11 Prince Albert Road, NW1

Basement Impact Assessment (BIA)

Ref No: 24075

Date November 2014

FLUID.STRUCTURES
Structural Engineers & Technical Designers

Quality management

Job No	24075
Client	Harrison Varma
Location	11 Prince Albert Road, NW1
Title	Basement Impact Assessment
Document Status	Planning
Date	November 2014
Prepared By	MR
Checked By	RWS

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Revision Status/ History

Rev	Date	Issue/ Purpose/ Comment	Prepared	Checked	Authorised
P1	21.11.14	For Information	MR	RWS	RWS
P2	26.11.14	For Information	MR	RWS	RWS

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1.0 INTRODUCTION

Fluid Structures have been commissioned by Harrison Varma to act as structural engineers for the proposed works at 11 Prince Albert Road, NW1 7SR.

The proposal includes the following structural alterations:

- Extension of the lower ground floor level at the flank wall side;
- Construction of a new basement level incorporating a swimming pool;
- Alterations at the existing lower ground level to change the internal layouts by removing/adding partitions and re-arranging door openings.
- Minor alterations on the upper floors.

1.1 PURPOSE

The purpose of this report is to document the specific details of the excavation, temporary works and construction techniques to be employed in the excavation of the basement. This report must be read in conjunction with all relevant Architectural drawings (existing and proposed) by AD Design Concepts and the site investigation report by Geotechnical and Environmental Associates dated February 2014.

This report responds to the requirements of the London Borough of Camden Planning Guidance Document CPG4: Basements and lightwells, the Camden Development Policy DP27: Basements and Lightwells, and their Guidance for Subterranean Development prepared by Arup (Camden, Hydrogeological and Hydrological Study).

1.2 EXECUTIVE SUMMARY

This report highlights the outline structural philosophy for the subterranean works at 11 Prince Albert Road, London, NW1 7SR.

The proposed works include alterations at lower ground floor level, extension at lower ground level and construction of a new basement and a swimming pool.

The site investigation carried out by Geotechnical and Environmental Associates in February 2014 revealed that the ground conditions are made ground (to depth of 3.0m) overlying London Clay Formation which was proved to the maximum depth investigated (6.0m).
Groundwater was not encountered to the maximum depth investigated.

It is proposed that the basement is formed with a perimeter of contiguous piles, which would be installed prior to excavations commencing. During the excavation process the RC pile walls will be propped by using temporary lateral propping to guarantee the stability of the excavation and of any adjoining structures at all times. A reinforced concrete 'box' structure will enclose the basement and the swimming pool area with the basement RC slab supported by RC piles.

The superstructure of the property is proposed to be mainly retained during construction, including the existing masonry facades during the construction of the subterranean works.

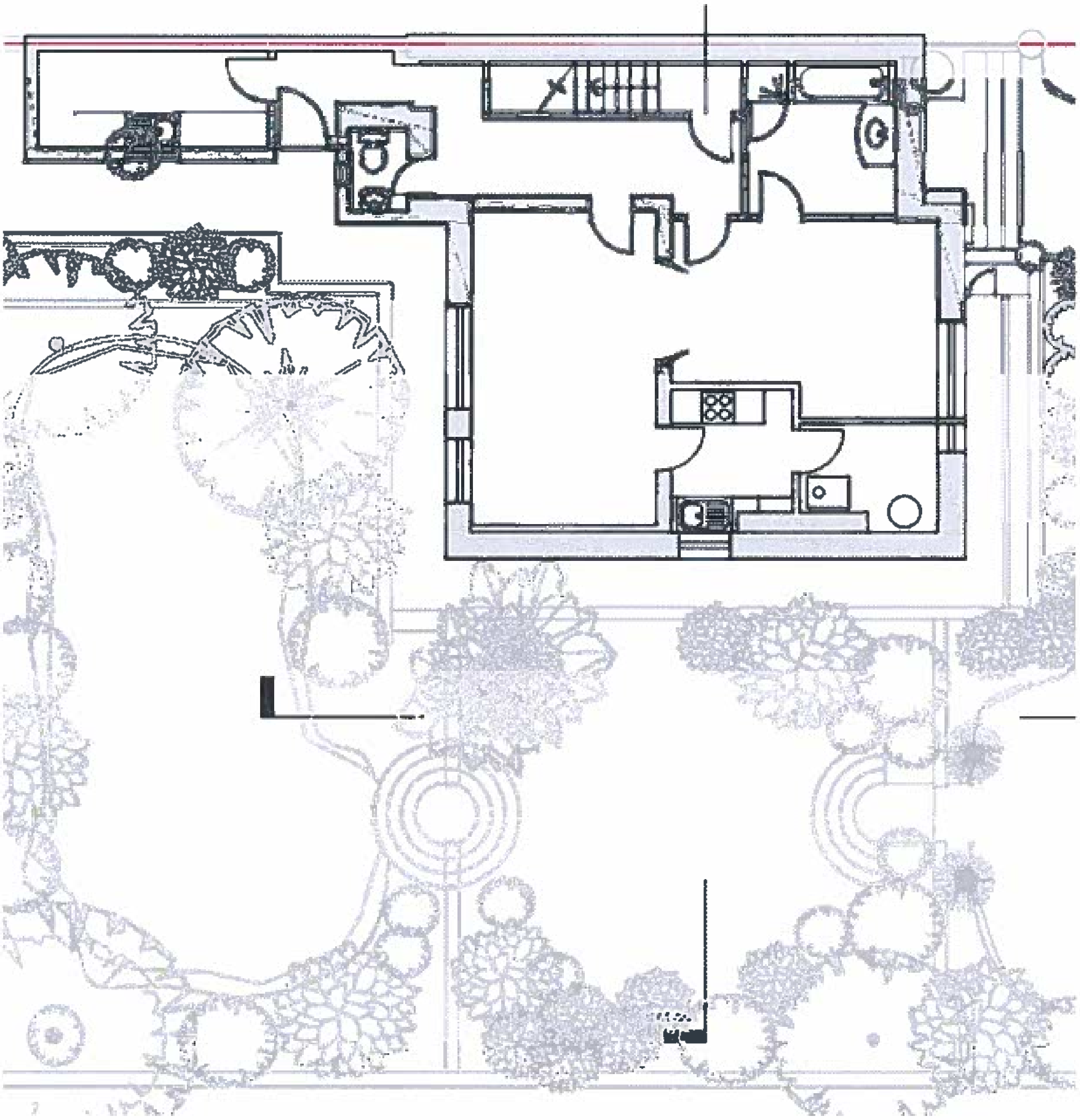
2.0 EXISTING SITE

The site is located along the northern side of Regent's Park in Primrose Hill, northwest London, approximately 550m west of Camden Town London Underground station and 800m south of Chalk Farm London Underground station. It fronts onto Prince Albert Road to the south and is bordered by semi-detached villas to the east and west and semi-detached townhouses to the north.

The site is roughly rectangular in shape, measuring approximately 30m north-south by 18m east-west and is occupied by No. 11 Prince Albert Road, a four storey semi-detached Regency villa with single storey elevation at the rear of the house and partial lower ground floor, which is present under the western half of the existing building. The house is centrally positioned on the site with a hard covered driveway to the front and garden at the rear. The rear garden is approximately 2.5m below the front of the site, is accessed via steps on the western side of the house and comprises a central lawn with bushes along the northern and western boundaries; a paved path runs along the back of the house and a small patio area is present in the east of the garden. There are a number of semi-mature and mature deciduous trees of up to 15m in height located on the southern and western boundaries of the site.

The lower ground floor level is approximately 3.0m below the level of the front driveway, but due to the sloping nature of the site, exits at the garden level along the northern extent. A lightwell is also present along the southern and western extents of the lower ground floor, which is supported by brick built retaining walls.

Site location



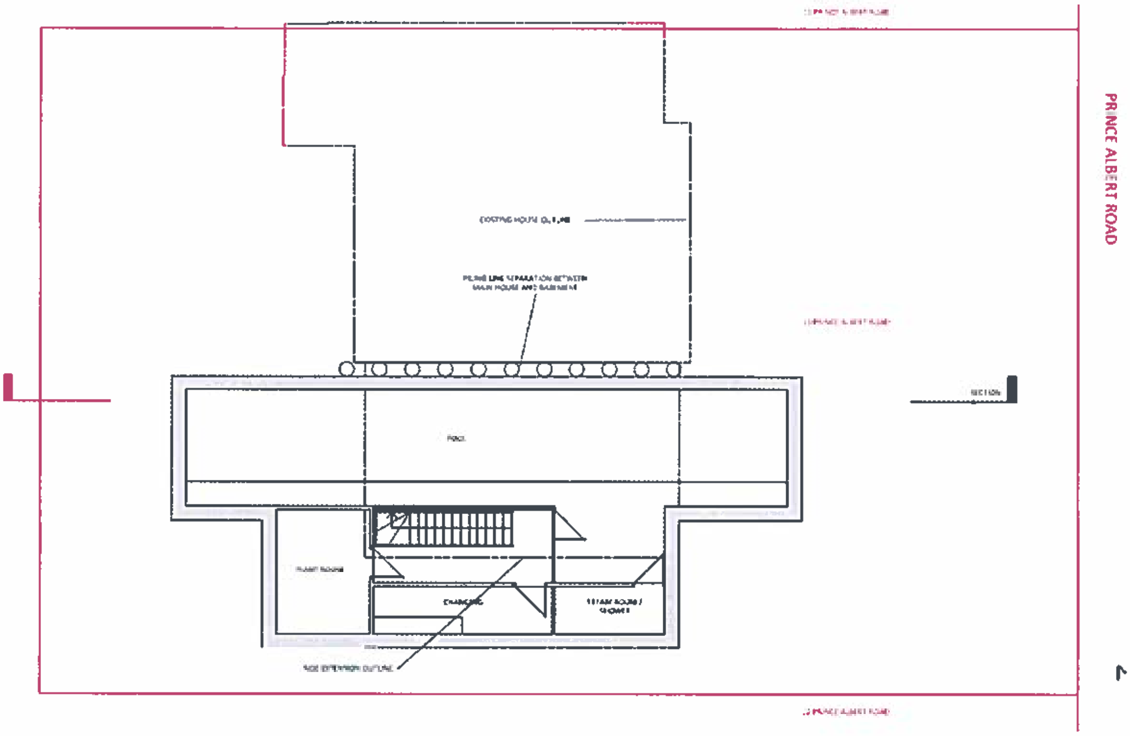
Existing lower ground floor plan

Existing front elevation

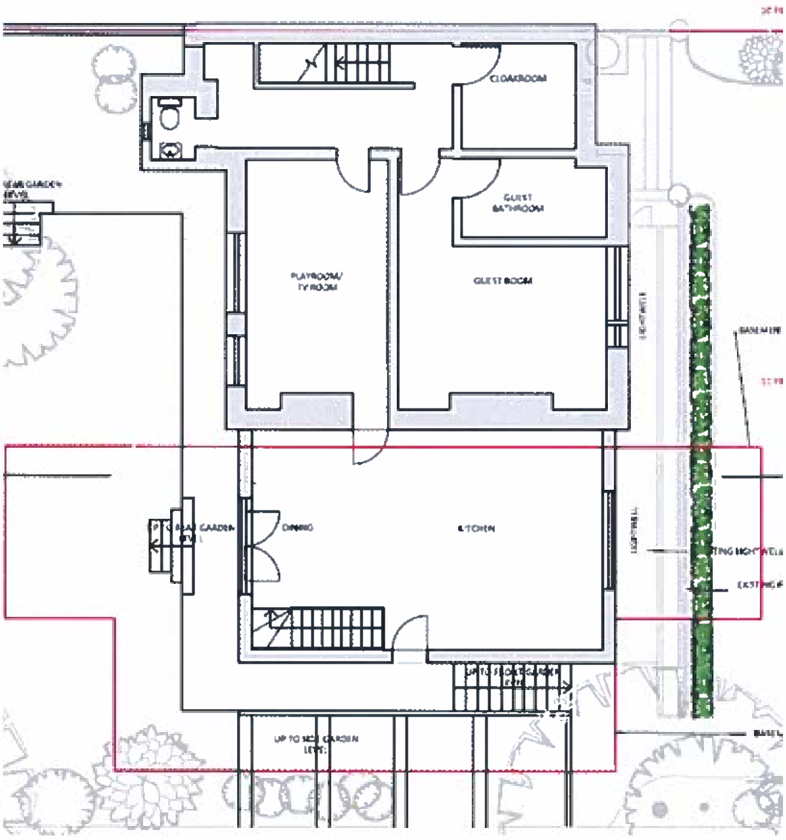
3.0 THE PROPOSED WORKS

The proposed works will include:

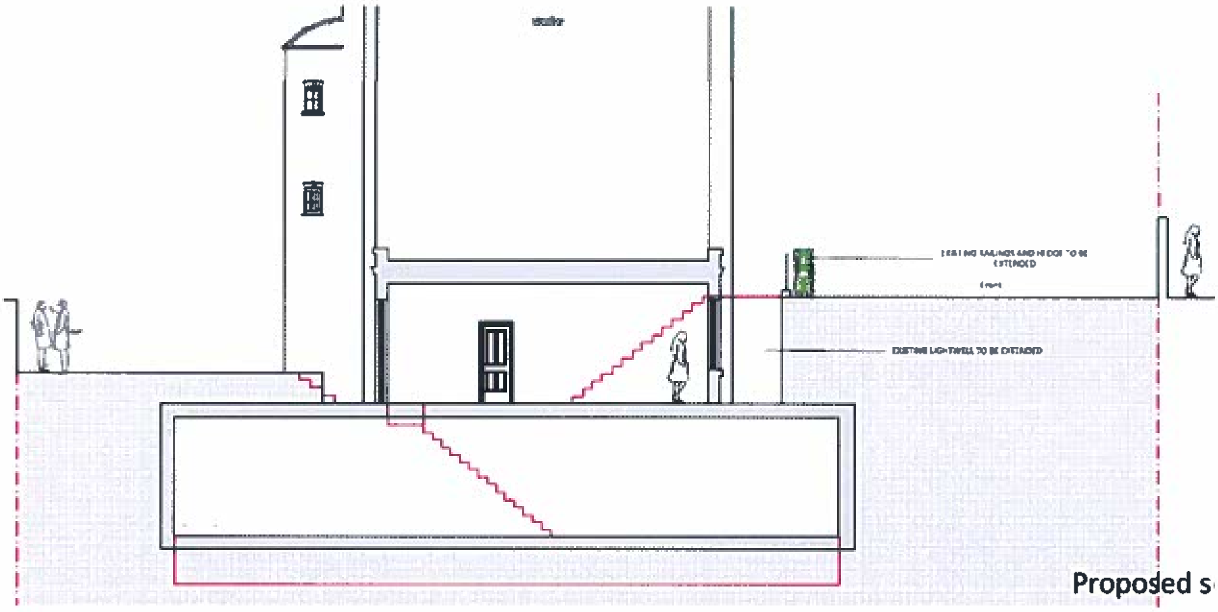
- The extension of the lower ground level through the west flank wall;
- The construction of a new basement beneath the lower ground floor extension. The basement footprint is proposed to be larger than the ground floor extension;
- The construction of a swimming pool within the basement area, on the east side;
- Alterations at the lower ground floor which will include the removal of the existing kitchen to form a guest room, closing some door openings, creating new door openings.



Proposed basement plan



Proposed lower ground floor plan



Proposed cross section

Proposed front elevation

4.0 STAGE 1 – SCREENING

Screening (Stage 1) is a process of determining whether or not a full BIA is required. CPG4 provides flowcharts for each of the three disciplines: Groundwater Flow, Land Stability and Surface Flow/Flooding. An answer of 'Yes' or 'Unknown' to any of the questions in the flowcharts will require progression to the Stage 2-Scoping. An answer of 'No' indicates that no further investigation is required however will require written justification.

4.1 GROUNDWATER FLOW

Impact question	*Answer*	*Justification*	*Reference*
1a. Is the site located directly above an aquifer?	Unknown	The BGS map shows the site be underlain by the London Clay. This stratum is normally regarded as 'Unproductive'. The presence of water to be confirmed by SI.	BGS published geology
1b. Will the proposed basement extend beneath the water table surface?	Unknown	The water level is unknown and need to be confirmed by SI.	BGS published geology
2. Is the site within 100m of a watercourse, well (used/disused) or potential spring line?	Yes	The Regent's Canal is less than 100m away from the site	OS map
3. Is the site within the catchment of the pond chains on Hampstead Heath?	No	Map review indicates the site located outside the catchment of the pond chains on Hampstead Heath	Hampstead Heath Surface Water Catchments and drainage/Arup fig. 14
4. Will the proposed basement development result in a change in the proportion of hard surfaced/paved areas?	Unknown	No information available	Existing and proposed landscape drawings
5. As part of the site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or SUDS)?	Unknown	No information available	Existing and proposed drainage drawings
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	Unknown	No information available	Proposed basement drawings/ Watercourses-Arup fig.11/ Camden Surface Water Features-Arup fig.12/

water level in any local pond (not just the pond chains on Hampstead Heath) or spring line?			

4.2 LAND STABILITY

Impact question	*Answer*	*Justification*	*Reference*
1. Does the existing site include slopes, natural or manmade, greater than 7? (approximately 1 in 8)	No	No significant apparent slope indicated by survey plans.	Slope angle map/Arup fig. 16
2. Will the proposed re-profiling of landscaping at site change slopes at the property boundary to more than 7? (approximately 1 in 8)	No	There are no plans to alter the site levels.	Slope angle map/Arup fig. 16
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7? (approximately 1 in 8)	No	Available survey information shows no other slopes greater than 7 degrees within a relevant distance	Slope angle map/Arup fig. 16
4. Is the site within a wider hillside setting in which the general slope is greater than 7? (approximately 1 in 8)	Unknown	Available survey information shows the site could be within a wider hillside setting greater than 7 degrees within a relevant distance	OS map/Slope angle map/Arup fig. 16
5. Is the London Clay the shallowest strata at the site?	Yes	Available data shows London Clay to be the shallowest strata	BGS published geology
6. Will any tree/s 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	Unknown	Trees are present within the boundary however the boundaries of a possible tree protection zone are unknown. The proposed landscape development is unknown.	Existing and proposed landscape drawings
7. Is there a history of seasonal shrink-swell subsidence in the local area, and/or evidence of such effects at the site?	Unknown	We have not been provided with any evidence of seasonal shrink/swelling subsidence however the presence of London clay and trees suggests that shrinkage	BGS published geology/ Existing and proposed site plans

		may be an issue.	
8. Is the site within 100m of a watercourse or a potential spring line?	Yes	The Regent's Canal is less than 100m away from the site	OS map/Camden Surface Water Features-Arup fig.12
9. Is the site within an area of previously worked ground?	Unknown	Available map shows absence of any made ground however	Slope angle map/Arup fig. 16
10. Is the site within an aquifer? If so, will the proposed basement extend beneath the water table such that dewatering may be required during construction?	Unknown	The BGS map shows the site be underlain by the London Clay. This stratum is normally regarded as 'Unproductive'. The presence of water to be confirmed by SI.	BGS published geology
11. Is the site within 50m of the Hampstead Heath ponds?	No	Site is located outside of50m radius of Hampstead Heat Ponds.	Hampstead Heath Surface Water Catchments and drainage/Arup fig. 14
12. Is the site within 5m of a highway or pedestrian right of way?	No	The proposed basement is not within 5m of the pavement at Prince Albert Road.	Proposed Architect drawings
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Unknown	Potential basement built at No. 12 Prince Albert Road but shallower than the proposed basement at No. 11.	Proposed drawings for the development at No. 12 as found on the Camden planning portal.
14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	Unknown	There is the overground line at about 200mm east of the site, however it is unknown whether the site is within the exclusion zone.	OS map

4.3 SURFACE FLOW AND FLOODING

Impact question	***Answer***	***Justification***	***Reference***
1. Is the site within the catchment of the pond chains on Hampstead Heath?	No	Map review indicates the site located outside the catchment of the pond chains on Hampstead Heath	Hampstead Heath Surface Water Catchments and drainage/Arup fig. 14
2. As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be	Unknown	No information available	Existing and proposed drainage drawings

materially changed from the existing route?			
3. Will the proposed basement development results in a change in the proportion of hard surfaced/paved external area?	Unknown	No information available	Existing and proposed landscape drawings
4. Will the proposed basement result in changes to the profile of the inflows (instantaneous and long-term) of surface water being received by adjacent properties or downstream watercourses?	Unknown	The BGS map shows the site be underlain by the London Clay. This stratum is normally regarded as 'Unproductive'. The presence of water to be confirmed by SI.	BGS published geology
5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	Unknown	No information available	BGS published geology
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 King's Cross, or is it at risk from flooding, for example because the proposed basement is below the static water level of a nearby surface water feature?	Unknown	The site is not within an area known to be at risk of flood, however the presence of water need to be confirmed by the SI.	'Streets at risk of surface water flooding'-CPG4 page 29/ Flood Map – Arup Fig. 15

5.0 STAGE 2 – SCOPING

The scoping stage of the BIA requires identifying the potential impacts of the proposed scheme as set out in chapter 5 of the Camden Geological, Hydrogeological and Hydrological Study which are shown by the screening process to need further investigation.

5.1 GROUNDWATER FLOW

The BGS maps indicate that the site is underlain by London Clay which is regarded as 'unproductive' **(Question 1a).** The proposed basement will extend to approximately 9.0m below ground level, however the water level is unknown at this stage and should be assessed by a site investigation **(Question 1b).**

The site is within the 100m radius from the Regent's Canal and any impacts on the groundwater flow should be assessed by a desk study and a site investigation **(Question 2).**

At this stage there are no existing/proposed landscape drawings available therefore it is not possible to assess the change in the proportion of hard surfaced/paved areas **(Question 4).**

At this stage there are no existing/proposed drainage drawings available therefore it is not possible to assess the change in discharge of the surface water **(Question 5).**

There are no information available about the final proposed basement levels therefore the lowest point of the excavation need to be confirmed. The Regent's Canal is the only water course known at this stage, any further local pond/spring line need to be confirmed by a desk study/site investigation **(Question 6).**

5.2 LAND STABILITY

According to the 'Slope angle map' (Arup fig.16) the site seems to be within a wider hillside setting greater than 7 degrees within a relevant distance according (to the south-west of the site), however this need to be confirmed by a desk study **(Question 4).**

According to the BGS maps the London Clay is expected to be the shallowest strata beneath a layer of made ground **(Question 5)** and therefore the presence of trees could have an effect on the soil volume change (subsidence/heave) **(Question 7)** either if these will be kept or removed **(Question 6).**

The effects of any nearby vegetation will need to be assessed by a site investigation.

The presence of water and the possible changes to the water levels need to be confirmed by a site investigation and by monitoring the water level over a certain period of time **(Question 8).**

The 'Slope angle map' (Arup-fig. 16) indicates the site is not within an area of previously worked ground however any presence of made ground and its composition need to be confirmed by a site investigation **(Question 9).**

The BGS maps indicate that the site is underlain by London Clay which is regarded as 'unproductive'. The proposed basement will extend to approximately 9.0m below ground level, however the water level is unknown at this stage and should be assessed by a site investigation **(Question 10).**

'Camden Planning Portal' indicates that it was proposed to build a basement at No.12 Prince Albert Road and proposed drawings show the proposed basement construction however we do not have available information which confirms the construction of this basement **(Question 13).**

The overground line is about 200m East of the site, however we do not have available information which confirms whether the site is within the exclusion zone **(Question 14).**

5.3 SURFACE FLOW AND FLOODING

At this stage there are no existing/proposed drainage drawings available therefore it is not possible to assess how the surface water flows will be changed from the existing route **(Question 2).**

At this stage there are no existing/proposed landscape drawings available therefore it is not possible to assess the change in the proportion of hard surfaced/paved areas **(Question 3).**

The presence of water and the possible changes to the water levels need to be confirmed by a site investigation and by monitoring the water level over a certain period of time **(Questions 4 and 5).**

According to the 'Streets at risk of surface water flooding' table and 'Flood map' (Arup fig.15) the site is not within an area known to be at risk of flood **(Question 6).**

6.0 STAGE 3 – SITE INVESTIGATION AND STUDY

The purpose of the stage 3 is to develop an understanding of the site and its immediate surroundings.

A site investigation was carried out by GEA in February 2014 (see Appendix 'A') and comprised:

- Desk study;
- Soil investigation;
- Monitoring;
- Reporting;
- Interpretation.

The scope of works at the time the site investigation was undertaken did not include the construction of a basement and swimming pool therefore an additional site investigation will be required.

7.0 STAGE 4 – IMPACT ASSESSMENT

The information available from the ground investigation carried out by GEA in February 2014 have provided responses to some of the 'Yes' and 'Unknown' answers, as described below.

7.1 GROUNDWATER FLOW

The site investigation confirmed the site to be underlain by London Clay with no presence of water down to the depth investigated (6.0m). Water standpipes also did not record any presence of water **(Question 1a).**

The proposed basement will extend approximately 9.0m below ground level therefore an additional site investigation with deeper boreholes will be required **(Question 1b).**

The Regent's Canal was confirmed approximately 45m to the southwest of the site however any potential impacts on the groundwater flow should be confirmed by an additional site investigation **(Question 2).**

7.2 LAND STABILITY

The desk study did not confirm whether the site is within a wider hillside setting with a general slope greater than 7 degrees, to be confirmed by a further desk study/site investigation **(Question 4).**

The site investigation confirmed London Clay to be the shallowest strata **(Question 5)** and to be of high shrinkability with plasticity indices of between 48% and 57%, therefore the presence of trees **(Question 6)** and their effect on soil volume change **(Question 7)** are an issue. Following a further site investigation the GEA report should give recommendations for the basement construction.

The Regent's Canal was confirmed approximately 45m to the southwest of the site however any potential impacts on the groundwater flow should be confirmed by an additional site investigation **(Question 8).**

The made ground was found to extend to a depth of between 0.4m and 3.0m and generally comprises an initial horizon of dark brown clayey silt with gravel, abundant roots, brick, concrete, coal, charcoal and chalk fragments. The site investigation did not indicated the site being in an area of a worked ground **(Question 9).**

The site investigation confirmed the site to be underlain by London Clay with no presence of water down to the depth investigated (6.0m). Water standpipes also did not record any presence of water **(Question 10).** Additional water monitoring is recommended by GEA.

The desk study did not indicated any tunnels or railway lines except the overground line to the East of the site, however there was no indication whether the site is within any exclusion zone **(Question 14).**

7.3 SURFACE FLOW AND FLOODING

The site investigation confirmed the site to be underlain by London Clay with no presence of water down to the depth investigated (6.0m). Water standpipes also did not record any presence of water **(Question 4).** Additional water monitoring is recommended by GEA.

The impact of the basement construction to the profile of the inflows of surface water and to the quality of the surface water need to be assessed following a further site investigation **(Questions 4 and 5).**

The presence of water below the basement level need to be confirmed by a further site investigation however it was confirmed that the site is not within an area indicated by the Environment Agency to be at risk from flooding **(Question 6).**

8.0 BASEMENT CONSTRUCTION METHOD STATEMENT

The following suggested sequence of works for the basement construction should be read in conjunction with the sketches as in the Appendix 'B'.

Stage 1 – Piling along proposed basement perimeter

1. Install RC contiguous pile along the proposed basement perimeter;
2. Excavate the soil down to the lower ground floor level;
3. Demolish the existing retaining wall adjacent the west flank wall;
4. Install RC contiguous pile next the flank wall without trimming the existing corbel footing;

Stage 2 – Excavation and propping

5. Excavate approximately 1.0m of soil below the lower ground level;
6. Install waling beams and propping to ensure that the excavation is laterally stable and to guarantee stability to the house and to the adjoining site;
7. Continue to excavate down to the proposed basement/swimming pool level;
8. Install additional wailing beams and propping at lower level as required;

Stage 3 – Piling and formation of basement slab

9. Once the formation level is reached, level the ground;
10. Install RC piles to support the basement RC slab;
11. Cast the concrete blinding and the void former;
12. Cast the basement RC slab over the void former and anchor into the head of RC piles;

Stage 4 – Formation of basement walls/lower ground extension

13. Remove the bottom line of propping;
14. Cast the RC walls against the RC pile retaining walls;
15. Prop the top of the RC walls;
16. Remove the line of propping at the lower ground floor level;
17. Cast the RC slab to form the basement roof/lower ground floor;
18. Cast the RC walls to enclose the lower ground floor extension.

9.0 CONCLUSION

A site investigation carried out by GEA in February 2014 did not include within their scope the construction of a new basement and swimming pool therefore an additional site investigation will need to be undertaken.

Ground water was not found down to the maximum depth investigated (6.0m) during the site investigation, indicating that the proposed excavation works should therefore not encounter the groundwater table. There was also no evidence of desiccated soil on site.

The contamination testing has found there to be elevated concentrations of arsenic, lead and total PAH within the made ground. The basement excavation is likely to remove the majority of the made ground with the proposed structure that will form a permanent barrier between the end users and the underlying soil. However, in the remaining areas of any proposed soft landscaping, end users could come into contact with the contamination.

RC contiguous piles will be installed along the basement perimeter before any excavation commence to mantain stability of the existing house and the adjoining properties.

The retaining structure and excavated ground will be fully propped to retain lateral stability during the construction works.

The potential heave as a result of the unloading of the soil during excavation will be counteracted partly by the additional loading provided by the concrete 'box' structure and the tension piles installed.

The new RC basement slab will be cast on top of a void former.

APPENDICES

APPENDIX A

Ground Investigation Report

11 Prince Albert Road
London
NW1 7SR

Client: Harrison Varma

J14004A

November 2014

Geotechnical & Environmental Associates

Document Control

Project title	11 Prince Albert Road, London NW1 7SR	Project ref	J14004A
Report prepared by	Matthew Legg BEng FGS		
Report checked and approved for issue by	Steve Branch BSc MSc CGeol FGS FRGS MIEnvSc		

Issue No	Status	Date	Approved for Issue
1	Final	27 February 2014	
2	Final (revised)	25/11/14	

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

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CONTENTS

EXECUTIVE SUMMARY

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

BRIEF

This report describes the findings of a site investigation carried out by Geotechnical and Environmental Associates Limited (GEA), on the instructions of Harrison Varma, with respect to the proposed redevelopment of this site through the construction of an extension to lower ground floor, which is also to include a single level basement. The purpose of the investigation has been to determine the ground conditions, to assess the extent of any contamination and to provide information to assist with the design of the basement structure and spread foundations for the proposed development. A Desk Study and Basement Impact Assessment (BIA) has previously been carried out by GEA, (report ref: J14004, dated January 2014) and relevant details from the previous report are included herein. A ground movement analysis is currently being completed and therefore the above BIA report, in addition to this report, will be revised and re-issued upon completion of the additional work.

PREVIOUS DESK STUDY FINDINGS

The desk study indicated that the site has been developed with the existing house since at least 1875 and, along with the surrounding area, has remained essentially unchanged up to the present day. No potential off-site sources of contamination, including historical or existing landfill sites have been identified by the desk study, although an infilled section of the Regents Canal presents a theoretical risk of hazardous gases produced from the organic degradation of the fill materials. As however the canal was infilled in 1941, it is considered unlikely that high volumes of hazardous gas are still being produced.

GROUND CONDITIONS

The investigation has encountered the expected ground conditions in that, below a generally significant thickness of made ground, the London Clay Formation was encountered and proved to the maximum depth investigated. The made ground extended to depths of between 0.40 m and 3.00 m, although the base of the made ground was not proved in a number of the trial pits excavated below lower ground floor level. It generally comprised dark brown clayey silt or silty clay with gravel, abundant roots, brick, concrete, coal, charcoal and chalk fragments. The underlying London Clay comprised firm fissured initially orange-brown becoming brown mottled grey fissured clay with partings of orange-brown silt, bluish grey staining along fissures, selenite crystals, occasional white foraminifera and decayed roots and was proved to the maximum depth investigated, of 6.45 m. In a number of the boreholes this stratum was found to include pockets of coarse selenite crystals and orange-brown fine sand at various depths.

Groundwater was not encountered during the drilling of the boreholes and monitoring of the standpipes installed in a number of the boreholes were found to be dry on each occasion. Elevated concentrations of arsenic, lead and total PAH, including benzo(a)pyrene, have been recorded in the made ground.

RECOMMENDATIONS

Excavations for the proposed basement structure will require temporary support to maintain stability and to prevent any excessive ground movements. Based on the groundwater observations to date, significant groundwater inflows are not expected within the basement excavation. The use of a bored pile wall along with localised underpinning, if necessary, is likely to be the best method of forming the basement excavation. Moderate width pad or strip foundations, excavated from basement level to bear in the firm clay, may be designed to apply a net allowable bearing pressure of 150 kN/m^2. Consideration will need to be given to the founding depth for spread foundations excavated from existing ground floor level, along the northern extent of the proposed extension. On the basis of the measured concentrations within the made ground, suitable precautions will be required in areas of proposed soft landscaping in order to protect future end users.

Part 1: INVESTIGATION REPORT

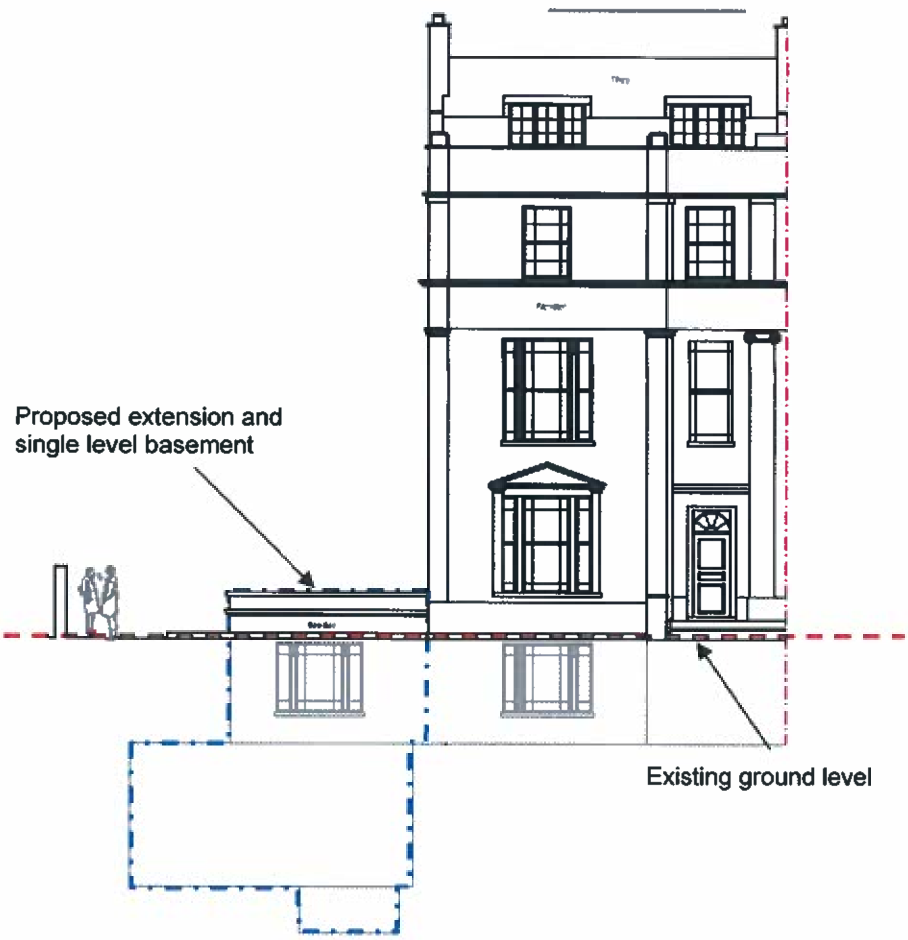
This section of the report details the objectives of the investigation, the work that has been carried out to meet these objectives and the results of the investigation. Interpretation of the findings is presented in Part 2.

1.0 INTRODUCTION

Geotechnical and Environmental Associates (GEA) has been commissioned by Harrison Varma to carry out a ground investigation at 11 Prince Albert Road, London NW1 7SR. A Desk Study and Basement Impact Assessment (BIA) has previously been carried out by GEA, (report ref: J14004, dated January 2014), the summarised details of which are included within this report and referred to where appropriate. A ground movement analysis is currently being completed and therefore the above BIA report, in addition to this report, will be revised and re-issued upon completion of the additional work.

1.1 Proposed Development

Consideration is being given to the extension of the existing lower ground floor, which is also to include a single level basement. At the rear of the existing building, due to the sloping nature of the site, the new lower ground floor level will exit at existing ground level, whilst the maximum depth of excavation for the new basement level will be 6 m from existing ground level. A section of the front elevation indicating the proposed extension is shown below.



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 ground conditions and their engineering properties;
- to provide advice with respect to the design of spread foundations and retaining walls;
- to provide an indication of the degree of soil contamination present; and
- to assess the risk that any such contamination may pose to the proposed development, its users or the wider environment.

1.3 Scope of Work

In order to meet the above objectives, an intrusive ground investigation was carried out which comprised, in summary, the following activities:

- a series of three boreholes advanced to a depth of 6.00 m using an opendrive percussive sampler (Terrier rig);
- standard penetration tests (SPTs), carried out at regular intervals in the boreholes, to provide additional quantitative data on the strength of the soils;
- the installation of two groundwater monitoring standpipes and two subsequent monitoring visits;
- a total of eight hand dug trial pits in order expose 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) 11[1] and involves identifying, making decisions on, and taking appropriate action to deal with, land contamination in a way that is consistent with government policies and legislation within the United Kingdom. The risk assessment is thus divided into three stages comprising Preliminary Risk Assessment, Generic Quantitative Risk Assessment, and Site-Specific Risk Assessment.

1.4 Limitations

The conclusions and recommendations made in this report are limited to those that can be made on the basis of the investigation. The results of the work should be viewed in the context of the range of data sources consulted, the number of locations where the ground was sampled and the number of soil, gas or groundwater samples tested; no liability can be

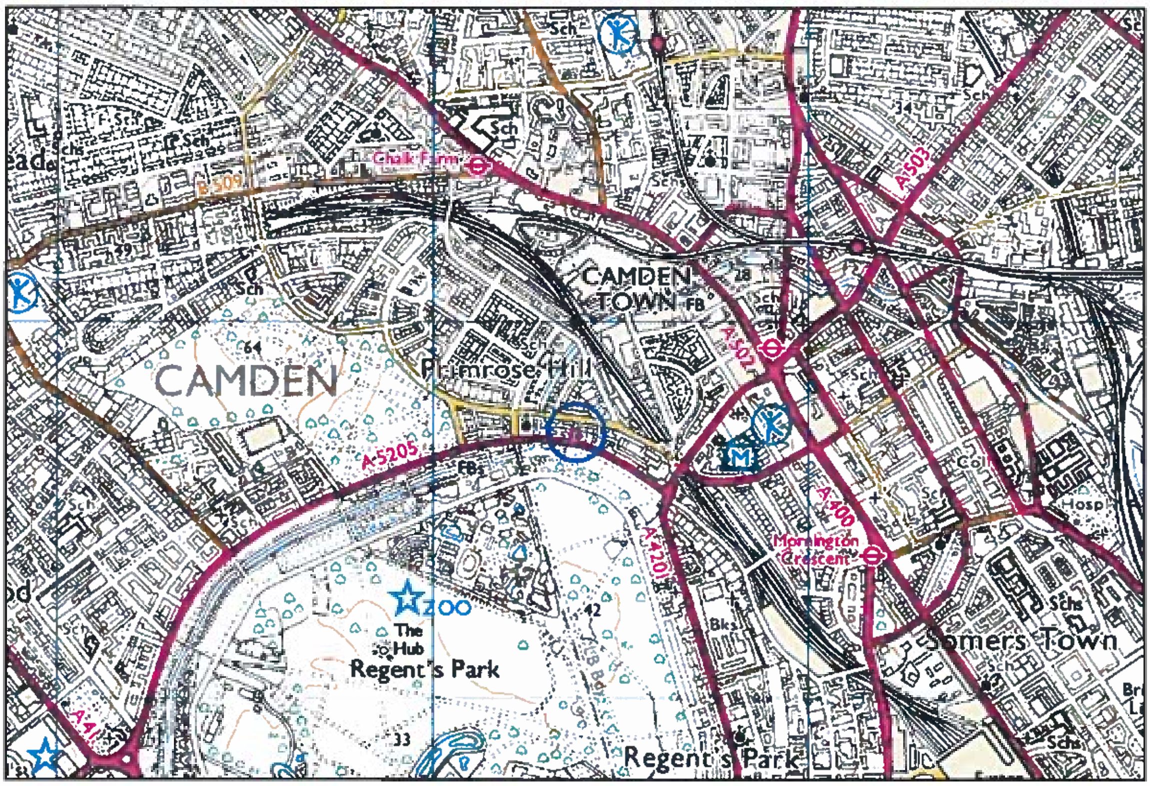
1 *Model Procedures for the Management of Land Contamination* issued jointly by the Environment Agency and the Department for Environment, Food and Rural Affairs (DEFRA) Sept 2004

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 along the northern side of Regent's Park in Primrose Hill, northwest London, approximately 550 m west of Camden Town London Underground station and 800 m south of Chalk Farm London Underground station. It fronts onto Prince Albert Road to the south and is bordered by semi-detached villas to the east and west and semi-detached townhouses to the north. It may be additionally located by National Grid Reference 528383,183698, as shown by the location map below.



The site is roughly rectangular in shape, measuring approximately 30 m north-south by 18 m east-west and is occupied by No 11 Prince Albert Road, a four-storey semi-detached Regency villa with single storey elevation at the rear of the house and partial lower ground floor, which is present under the western half of the existing building. The house is centrally positioned on the site with a hard covered driveway to the front and garden at the rear. The rear garden is approximately 2.5 m below the front of the site, is accessed via steps on the western side of the house and comprises a central lawn with bushes along the northern and western boundaries; a paved path runs along the back of the house and a small patio area is present in the east of the garden. There are a number of semi-mature and mature deciduous trees of up to 15 m in height located on the southern and western boundaries of the site.

The lower ground floor level is approximately 3.0 m below the level of the front driveway, but due to the sloping nature of the site, exits at garden level along the northern extent. A lightwell is also present along the southern and western extents of the lower ground floor, which is supported by brick built retaining walls.

Evidence of structural damage was noted on the house and a number of the other structures, with cracks seen on the main building, retaining walls and a number of the boundary walls. The site and surrounding area are essentially level at an Ordnance Datum (OD) level of approximately 34.0 m OD according to the most recent Ordnance Survey (OS) map.

2.2 Previous Desk Study

The desk study has indicated that the site has been developed with the existing house since at least 1875 and, along with the surrounding area, has remained essentially unchanged up to the present day. No potential off-site sources of contamination, including historical or existing landfill sites have been identified by the desk study, although an infilled section of the Regents Canal presents a theoretical risk of hazardous gases produced from the organic degradation of the fill materials. As however the canal was infilled in 1941, it is considered unlikely that high volumes of hazardous gas are still being produced.

The desk study concluded that there is considered to be a very low risk of significant contamination being present at the site that would result in a requirement remediation.

2.3 Other Information

The British Geological Survey (BGS) map of the area (Sheet 256) shows the site to be directly underlain by London Clay. GEA has previously carried out a ground investigation at 13 Albert Road, approximately 25 m to the west of the site. A single cable percussion borehole was advanced to a depth of 20 m and was supplemented by two window sampler boreholes which extended to a maximum depth of 6.0 m. The boreholes encountered a moderate thickness of made ground, to depths of between 0.5 m and 1.8 m, underlain by the London Clay Formation. The London Clay initially comprised firm brown mottled grey fissured clay which extended to the base of the window sampler boreholes and to 13.0 m in Borehole No 1. Below the weathered clay, stiff grey fissured clay was encountered and extended to the maximum depth investigated of 20.0 m.

The Regent's Canal lies in a relatively steep sided cutting roughly 45 m to the southwest of the site. The canal forms part of the Grand Union Canal and connects with the River Thames at Limehouse, 8.5 km to the southeast.

The underlying London Clay is classified as Unproductive Strata. The site does not lie within an Environment Agency designated Source Protection Zone (SPZ), but the Barrow Hill reservoir, located 700 m to the west of the site, is identified as a groundwater source. The site is not within an area indicated by the Environment Agency to be at risk from flooding.

In the aforementioned GEA investigation, seepage of groundwater was recorded at a depth of 4.0 m in one of the window sampler boreholes advanced from lower ground floor level. No other inflows were recorded in the other boreholes, particularly the deep borehole which was recorded to be dry to a depth of 20.0 m. A standpipe was installed to a depth of 7.0 m and was recorded to be dry during subsequent monitoring visits. In addition, GEA has carried out a number of other investigations in the area close to the site, none of which encountered groundwater within the London Clay.

3.0 EXPLORATORY WORK

In order to meet the objectives described in Section 1.2, three boreholes were advanced to a depth of 6.00 m using an opendrive percussive sampler (Terrier rig). Standard penetration tests (SPTs) were carried out at regular intervals in the borehole and disturbed samples were recovered for subsequent laboratory examination, geotechnical testing and contamination analysis.

Groundwater monitoring standpipes were installed in two of the boreholes to a depth of 6.0 m, and have been monitored on a two occasions to date. In addition to the boreholes, a series of eight trial pits was manually excavated adjacent to various elevations and boundary walls in order to determine the configuration and bearing stratum of existing foundations.

The borehole and trial pit records, along with the results of the laboratory analyses are appended, together with a site plan indicating the exploratory positions.

3.1 Sampling Strategy

The boreholes were positioned in accessible external locations determined by GEA and confirmed to avoid areas of known underground services. The trial pit locations were also selected by GEA, but agreed with the structural engineer prior to the fieldwork and then positioned on site as to avoid known buried services.

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

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

4.0 GROUND CONDITIONS

The investigation has confirmed the expected ground conditions in that, beneath a generally significant thickness of made ground, London Clay was encountered and proved to the full depth of the investigation.

4.1 Made Ground

The made ground extended to depths of between 0.40 m and 3.00 m, although the base of the made ground was not proved in a number of the trial pits excavated below lower ground floor level and to a depth of 1.1 m below ground level. It generally comprised an initial horizon of dark brown clayey silt with gravel, abundant roots, brick, concrete, coal, charcoal and chalk fragments.

Where the greater thicknesses of made ground were encountered, mainly in the boreholes, the initial horizon was underlain by brown mottled brownish grey silty clay with roots, gravel, concrete, brick, coal and charcoal fragments. This horizon was assessed as being re-worked London Clay and, within Borehole No 1, was noted to be stiff and assessed as being desiccated.

No visual or olfactory evidence of contamination was observed within these soils, although fragments of coal and charcoal and other extraneous material was noted within the made ground, which can commonly contain elevated concentrations of PAH, including benzo(a)pyrene and naphthalene. Four samples of the made ground have been analysed for a range of contaminants and the results are summarised in Section 4.4.

4.2 London Clay

This stratum comprised firm fissured initially orange-brown becoming brown mottled grey fissured clay with partings of orange-brown silt, bluish grey staining along fissures, selenite crystals, occasional white foraminifera and decayed roots and was proved to the maximum depth investigated, of 6.45 m In a number of the boreholes this stratum was found to include pockets of coarse selenite crystals and orange-brown fine sand and various depths.

Desiccation of the clay soils was not encountered during the investigation, which has been confirmed by laboratory plasticity index tests. These results have also confirmed the clay to be of high shrinkability with plasticity indices of between 48% and 57%. The natural soils were noted to be free from the evidence of any contamination.

4.3 Groundwater

Groundwater was not encountered during the drilling of the boreholes and monitoring of the standpipes on two occasions recorded each of them to be dry on each occasion. Groundwater was however encountered in a number of the trial pits, perched under the foundations, on top of the London Clay.

4.4 Soil Contamination

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

Determinant	BH2 at 0.5 m	BH3 at 0.6 m	TP2 at 0.4 m	TP6 at 0.4 m
Arsenic	30	**44**	**44**	37
Cadmium	0.75	2.00	0.45	0.54
Chromium	42	61	40	32
Copper	100	170	190	250
Mercury	1.4	2.4	2.5	1.6
Nickel	29	53	45	50
Lead	**1900**	**2000**	**2500**	**1900**
Selenium	<0.2	<0.2	<0.2	<0.2
Zinc	410	490	480	470
Total Cyanide	<0.5	<0.5	<0.5	<0.5
Total Phenols	<0.3	<0.3	<0.3	<0.3

Determinant	BH2 at 0.5 m	BH3 at 0.6 m	TP2 at 0.4 m	TP6 at 0.4 m
Sulphide	2.5	3.8	3.2	3.0
Total PAH	**13**	**26**	**8.3**	**16**
Benzo(a)pyrene	**0.99**	**2.30**	0.59	**1.3**
Naphthalene	0.67	1.1	1.6	1.7
TPH	19	30	35	30
Total Organic Carbon %	3.2	3.2	6.6	5.1
Figure in bold indicates concentration in excess of risk-based soil guideline values, as discussed in Part 2 of this report				

4.4.1 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 contaminants of concern are those that have values in excess of a generic human health risk based guideline values which are either that of the CLEA[2] Soil Guideline Value where available, or is a Generic Guideline Value calculated using the CLEA UK Version 1.06 software assuming a residential with plant uptake end use. The key generic assumptions for this end use are as follows:

- that groundwater will not be a critical risk receptor;
- that the critical receptor for human health will be 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.

It is considered that these assumptions are acceptable for this generic assessment of this site, which is underlain by unproductive strata. 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;

2 *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.

- 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.

A comparison of the measured concentrations against the generic screening values has indicated elevated concentrations of arsenic, lead and total PAH including benzo(a)pyrene within the made ground. This assessment is based upon the potential for risk to human health, which is considered to be the critical risk receptor.

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

4.5 Existing Foundations

Trial Pit Nos 1 and 2 were excavated adjacent to the western boundary wall, although from slightly different levels. They encountered a concrete and brick footing bearing on made ground at depths of 0.9 m and 1.0 m below ground level respectively. Trial Pit No 2 was also excavated adjacent to a small brick retaining wall, which was founded on made ground at 0.4 m. The northern boundary wall was found to be supported by a brick footing bearing on made ground at 0.9 m below ground level.

Trial Pit No 3 was excavated adjacent to the rear elevation of the existing house, which was found to be supported by a brick footing that extended away from the wall by 180 mm and was bearing on London Clay at a depth of 1.0 m. An identical brick footing was also encountered in Trial Pit No 5, which was excavated adjacent to the western elevation of the house, within the existing lightwell.

Trial Pit No 4 was also positioned along the northern elevation, although was terminated due to the presence of a 150 mm diameter pipe, which had been set in concrete 100 mm below ground level.

Trial Pit Nos 7 and 8 were positioned adjacent to the northern elevation within the lightwell and were excavated in order to assess the footings of both the house and the retaining walls around the extent of the existing lightwell. Trial Pit No 7 however was terminated on a concrete obstruction that spanned the width of the lightwell and was at least 250 mm thick. The concrete was not broken out in case it formed part of an existing footing. At the base of the retaining wall within this trial pit, what appeared to be new engineering bricks were identified. It is therefore possible that structural work, including possibly underpinning, has taken place to the either the retaining wall and / or the existing house. Trial Pit No 8 was also terminated at a shallow depth due to the presence of a relic brick structure, a concrete obstruction and a concrete surround to a surface drain.

Logs and photographs of the trial pits are included within 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 contamination issues.

5.0 INTRODUCTION

Consideration is being given to the extension of the existing lower ground floor, which will also include a single level basement. Proposed loads are not known at this stage but are anticipated to be relatively light to moderate.

6.0 GROUND MODEL

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

- Beneath a generally significant thickness of made ground, the London Clay is present;
- the made ground extends to depths of between 0.40 m and 3.00 m, with the lesser thicknesses being present in close proximity of existing foundations;
- the London Clay comprises a firm high shrinkability clay and was proved to the maximum depth investigated;
- a shallow groundwater table is not present below the site, although pockets of perched water are present trapped beneath existing foundations; and
- elevated concentrations of arsenic, lead and total PAH, including benzo(a)pyrene were measured within the made ground.

7.0 ADVICE AND RECOMMENDATIONS

The excavation for the proposed semi-basement structure will require temporary support to maintain stability of the existing and surrounding structures and to prevent any excessive ground movements. The formation level of the new basement at its maximum extent, is anticipated to be roughly 6 m below existing ground floor level, although will be approximately 3.0 m along the northern extent, due to the sloping nature of the site.

Based on the groundwater observations to date, significant groundwater inflows are not expected within the basement excavation.

Formation level for the proposed development will be within the London Clay, which should provide an eminently suitable bearing stratum for spread foundations excavated from basement level. Piled foundations or a basement raft would also provide suitable alternatives.

7.1 Basement Excavation

The excavation of the lower ground floor extension will require a maximum excavation of approximately 6.0 m at the front of the site, which, due to the sloping nature of the site, will reduce northwards to 3.0 m along the northern extent. Groundwater was not encountered during the drilling of the boreholes and the standpipes have been recorded to be dry on each occasion they have been monitored. Perched groundwater was however encountered in close proximity of existing foundations. Groundwater is therefore not anticipated to be encountered within the bulk excavation of the basement, but seepages of perched water maybe present. Such occurrences should be adequately dealt with using sump pumping. It would be prudent to continue to monitor the standpipes for as long as possible and it should be noted that groundwater seepages may occur within the London Clay, mainly along fissures and from within silt and sand pockets and partings. Given the low horizontal permeability and an even lower vertical permeability of the London Clay, such inflows would however be expected to be very slow and not prolonged.

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 building and surrounding structures and to protect against groundwater inflows. The choice of wall may be governed to a large extent by the access restrictions and whether or not it is to have load bearing function.

It is likely that the best method of constructing the basement retaining walls will be through the use of a bored piled wall, which could have the advantage of being incorporated into the permanent works and being able to provide support for structural loads. On the basis of the groundwater observations to date, it should be possible to adopt a contiguous bored pile wall, with the use of localised grouting and / or sump pumping if necessary in order to deal with minor groundwater inflows. A contiguous bored piled wall would however have the disadvantage of reducing usable space in the basement, and consideration could be given to the use of a secant wall, which would also overcome the requirement for any secondary groundwater protection in the permanent works and maximise the basement area.

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

7.1.1 Basement Retaining Walls

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

Stratum	Bulk Density (kg/m^3)	Effective Cohesion (c' – kN/m^2)	Effective Friction Angle (Φ' – degrees)
Made ground	1850	Zero	26
London Clay	1950	Zero	25

Groundwater is unlikely to be encountered within the excavation, although monitoring of the standpipes should be carried out to confirm the equilibrium levels. At this stage, it is recommended that the basement is designed with a water level assumed to be two-thirds of the basement depth, unless a fully effective drainage system can be ensured to prevent the build-up of surface water behind the retaining walls; the advice in BS8102:2009[3] should also be followed in this respect.

7.1.2 Basement Heave

The excavation of a 6 m thickness of soil will result in an unloading of approximately 120 kN/m^2, although this will reduce northwards across the excavation to approximately 55 kN/m^2 along the northern elevation. The unloading will result in heave of the underlying clay, which will comprise short term elastic movement and longer term swelling that will continue over a number of years. Given the variation in unloading, this will give rise to differential movement across the excavation area. These movements will be mitigated to some extent by pressure applied by the proposed structure, although it is considered that a more detailed analysis of the possible heave should be carried out, which will be undertaken once the basement design has been finalised.

7.2 Spread Foundations

Moderate width pad or strip foundations, excavated from basement level to bear in the firm clay, may be designed to apply a net allowable bearing pressure of 150 kN/m^2. This value incorporates an adequate factor of safety against bearing capacity failure and should ensure that settlement remains within normal tolerable limits.

If any shallow foundations are proposed in the northern half of the site, from lower ground floor level, spread foundations will need to be designed to bear at a minimum depth of 1.00 m, assuming that restrictions are applied on the planting of shrubs in the vicinity of foundations, or at a depth of 1.50 m if there is unrestricted planting of shrubs in the new development, subject also to the further restrictions on new tree planting as detailed in the NHBC guidelines.

Foundations will need to bypass the made ground and be deepened in the vicinity of existing and proposed trees in accordance with NHBC guidelines; high shrinkability clays 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. 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.

In addition to the above, foundations will need to extend beyond the depth of any desiccation. Desiccated of the natural clay soil has not been encountered during the investigation, although may exist in areas not investigated. It would therefore be prudent to have shallow foundation excavations within the zone of influence of trees inspected by a suitably experienced geotechnical engineer.

Care should be taken not to undermine or apply excessive additional pressure to existing foundations and consideration should be given to the installation of a movement joint between the existing structure and the new extension in order to prevent differential movement.

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

7.3 Basement Raft Foundation

The suitability of a raft foundation will depend on the net foundation pressure that will be applied following excavation of the basement and whether the structural loads can be relatively evenly distributed. If the use of a basement raft is to be considered, further analysis of likely movements will need to be carried out on the basis of the proposed loadings.

7.4 Piled Foundations

For the ground conditions at this site some form of bored pile is likely to be the most appropriate type. Given the likely absence of groundwater below the site, a conventional rotary augered pile may be appropriate, with temporary casing installed to maintain stability and prevent any perched groundwater inflows. The final choice of pile is likely to be dictated by the limited access.

A suitable borehole for pile design has not been advanced on site and therefore site specific parameters cannot be provided. However, based on our knowledge of the ground conditions in the area, it might be expected that a 300 mm diameter pile founding at a depth of 12 m below ground level should provide a safe working load of approximately 180 kN.

The above examples are not intended to constitute any form of recommendation with regard to pile size or type and whilst it would be beneficial to advance a deeper borehole on the site in order to provide site specific parameters for the design of piled foundations, specialist piling contractors should be consulted with regard to the design of a suitable piling scheme for this site.

7.5 Basement Floor Slab

Following the excavation of the basement, it should be possible to adopt a ground bearing floor slab bearing on the London Clay. Consideration will however need to be given to designing the slab to withstand heave and theoretical water pressure; further analysis will be carried out in this respect.

7.6 Effect of Sulphates

Relatively low concentrations of soluble sulphate have been measured in selected soil samples and therefore indicate that buried concrete should be designed in accordance with Class DS-2 conditions of Table C1 of BRE Special Digest 1: SD1 Third Edition (2005). The measured pH conditions are mildly alkaline and therefore on the basis of static groundwater conditions being assumed for buried concrete an ACEC classification of AC-1s may be adopted. The guidelines contained in the above digest should be followed in the design of foundation concrete.

7.7 Basement Impact Assessment Summary

The previous desk study and BIA identified three potential impacts of the development which comprised groundwater, the Regent's Canal, seasonal shrink-swell, the location of the public highway and founding depths relative to neighbours.

It was concluded that these impacts could be mitigated by appropriate design and standard construction practice, particularly with respect to seasonal shrink / swell and the stability of the highway. The canal is at sufficient distance and depth to be unaffected by the development.

It was concluded that standard safe working practices and measures that will be adopted to construct the basement mean that the proposed development is unlikely to result in any specific groundwater, surface water, land or slope stability issues. It is however proposed to carry out a ground movement analysis, once the design has been finalised.

7.8 Site Specific Risk Assessment

The chemical analyses have highlighted elevated concentrations of arsenic, lead and total PAH, including benzo(a)pyrene within the made ground. These concentrations could thus pose a potentially unacceptable risk to human health through direct contact, accidental ingestion or inhalation of soil or soil derived dust.

Although the exact source of the contamination is unknown, fragments of coal and other extraneous material were noted within the made ground and relatively high levels of lead and other metals are common within fill materials in London, which have usually been derived from demolition material. Further analysis of the speciated PAH results has indicated that the contamination is likely to be of pyrogenic origin and therefore results from the partial combustion of hydrocarbons. Fragments of coal and charcoal, along with variable amounts of other extraneous material, were encountered within the made ground and it is therefore likely that fragments of such material were present within the samples tested and therefore form the source of both the PAH and the metallic contamination.

The excavation of the basement and construction of the extension is likely to remove the majority of the made ground and the presence of the proposed structure across the majority of the existing garden area, along with the existing driveway at the front of the site, will form a permanent barrier between end users and the underlying soil. However, in the remaining areas of any proposed soft landscaping, end users could conceivably come into contact with the contamination. The contamination also poses a risk to site workers in the short term, as discussed below.

8.7.1 End Users

In areas of soft landscaping, end users could come into contact with the soil contamination via direct soil and indoor dust ingestion, consumption of homegrown produce, consumption of soil adhering to homegrown produce and skin contact with soils and dust. In the absence of further testing, suitable precautions will need to be taken in order to protect end users and to allow successful plant growth. At this stage it is recommended that a cover thickness of imported subsoil and topsoil of 600 mm is imported into the soft landscaping areas, in accordance with recommendations from BRE[4]. The upper 150 mm will need to be classified as topsoil, in accordance with BS3882:2007. It may be possible to reduce the final thickness of cover required, but this will need to be determined once final levels have been established and the concentrations of potential contaminants within the imported material are known. Any soil that is brought onto site will need to be certified as 'clean' with the appropriate documentation.

8.7.2 Site Workers

Elevated concentrations of potentially toxic arsenic and lead, and carcinogenic hydrocarbons have been measured within the made ground. Site workers should be made aware of the contamination and a programme of working should be identified to protect workers handling

4 BRE (2004) *Cover systems for land regeneration. Thickness of cover systems for contaminated land.* BRE pub 465

any soil. The method of site working should be in accordance with guidelines set out by HSE[5] and CIRIA[6] and the requirements of the Local Authority Environmental Health Officer.

7.9 Waste Disposal

Any spoil arising from excavations or landscaping works, which is not to be re-used in accordance with the CL:AIRE guidance[7], will need to be disposed of to a licensed tip. Under the European Waste Directive, waste is classified as being either Hazardous or Non-Hazardous and landfills receiving waste are classified as accepting hazardous or non-hazardous wastes or the non-hazardous sub-category of inert waste in accordance with the Waste Directive. Waste going to landfill is subject to landfill tax at either the standard rate of £64 per tonne (about £120 per m^3) or at the lower rate of £2.50 per tonne (roughly £5 per m^3). However, the classifications for tax purposes and disposal purposes differ and currently all made ground and topsoil is taxable at the 'standard' rate and only naturally occurring rocks and soils, which are accurately described as such in terms of the 2011 Order[8], would qualify for the 'lower rate' of landfill tax.

Based upon on the technical guidance provided by the Environment Agency[9] it is considered likely that the made ground from this site, as represented by the four chemical analyses carried out, would be classified as NON-HAZARDOUS waste under the waste code 17 05 04 (soils and stones not containing dangerous substances) and would be taxable at the standard rate. It is likely that the natural soils, if separated out, could be classified as an INERT waste also under the waste code 17 05 04. This material would be taxable at the lower rate, if accurately described as naturally occurring clay in terms of the 2011 Order on the waste transfer note. As the site has never been developed or used for the storage of potentially hazardous materials, it is likely that WAC leaching tests would not be required for such inert waste going to landfill. This would however need to be confirmed by the receiving landfill site.

Under the requirements of the European Waste Directive all waste needs to be pre-treated prior to disposal. The pre-treatment process must be physical, thermal, chemical or biological, including sorting. It must change the characteristics of the waste in order to reduce its volume, hazardous nature, facilitate handling or enhance recovery. The waste producer can carry out the treatment but they will need to provide documentation to prove that this has been carried out. Alternatively, the treatment can be carried out by an approved contractor. The Environment Agency has issued a position paper[10] which states that in certain circumstances, segregation at source may be considered as pre-treatment and thus excavated material may not have to be treated prior to landfilling if the soils can be "segregated" on site by sufficiently characterising the soils insitu prior to excavation.

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

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

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

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

8 *Landfill Tax (Qualifying Material) Order 2011*

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

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

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

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

8.0 OUTSTANDING RISKS AND ISSUES

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

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

It should be noted that the pile design parameters given within this report are based on the results of nearby boreholes and are not site specific. Ideally a deep borehole would be advanced on the site, although in any case a specialist piling contractor should be consulted with regard to the design of a suitable piling scheme for this site.

It is recommended that continued monitoring of the standpipes installed in the boreholes is carried out.

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

APPENDIX

Borehole Records

SPT Summary Sheet

Trial Pit Record

Geotechnical Test Results

Mositure Content / Depth Graph

Contamination Test Results

Generic Guideline Values

Site Plan

GEA Geotechnical & Environmental Associates

Tyttenhanger House
Coursers Road
St Albans
AL4 0PG

Site 11 Prince Albert Road, London NW1 7SR					**Number** BH1
Excavation Method Opendrive Percussive Sampler (Terrier rig)	**Dimensions**	**Ground Level (mOD)**	**Client** Harrison Varma		**Job Number** J14004
	Location	**Dates** 15/01/2014	**Engineer**		**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.30	D1				(1.00)	Made Ground (dark brown clayey silt with gravel, abundant roots, brick, concrete, coal, charcoal and chalk fragments)			
1.00-1.45	SPT N=10		1,1/2,2,2,4		1.00	Made Ground (brown mottled brownish grey silty clay with roots, gravel, concrete, shell and coal fragments) - Reworked London Clay - Desiccated Soil			
1.00	D2								
1.50	D3				(0.90)				
2.00-2.45	SPT N=11		1,2/2,2,3,4		1.90	Firm fissured initially orange-brown becoming brown silty CLAY with partings of orange-brown silt, bluish grey staining along fissures, selenite crystals, occsaional white forminerra and decayed roots			
2.00	D4								
2.50	D5								
3.00-3.45	SPT N=14		2,2/3,3,4,4						
3.00	D6								
3.50	D7								
					(4.10)	pocket of coarse selenite crystals at 3.9 m			
4.00-4.45	SPT N=13		1,2/2,3,3,5						
4.00	D8								
4.50	D9								
						pocket of fine orange-brown sand at 4.8 m			
5.00-5.45	SPT N=16		1,2/4,3,4,5						
5.50	D10					pocket of fine orange-brown sand at 5.5 m			
6.00-6.45	SPT N=17		2,3/3,4,5,5		6.00				
						Complete at 6.45m			

Remarks
Groundwater not encountered.
Groundwater monitoring standpipe installed to 6.00 m.

Scale (approx)	Logged By
1:50	ML

Figure No. J14004.BH1

Geotechnical & Environmental Associates	Tyttenhanger House, Coursers Road, St Albans, AL4 0PG	Site: 11 Prince Albert Road, London NW1 7SR	Number: BH2

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Opendrive Percussive Sampler (Terrier rig)			Harrison Varma	J14004
	Location	**Dates**	**Engineer**	**Sheet**
		15/01/2014		1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
						Made Ground (dark brown clayey silt with gravel, abundant roots, brick, concrete, coal, charcoal and chalk fragments)		
					(0.90)			
0.50	D1							
					0.90	Made Ground (crushed brick)		
1.00-1.45	SPT N=7		3,3/2,2,1,2		(0.50)			
					1.40	Made Ground (brown silty clay with gravel, roots, brick, coal and charcoal fragments) - Reworked London Clay		
1.50	D2				(0.40)			
					1.80	Firm fissured brown silty CLAY with partings of orange-brown silt, bluish grey staining along fissures, selenite crystals and decayed roots		
2.00-2.45 2.00	SPT N=12 D3		1,2/2,2,4,4					
3.00-3.45 3.00	SPT N=15 D4		1,2/3,3,4,5					
4.00-4.45 4.00	SPT N=14 D5		1,1/3,3,4,4		(4.65)			
5.00-5.45 5.00	SPT N=18 D6		2,2/3,4,5,6					
6.00-6.45 6.00	SPT N=19 D7		2,2/4,4,5,6					
					6.45			
						Complete at 6.45m		

Remarks	Scale (approx)	Logged By
Groundwater not encountered.	1:50	ML
	Figure No. J14004.BH2	

GEA Geotechnical & Environmental Associates

Tyttenhanger House
Coursers Road
St Albans
AL4 0PG

Site	Number
11 Prince Albert Road, London NW1 7SR	BH3

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Opendrive Percussive Sampler (Terrier rig)			Harrison Varma	J14004
	Location	**Dates** 15/01/2014	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
					(0.50)	Made Ground (pea shingle over crushed hardcore)			
					0.50				
0.60	D1					Made Ground (brown becoming brownish grey silty clay with gravel and brick fragments) - Reworked London Clay			
1.00-1.45	SPT N=9		2,2/2,2,2,3						
1.00	D2				(1.50)				
1.50	D3								
					2.00				
2.00-2.45	SPT N=10		1,1/2,3,2,3			Made Ground (grey silty clay with fine gravel and a slight organic odour)			
2.00	D4								
2.50	D5				(1.00)				
					3.00				
3.00-3.45	SPT N=12		1,2/2,2,3,5			Firm fissured brown silty CLAY with partings of orange-brown silt, selenite crystals, occasional white forminerra and decayed roots			
3.00	D6								
3.50	D7								
4.00-4.45	SPT N=14		2,2/3,3,4,4						
4.00	D8								
4.50	D9				(3.00)				
5.00	D10								
5.50	D11								
6.00	D12				6.00				
						Complete at 6.00m			

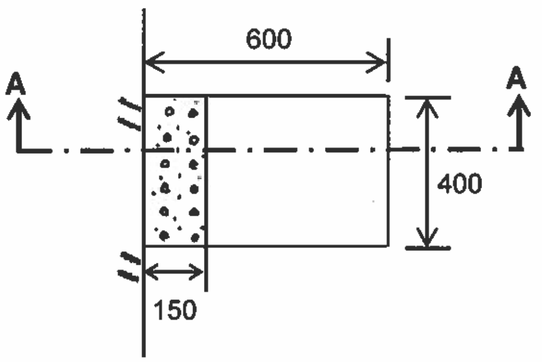
Remarks
Groundwater not encountered.
Groundwater monitoring standpipe installed to 6.0 m.

Scale (approx)	Logged By
1:50	ML

Figure No. J14004.BH3

GEA Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans Herts AL4 0PG		Site 11 Prince Albert Road, London NW1 7SR	Trial Pit Number 1
Excavation Method Manual	Dimensions 600 x 400 x 900	Ground Level (mOD)	Client Harrison Varma	Job Number J14004
	Location	Dates 15/01/2014	Engineer	Sheet 1 / 2

Plan: -



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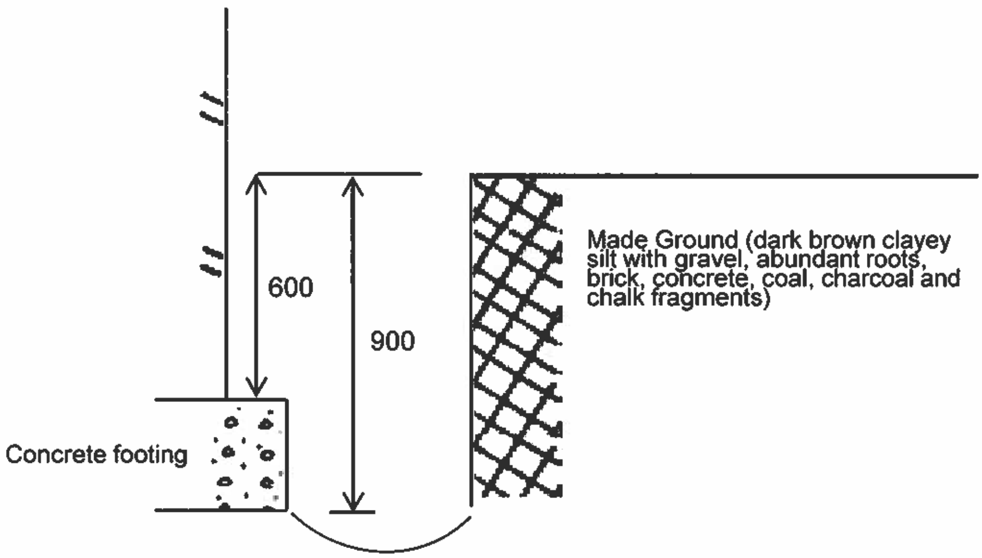


Remarks:	Scale:
All dimensions in millimetres	1:20
Sides of trial pit remained stable during excavation	Logged by:
Groundwater: Not encountered	ML

GEA Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans Herts AL4 0PG	Site 11 Prince Albert Road, London NW1 7SR	Trial Pit Number 1

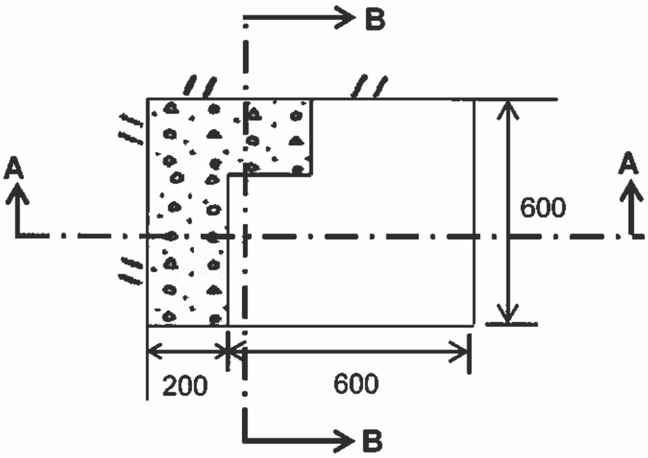
Excavation Method Manual	Dimensions 600 x 400 x 900	Ground Level (mOD)	Client Harrison Varma	Job Number J14004
	Location	Dates 15/01/2014	Engineer	Sheet 2 / 2

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

Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans Herts AL4 0PG	Site 11 Prince Albert Road, London NW1 7SR	Trial Pit Number 2

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Manual	800 x 600 x 1000		Harrison Varma	J14004
	Location	**Dates**	**Engineer**	**Sheet**
		15/01/2014		1 / 3

Plan: -



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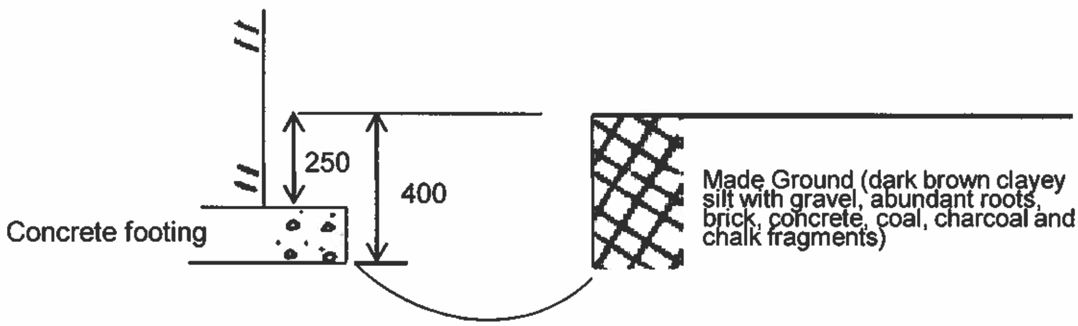
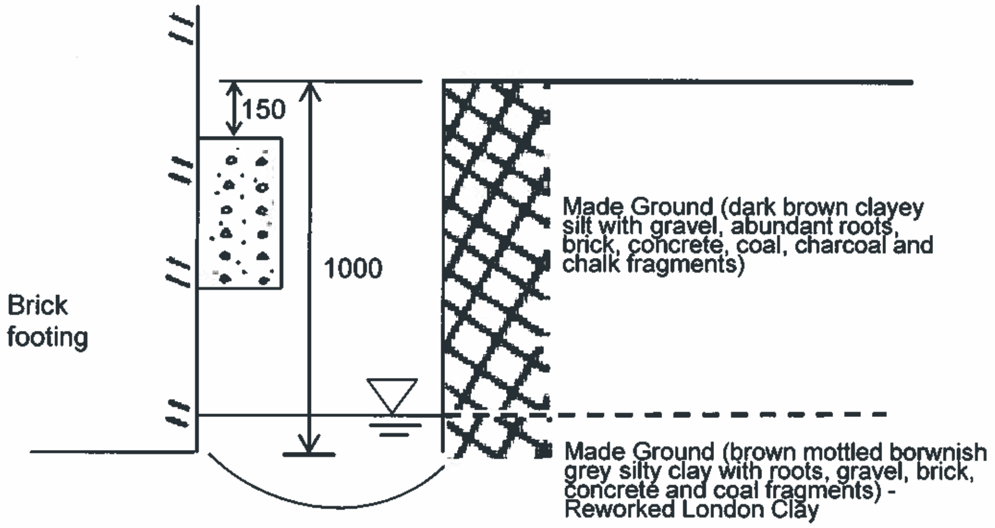


Remarks:		Scale:
All dimensions in millimetres	Sample: 0.4 m	1:20
Sides of trial pit remained stable during excavation		Logged by:
Groundwater: perched at 0.9 m		ML

GEA Geotechnical & Environmental Associates	Tyttenhanger House Coursers Road St Albans Herts AL4 0PG		Site 11 Prince Albert Road, London NW1 7SR	Trial Pit Number 2
Excavation Method Manual	Dimensions 800 x 600 x 1000	Ground Level (mOD)	Client Harrison Varma	Job Number J14004
	Location	Dates 15/01/2014	Engineer	Sheet 2 / 3

Section B - B: -



Remarks:		Scale:
All dimensions in millimetres	Sample: 0.4 m	1:20
Sides of trial pit remained stable during excavation		Logged by:
Groundwater: perched at 0.9 m		ML