and the advice in BS8102:2009⁶ should be followed with respect to waterproofing.

The retaining walls will need to be designed to take account of the overall stability of the slope.

8.1.3 Basement Heave

The excavation of up to 3.5 of soil for the proposed basement will result in an unloading of up to approximately 65 kN/m², which will result in heave of the underlying London Clay. This will comprise an “immediate” elastic component that may be expected to occur within the construction period, together with long term swelling movement that would theoretically occur over a period of many years. The effects are likely to be mitigated to some extent by the loads applied by the existing and proposed structures. However, a detailed analysis of the likely movements should be carried out once the basement design has been finalised.

8.2 Spread Foundations

Moderate width strip or pad foundations bearing on the soft to firm clay of the London Clay at a

⁶ BS8102 (2009) Code of practice for protection of below ground structures against water from the ground

minimum depth of 1.5 m may be designed to apply a net allowable bearing pressure of 120 kN/m². Below a depth of 4.0 m, foundations bearing in the stiff clay of the London Clay may be designed to apply a net allowable bearing pressure of 150 kN/m².

The recommended bearing pressures include an adequate factor of safety to protect against bearing capacity failure and should ensure that settlement remains within normal tolerable limits.

Foundations will need to be deepened in the vicinity of proposed trees and National House Building Council (NHBC) guidelines should be followed in this respect. High shrinkability clay should be assumed. Where trees are to be removed the required founding depth should be determined on the basis of the existing tree height if it is less than 50% of the mature height and on the basis of full mature height if the current height is more than 50% of the mature height. Where a tree is to be retained the final mature height should be adopted. Notwithstanding NHBC guidelines, all foundations should extend beyond the zone of any desiccation, which was noted to a maximum depth of 1.5 m, and roots, which were recorded to a maximum depth of 4.5 m during the ground investigation, and it would be prudent to have all foundation excavations inspected by a suitably experienced engineer. Due allowance should be made for future growth of the trees. The requirement for compressible material alongside foundations should be determined by reference to the NHBC guidelines.

To protect against slope instability care should be taken to ensure that spread foundations are placed at sufficient depth to ensure that a theoretical 45° line extended from the base of the footing does not intercept the surface of the slope.

On the basis of the groundwater monitoring carried out, groundwater is likely to be encountered within the 3 m to 3.5 m deep basement excavation and there may be difficulties in controlling groundwater to allow such foundations to be excavated. Any inflows into foundation excavations should be controllable by sump pumping, although it would be prudent to carry out trial excavations as noted in Section 8.1 above.

8.3 Piled Foundations

For the ground conditions at this site, driven or bored piles could be adopted. Driven piles would have the advantage of minimising the spoil that is generated, but the effects of noise and vibrations on neighbouring sites may not be acceptable. Some form of bored pile may therefore be more appropriate.

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

Ultimate Skin Friction		kN/m²
Basement excavation	GL to 3.5 m	Ignore
London Clay ($\alpha = 0.5$)	3.5 m to 20.0 m	Increasing linearly from 32 to 87
Ultimate End Bearing		kN/m²
London Clay	10.0 m to 20.0 m	Increasing linearly from 970 to 1575

In the absence of pile tests, guidance from the London District Surveyors Association⁷ (LDSA) suggests that a factor of safety of 2.6 should be applied to the above coefficients in the computation of safe theoretical working loads. On the basis of the above coefficients, applying a factor of safety of 2.6, it has been estimated that a 450 mm diameter pile extending 12 m below the proposed 3.5 m deep basement, to a depth of 15.5 m, should provide a safe working load of about 420 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 an appropriate piling scheme and their attention should be drawn to the presence of groundwater within the London Clay.

8.4 Shallow Excavations

On the basis of the boreholes, 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 London Clay 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. Such inflows should be suitably controlled by sump pumping.

8.5 Basement Floor Slabs

Following the excavation of the basement, it is likely that the floor slab for the proposed basement will need to be suspended over a void to accommodate the anticipated heave and any potential uplift forces from groundwater pressures unless the slab can be suitably reinforced to cope with these movements. This should be reviewed once the levels and loads are known.

8.6 Effect of Sulphates

Chemical analyses of three samples of the London Clay have revealed generally high to very high concentrations of soluble sulphate, moderately low concentrations of soluble magnesium and near neutral pH, corresponding to Class DS-5 and AC-4s of Table C2 of BRE Special Digest 1:2005, assuming static groundwater conditions. The high concentrations of soluble sulphate measured are likely to be due to the presence of selenite crystals within the clay. The guidelines contained in the above digest should be followed in the design of any new foundation concrete.

8.7 Site Specific Risk Assessment

The chemical analyses have highlighted the presence of the PAH dibenzo[a,h]anthracene within a sample of made ground which is in excess of the adopted generic screening values. This concentration could thus pose a potentially unacceptable risk to human health through direct contact, accidental ingestion or inhalation of soil or soil derived dust.

⁷ LDSA (2009) *Foundations No 1 – Guidance notes for the design of straight shafted bored piles in London Clay*. LDSA Publications

Upon completion of the development, much of the made ground will have been removed in the basement excavation and in any case the proposed building floors will form a barrier to direct contact between any remaining potentially contaminated soils and end users. Only in any areas of soft landscaping will there remain a potential for direct contact with the soil and there will be a requirement to provide a cover thickness of clean soil in any such areas.

The site is underlain by negligibly permeable London Clay, which is classified as a non-aquifer, and a risk to groundwater from contamination in the soil is not, therefore, envisaged.

Contaminants present within the soil could pose a potential risk to ground workers in the short term. Site workers should be made aware of the contamination and a programme of working should be identified to protect workers handling any soil. The method of site working should be in accordance with guidelines set out by HSE⁸ and CIRIA⁹ and the requirements of the Local Authority Environmental Health Officer.

Contaminants could potentially affect the integrity of buried plastic services if they are to pass through affected areas of soil. Consideration may need to be given to the protection of buried plastic services if they are to be laid within the made ground. Details of the proposed protection measures for buried plastic services will in any case need to be approved by the EHO and the relevant service authority prior to the adoption of any scheme. It is possible that barrier pipe may be required or that additional testing will need to be carried out to satisfy the Water Authority.

8.8 Waste Disposal

Any spoil arising from excavations or landscaping works will need to be disposed of to a licensed tip. Under the European Waste Directive landfills are classified as accepting inert, non-hazardous or hazardous wastes in accordance with the EU waste Directive.

Based upon on the technical guidance provided by the Environment Agency¹⁰ it is considered likely that the made ground from this site, as represented by the eight chemical analyses carried out, would be generally classified as a NON-HAZARDOUS waste, whilst the natural soils may be classified as an INERT waste. However, this classification should be confirmed by the receiving landfill once the soils to be discarded have been identified. In order to finalise this classification it may be necessary to carry out further analyses including WAC CEN method bulk leaching tests. Such tests should be carried out upon representative samples from the waste stream once the extent of the materials to be discarded has been established.

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 paper¹¹ which states that in certain circumstances,

⁸ HSE (1992) HS(G)66 *Protection of workers and the general public during the development of contaminated land*
HMSO

⁹ CIRIA (1996) *A guide for safe working on contaminated sites* Report 132, Construction Industry Research and Information Association

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

¹¹ Regulatory Position Statement *Treating non-hazardous waste for landfill - Enforcing the new requirement* Environment

segregation at source may be considered as pre-treatment and thus excavated material may not have to be treated prior to landfilling if the soils can be segregated onsite by sufficiently characterising the soils insitu prior to excavation.

The above opinion with regard to the classification of the excavated soils 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.

9.0 BASEMENT IMPACT ASSESSMENT

The current development proposal includes the construction of seven new three-storey properties with basements across the site, with the basements extending to a maximum depth of 3.5 m below existing ground level. Formation level will therefore be within the London Clay.

The slope stability screening identified seven potential impacts and the subterranean flow screening identified three potential impacts. In addition, the surface flow and flooding screening identified a requirement for a full surface flow and flooding risk assessment, which falls outside the scope of this report.

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

9.1 Slope Stability Impact Assessment

Potential Impact	Site Investigation Conclusions
Site includes slopes greater than 7° - <i>local instability within the site and adjoining sites may occur</i>	The average slope of the site is shallow and the existing slopes show no sign of any instability. The proposed development will not introduce any new slopes or involve any steepening of this existing slope. Additionally the proposed development, which will include the construction of new retaining walls as part of the new basement structure, will provide additional support to that already in place and further assessment is not deemed necessary at this stage. The design of basement support in the temporary and permanent conditions needs to take account of the need to maintain the stability of the existing slope.
London Clay is the shallowest strata at the site – <i>London Clay is prone to seasonal shrink-swell (subsidence and heave)</i>	Foundations must be extended to sufficient depth to be below the zone affected by volume changes of the clay, taking into account the presence of trees at the site in accordance with NHBC guidelines, and inspected to ensure they are below the depth of any desiccation.
Works are to be carried out within tree root protection zones – <i>Seasonal shrink-swell due to the presence of tree roots affecting the soil moisture content / loss of stability from binding by tree roots</i>	
The site is underlain by clay prone to shrink-swell – <i>seasonal shrink-swell can result in foundation movements and in particular if a new basement is dug to below the depth likely to be affected by tree roots this could lead to damaging differential movement between the subject site and adjoining properties</i>	The proposed development will not be structurally linked to adjacent properties. The stability of adjacent properties should be ensured at all times, with underpinning carried out if necessary.

Agency 23 Oct 2007

Potential Impact	Site Investigation Conclusions
The former course of the River Tyburn passed roughly 50 m east of the site – <i>changes in groundwater regimes within slopes can affect slope stability</i>	The River Tyburn no longer exists as a surface watercourse and is not considered likely to be affected, or have any effect on, the proposed development.
The site is within 5 m of a public highway - <i>excavation of a basement may result in structural damage to the road or footway</i>	The investigation has not indicated any specific problems, such as weak or unstable ground or voids, that would make working within 5 m of public infrastructure particularly problematic at this site. The design of basement support in the temporary and permanent conditions needs to take account of the need to maintain the stability of the excavation and the surrounding structures at all times.
Site close to London Underground Metropolitan line - <i>excavation for a basement and associated foundations may result in damage to the tunnel</i>	London Underground Ltd should be liaised with to ensure that their requirements are met in order to ensure that the rail tunnel is protected.

The screening and scoping stages have identified potential adverse impacts relating to land stability associated with the proposed development. However, the proposed development is unlikely to result in any specific land or slope stability issues; the design of the foundations and of basement support in the temporary and permanent conditions for the proposed development must take into account the need to maintain the stability of the excavation, the existing slop and the surrounding structures, and to protect against groundwater inflows. Liaison with London Underground Ltd will be required in relation to the nearby Metropolitan underground tunnel.

9.2 Subterranean (Groundwater) Flow Impact Assessment

Potential Impact	Site Investigation Conclusions
<i>The basement structure may extend into saturated ground - the groundwater flow regime may be altered by the proposed basement. Changes in flow regime could potentially cause the groundwater level within the zone encompassed by the new flow route to increase or decrease locally. For existing nearby structures the degree of dampness or seepage may potentially increase as a result of changes in groundwater level.</i>	The ground investigation has confirmed the presence of groundwater in the London Clay within the depth of the proposed basement excavation. However, further investigation is required to determine the volumes of water likely to be encountered in the excavation. Since the London Clay is not considered to be an aquifer and is of low permeability, it will not store or transmit significant quantities of groundwater and it is not, therefore, considered that the proposed basement will result in a significant change to the groundwater regime in the vicinity. The basement will not form a barrier to groundwater flow, since water where present will flow around it.
<i>The former course of the River Tyburn passed roughly 50 m east of the site – the flow from a watercourse may increase or decrease if the groundwater flow regime which supports that water feature is affected by a proposed basement. If the flow is diverted, it may result in the groundwater flow finding another location to issue from with new springs forming or old springs being reactivated. There may also be an impact on water quality.</i>	The site is underlain by low permeability London Clay, which will not store or transmit significant quantities of groundwater and it is not, therefore, considered that the proposed basement will result in a significant change to the groundwater flow in the vicinity. Any water flows associated with the former course of the River Tyburn are, therefore, unlikely to be affected by the proposed development.
<i>There will be a significant increase in the proportion of hard surfaced and paved areas following the construction of the proposed development – the sealing of the ground surface to rainfall, by increasing the building area, will result in decreased recharge to the underlying ground. In areas underlain by an aquifer, this may impact on groundwater flow or levels.</i>	The site is underlain by the London Clay, which is Non Productive strata and which does not receive significant recharge.

The screening and scoping stages have identified potential adverse impacts relating to subterranean flow associated with the proposed development. However, site specific information on the geology and hydrogeology beneath the site has established that the site is underlain by Non Productive strata (London Clay) which is not capable of storing and transmitting water in usable amounts and receives very low levels of annual recharge due to its lowly permeable nature. The proposal is therefore not likely to have a significant impact on

either the groundwater flow regime beneath the site or on the amount of annual recharge into the London Clay. The proposed basement will not effectively close a gap between underground structures and as such will not form a barrier to groundwater flow. It would be prudent to carry out trial excavations in order to determine the likely inflows of groundwater into the basement excavation, in order to ensure that appropriate groundwater control measures are included in the design of the temporary works.

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.

An issue that requires careful consideration at this site is the extent to which groundwater will affect the basement excavation in the temporary condition and the level of the water table to be adopted in the permanent design. It would be prudent to carry out ongoing groundwater monitoring of the existing standpipes and to carry out trial excavations to investigate the likely volumes of inflow that should be anticipated in the proposed basement excavation.

Consideration will need to be given to measures to guard against heave as a result of the basement excavation. It is likely that the floor slab for the proposed basement will need to be suspended over a void to accommodate the anticipated heave unless the slab can be suitably reinforced to cope with these movements.

The surface flow and flooding screening identified a requirement for a full surface flow and flooding risk assessment, which should be carried out by a suitably qualified hydrologist.

APPENDIX

Borehole Records

SPT Results

Trial Pit Records

Laboratory Geotechnical Test Results

SPT & Cohesion vs Depth Graph

Chemical Analyses

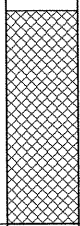
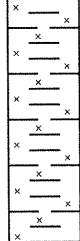
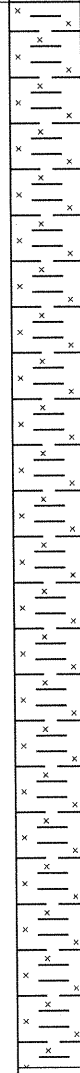
Generic Guideline Values

Envirocheck Report

Historical Maps


London Underground Ltd Letter







Site Plan

<div><div>GEA</div><div>Geotechnical & Environmental Associates</div></div>				Tyttenhanger House Coursers Road St Albans AL4 0PG		Site 39 College Crescent, London NW3 5LD		Borehole Number BH1	
Boring Method Cable Percussion		Casing Diameter		Ground Level (mOD) 60.60		Client Thameside Construction Co Ltd		Job Number J12079	
		Location		Dates 12/04/2012		Engineer Paul Carpenter Associates		Sheet 1/2	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.40	D1	1.20	DRY	1,1/1,2,2,2	59.20	(1.40)	Made Ground (brown clayey sand with fragments of brick and concrete)		
0.80	D2								
1.20-1.65	CPT N=7								
1.20	B3								
1.80	D4								
2.00-2.45	U5	1.50	DRY	1,2/2,2,2,3	57.60	(1.60)	Firm fissured high strength brown mottled orange-brown and grey silty CLAY with roots		
2.50	D6								
2.70	D7								
3.00-3.45	SPT N=9								
3.00	D8								
3.80	D9								
4.00-4.45	U10								
4.50	D11								
4.80	D12								
5.00-5.45	SPT N=15								
5.00	D13								
6.00-6.45	U14	1.50	DRY	2,2/3,3,4,5			Stiff fissured high strength brown with occasional grey mottling silty CLAY with selenite crystals. Roots to 4.5 m.		
6.50	D15								
7.50-7.95	SPT N=16	1.50	DRY	2,2/3,3,5,5					
7.50	D16								
9.00-9.45	U17								
9.50	D18								
<div>Remarks Inspection pit hand excavated to a depth of 1.2 m (1 1/4 hours) Groundwater monitoring standpipe installed to a depth of 5.0 m</div>								Scale (approx) 1:50	Logged By RR
								Figure No. J12079.BH1	

<div>GEA</div> <div>Geotechnical & Environmental Associates</div>				Tyttenhanger House Coursers Road St Albans AL4 0PG		Site 39 College Crescent, London NW3 5LD		Borehole Number BH1			
Boring Method Cable Percussion		Casing Diameter			Ground Level (mOD) 60.60		Client Thameside Construction Co Ltd		Job Number J12079		
		Location			Dates 12/04/2012		Engineer Paul Carpenter Associates		Sheet 2/2		
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water		
10.50-10.95 10.50	SPT N=20 D19	1.50	DRY	3,3/4,5,5,6	49.40	(8.20)	Stiff fissured high strength brownish grey silty CLAY with selenite crystals, claystones at 12.4 m and 17.5 m				
11.20	D20			Parting of orange-brown silt at 11.2 m		11.20					
12.00-12.45	U21										
12.50	D22			Seepage(1) at 12.40m.							
13.50-13.95 13.50	SPT N=22 D23	1.50	DRY	3,4/5,5,6,6		(8.80)					
15.00-15.45	U24										
15.50	D25										
16.50-16.95 16.50	SPT N=28 D26	1.50	DRY	5,6/6,7,7,8							
18.00-18.45	U27										
18.50	D28										
19.50-19.95 19.50	SPT N=30 D29	1.50	DRY	4,6/7,7,8,8							
						40.60	20.00				
Remarks Chiselling from 12.40m to 12.60m for 1/4 hour. Chiselling from 17.50m to 17.80m for 1/4 hour.								Scale (approx) 1:50		Logged By RR	
								Figure No. J12079.BH1			

<div><div>GEA</div><div>Geotechnical & Environmental Associates</div></div>					Tyttenhanger House Coursers Road St Albans AL4 0PG		Site 39 College Crescent, London NW3 5LD		Borehole Number BH2	
Boring Method Cable Percussion		Casing Diameter			Ground Level (mOD) 60.80		Client Thameside Construction Co Ltd		Job Number J12079	
		Location			Dates 13/04/2012- 16/04/2012		Engineer Paul Carpenter Associates		Sheet 1/2	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	
0.30	D1	1.50	DRY	2,2/2,3,3,3	60.30	(0.50)	Made Ground (brown sand with fragments of brick and concrete)			
0.90	D2					0.50	"Stiff" fissured very high strength brown mottled orange-brown silty CLAY with selenite crystals and roots (desiccated soil)			
1.20-1.65	U3					(1.00)				
1.70	D4					1.50	Firm fissured brown mottled orange-brown silty CLAY with selenite crystals and roots			
1.90	D5	1.50	DRY	2,2/2,3,4,4	58.80	(0.50)				
2.00-2.45	SPT N=11					2.00	Stiff fissured high strength brown occasionally mottled grey silty CLAY with occasional selenite crystals. Roots to 3.0 m.			
2.00	D6									
2.70	D7									
3.00-3.45	U8	1.50	DRY	2,2/2,3,4,4						
3.50	D9									
3.80	D10									
4.00-4.45	SPT N=13									
4.00	D11	1.50	DRY	2,3/4,4,4,5						
4.70	D12									
5.00-5.45	U13									
5.50	D14									
6.00-6.45	SPT N=17	1.50	DRY	2,3/4,4,4,5						
6.00	D15									
7.50-7.95	U16									
8.00	D17									
9.00-9.45	SPT N=21	1.50	DRY	3,3/4,5,6,6						
9.00	D18									
Remarks Groundwater monitoring standpipe installed to a depth of 5.0 m Groundwater not encountered Inspection pit hand excavated to a depth of 1.2 m (1 1/4 hours)								Scale (approx) 1:50	Logged By RR	
								Figure No. J12079.BH2		

 Geotechnical & Environmental Associates		Tyttenhanger House Coursers Road St Albans AL4 0PG			Site 39 College Crescent, London NW3 5LD		Borehole Number BH2		
Boring Method Cable Percussion		Casing Diameter		Ground Level (mOD) 60.80		Client Thameside Construction Co Ltd		Job Number J12079	
		Location		Dates 13/04/2012- 16/04/2012		Engineer Paul Carpenter Associates		Sheet 2/2	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
10.50-10.95	U19				50.00	(8.80)		x	
11.00	D20					10.80	Stiff fissured high to very high strength brownish grey silty CLAY with claystone at 18.4 m	x	
12.00-12.45 12.00	SPT N=22 D21	1.50	DRY	4,4/5,5,6,6				x	
13.50-13.95	U22							x	
14.00	D23							x	
15.00-15.45 15.00	SPT N=33 D24	1.50	DRY	3,5/7,8,8,10		(9.20)		x	
16.50-16.95	U25							x	
17.00	D26							x	
18.00-18.45 18.00	SPT N=44 D27	1.50	DRY	5,5/7,8,8,21				x	
19.90-19.98	SPT 29*/75	1.50	DRY	29/	40.80	20.00		x	
Remarks								Scale (approx) 1:50	Logged By RR
								Figure No. J12079.BH2	

 Geotechnical & Environmental Associates				Tyttenhanger House Coursers Road St Albans AL4 0PG		Site 39 College Crescent, London NW3 5LD		Borehole Number BH3			
Boring Method Cable Percussion		Casing Diameter			Ground Level (mOD) 62.05		Client Thameside Construction Co Ltd		Job Number J12079		
		Location			Dates 13/04/2012- 16/04/2012		Engineer Paul Carpenter Associates		Sheet 1/2		
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water		
0.40	D1	1.50	DRY	Seepage(1) at 1.80m. 1,2/2,2,2,2	61.90	(0.15) 0.15 (0.45)	Reinforced Concrete		▽1		
					61.45	0.60	Made Ground (sand with fragments of brick)				
0.90	D2						Firm medium strength orange-brown mottled brown silty CLAY with roots to 2.0 m				
1.20-1.65	U3										
1.50	D4										
1.80	D5										
2.00-2.45	SPT N=8										
2.00	D6							(3.40)			
2.80	D7										
3.00-3.45	U8										
3.50	D9	1.50	DRY	1,2/2,2,3,3	58.05	4.00	Stiff fissured high strength orange-brown mottled grey silty CLAY with selenite crystals				
3.70	D10					(1.00)					
4.00-4.45	SPT N=10										
4.00	D11										
4.70	D12										
5.00-5.45	U13							57.05	5.00	Stiff fissured high strength brown silty CLAY	
5.50	D14										
6.00-6.45	SPT N=14										
6.00	D15										
7.50-7.95	U16				1.50	DRY	2,2/3,3,4,4		(5.10)		
8.00	D17										
9.00-9.45	SPT N=20										
9.00	D18										
Remarks Inspection pit hand excavated to a depth of 1.2 m (1 hour) Groundwater monitoring standpipe installed to a depth of 5.0 m								Scale (approx) 1:50	Logged By RR		
								Figure No. J12079.BH3			

<div>GEA</div> <div>Geotechnical & Environmental Associates</div>		Tyttenhanger House Coursers Road St Albans AL4 0PG		Site 39 College Crescent, London NW3 5LD		Borehole Number BH3			
Boring Method Cable Percussion		Casing Diameter		Ground Level (mOD) 62.05		Client Thameside Construction Co Ltd		Job Number J12079	
		Location		Dates 13/04/2012- 16/04/2012		Engineer Paul Carpenter Associates		Sheet 2/2	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
10.20	D19	1.50	DRY	4,4/5,6,7,8	51.95	(5.10) 10.10	Stiff fissured high to very high strength brownish grey silty CLAY with claystone at 18.7 m	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>	



Geotechnical &
Environmental
Associates

Tythenhanger House
Coursers Road
St Albans
AL4 0PG

Standard Penetration Test Results

Site : 39 College Crescent, London NW3 5LD

Client : Thameside Construction Co Ltd

Engineer: Paul Carpenter Associates

Job Number

J12079

Sheet

1 / 1

Borehole Number	Base of Borehole (m)	End of Seating Drive (m)	End of Test Drive (m)	Test Type	Seating Blows per 75mm		Blows for each 75mm penetration				Result	Comments
					1	2	1	2	3	4		
BH1	1.20	1.35	1.65	CPT	1	1	1	2	2	2	N=7	
BH1	3.00	3.15	3.45	SPT	1	2	2	2	2	3	N=9	
BH1	5.00	5.15	5.45	SPT	2	2	3	3	4	5	N=15	
BH1	7.50	7.65	7.95	SPT	2	2	3	3	5	5	N=16	
BH1	10.50	10.65	10.95	SPT	3	3	4	5	5	6	N=20	
BH1	13.50	13.65	13.95	SPT	3	4	5	5	6	6	N=22	
BH1	16.50	16.65	16.95	SPT	5	6	6	7	7	8	N=28	
BH1	19.50	19.65	19.95	SPT	4	6	7	7	8	8	N=30	
BH2	2.00	2.15	2.45	SPT	2	2	2	3	3	3	N=11	Bouncing
BH2	4.00	4.15	4.45	SPT	2	2	2	3	4	4	N=13	
BH2	6.00	6.15	6.45	SPT	2	3	4	4	4	5	N=17	
BH2	9.00	9.15	9.45	SPT	3	3	4	5	6	6	N=21	
BH2	12.00	12.15	12.45	SPT	4	4	5	5	6	6	N=22	
BH2	15.00	15.15	15.45	SPT	3	5	7	8	8	10	N=33	
BH2	18.00	18.15	18.45	SPT	5	5	7	8	8	21	N=44	
BH2	19.90	19.98		SPT	29						29*/75mm	
BH3	2.00	2.15	2.45	SPT	1	2	2	2	2	2	N=8	
BH3	4.00	4.15	4.45	SPT	1	2	2	2	3	3	N=10	
BH3	6.00	6.15	6.45	SPT	2	2	3	3	4	4	N=14	
BH3	9.00	9.15	9.45	SPT	3	3	4	4	6	6	N=20	
BH3	12.00	12.15	12.45	SPT	4	4	5	6	7	8	N=26	
BH3	15.00	15.15	15.45	SPT	5	5	6	7	7	8	N=28	
BH3	18.00	18.15	18.45	SPT	5	6	7	8	8	9	N=32	



Geotechnical &
Environmental
Associates

Tythenhanger House
Coursers Road
St Albans
Herts AL4 0PG

Site

39 College Crescent

**Trial Pit
Number
TP2**

Excavation Method
Excavator

Dimensions

1.4 m x 3.0 m x 3.6 m

Ground Level (mOD)

Client

Thameside Construction Co Ltd

Job

Number
J12079

Location

Dates

12/04/2012

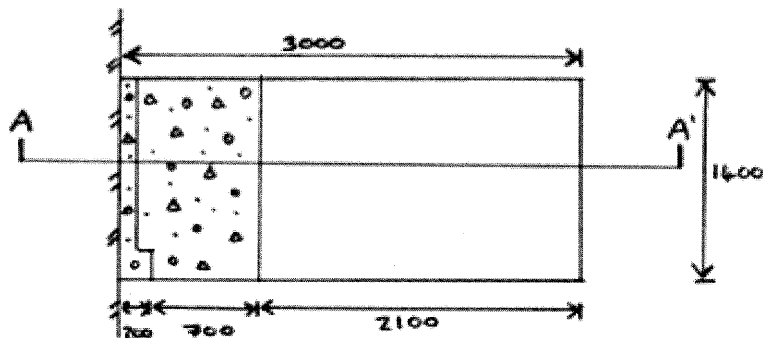
Engineer

Paul Carpenter Associates

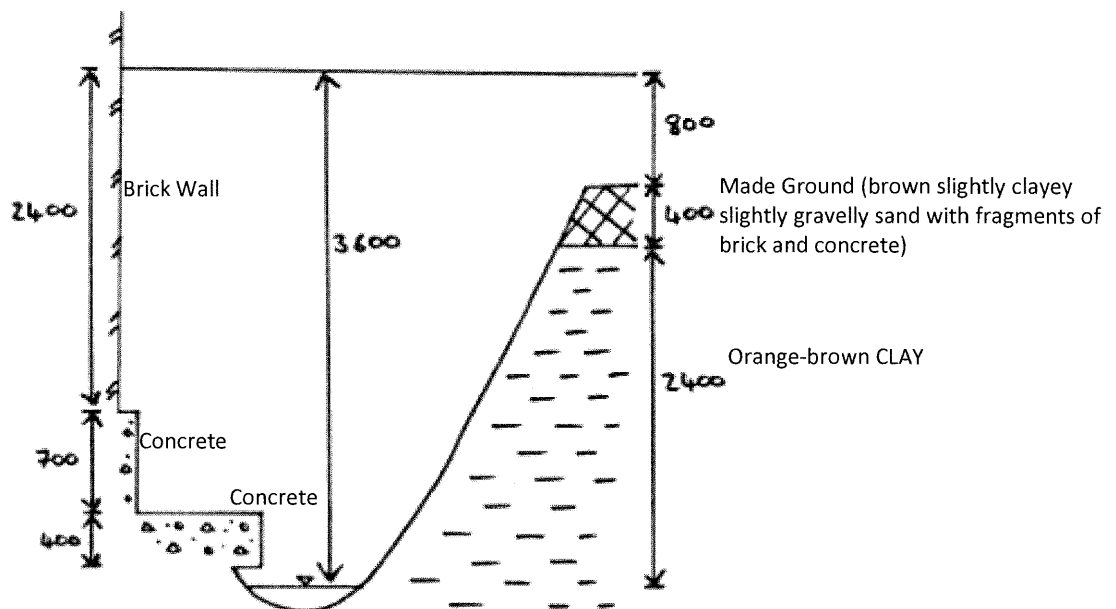
Sheet

1 / 2

PLAN:



SECTION A - A':



Remarks:

All dimensions in millimetres

Sides of trial pit remained stable

Groundwater: pit excavated 2 days prior to GEA logging - water assumed to be surface / rainwater

Scale:

1:20

Logged by:

RR



Geotechnical &
Environmental
Associates

Tytenhanger House
Coursers Road
St Albans
AL4 0PG

Trial Pit 2

Site 39 College Crescent, London NW3 5LD

Client Thameside Construction Co Ltd

Engineer Paul Carpenter Associates

GEA Engineer
RR

Job Number
J12079

Date
12/04/2012

Sheet
2/2



PROJECT NAME	39 COLLEGE CRESCENT, LONDON NW3 5LD		Date 12/05/2012
	Job Number: J12079		Approved <i>Simon Burke</i>
PROJECT NO:	GEO / 18238		Page 1 of 3

Sample details				Description	Classification Tests					Density Tests		Undrained Triaxial Compression Tests			Chemical Tests			Other tests and comments
Borehole No.	Depth (m)	No.	Type		MC (%)	LL (%)	PL (%)	PI (%)	<425 mic (%)	Bulk (Mg/m³)	Dry (Mg/m³)	Cell Pressure (kPa)	Deviator Stress (kPa)	Shear Stress (kPa)	pH	2:1 W/S SO4 (g/l)	Magnesium Water Soluble (mg/kg)	
1	2.00	U5	U	Stiff brown CLAY with blue-grey veins	33					1.97	1.48	40	153	76				
1	3.00	D8	D												7.2	4.8	510	
1	3.80	D9	D	Stiff mottled brown silty CLAY with rare grey staining and selenite crystals	32	76	30	46	100									
1	4.00	U10	U	Stiff brown CLAY with blue-grey veins	32					1.99	1.51	80	172	86				
1	4.50	D11	D	Stiff mottled brown silty CLAY with rare grey staining and selenite crystals	33													
1	4.80	D12	D	Stiff mottled brown slightly fine sandy silty CLAY with rare grey staining and selenite crystals	32	80	30	50	100									
1	5.00	D13	D	Stiff mottled brown slightly fine sandy silty CLAY with rare grey staining and selenite crystals	32													
1	6.00	U14	U	Stiff fissured brown CLAY with blue-grey veins	30					1.99	1.53	120	282	141				
1	9.00	U17	U	Stiff fissured grey-brown CLAY	28					2.04	1.59	180	309	155				
1	12.00	U21	U	Stiff fissured grey-brown CLAY	29					2.01	1.56	240	262	131				
1	15.00	U24	U	Stiff fissured grey-brown CLAY	29					2.04	1.57	300	265	133				
1	18.00	U27	U	Stiff fissured grey-brown CLAY	29					2.04	1.58	360	314	157				

SUMMARY OF GEOTECHNICAL TESTING

PROJECT NAME	39 COLLEGE CRESCENT, LONDON NW3 5LD	Date	12/05/2012
		Approved	<i>Simon Burke</i>
		Page	2 of 3
PROJECT NO:	GEO / 18238		

Sample details				Description	Classification Tests					Density Tests		Undrained Triaxial Compression Tests			Chemical Tests			Other tests and comments
Borehole	Depth	No.	Type		MC	LL	PL	PI	<425 mic	Bulk	Dry	Cell Pressure	Deviator Stress	Shear Stress	pH	2:1 W/S SO4	Magnesium Water Soluble	
No.	(m)				(%)	(%)	(%)	(%)	(%)	(Mg/m ³)	(Mg/m ³)	(kPa)	(kPa)	(kPa)		(g/l)	(mg/kg)	
2	1.20	U3	U	Stiff brown CLAY with pockets of orange silty and selenite crystals	27					2.03	1.60	25	340	170				
2	2.00	D6	D	Stiff mottled brown silty CLAY with rare grey staining and selenite crystals	31													
2	2.70	D7	D	Stiff mottled brown silty CLAY with rare selenite crystals	32	82	29	53	100									
2	3.00	U8	U	Stiff brown CLAY with grey veins rare selenite crystals and pyrite nodules	31					1.97	1.50	60	167	83				
2	3.50	D9	D	Stiff mottled brown slightly fine sandy silty CLAY with rare grey staining and selenite crystals	32	80	29	51	100									
2	4.00	D11	D	Stiff mottled brown slightly fine sandy silty CLAY with rare grey staining and selenite crystals	31													
2	5.00	U13	U	Stiff brown CLAY with rare selenite crystals	31					2.00	1.53	100	234	117				
2	6.00	D15	D												7.1	7.2	790	
2	7.50	U16	U	Stiff fissured brown CLAY with rare selenite crystals	31					1.94	1.48	150	255	128				
2	10.50	U19	U	Very stiff fissured brown CLAY with rare selenite crystals	28					2.03	1.58	210	348	174				
2	13.50	U22	U	Stiff fissured grey-brown CLAY	28					2.01	1.57	270	264	132				
2	16.50	U25	U	Very stiff fissured grey-brown CLAY	28					2.02	1.57	330	311	156				

SUMMARY OF GEOTECHNICAL TESTING

GEOLABS®

Test Report by GEOLABS Limited Bucknalls Lane, Garston, Watford, Hertfordshire, WD25 9XX

Authorised Signatories: • J R Masters (Qual Mgr) • C F Wallace (Tech Mgr) • J Sturges (Ops Mgr) [X] Simon Burke (Snr Tech) • J J M Powell (Tech Dir)

Client: Geotechnical & Environmental Associates Limited, Tyttenhanger House, Courses Road, St Albans, Hertfordshire AL4 0PG

© GEOLABS LIMITED

(Ref5041.462708)

Page 1 of 1

GEOLABS®