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Wallace House
Fitzroy Park, London, N6 6HT

Structural and Civil Engineering Planning Report

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Document Control

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revision:	P1	prepared by:	Theo Williamson	checked by:	Adam Smith	approved by:	Graham Starling
date:	July 2017	signature:	TWi	signature:	ASm	signature:	GSt

Contents

Appendices

1.0 Non-Technical Summary

1.1 The following report has been prepared to show that the property and neighbouring properties will be safeguarded during the works. This report follows the guidance given in the Camden Planning Guidance on Basements and Lightwells CPG4. This assessment has been prepared in accordance with the guidance given in CPG4, DP23 and DP27.

1.2 If the recommended measures and sequence of works outlined in this report are properly undertaken by a suitability qualified contractor, the development should not pose any significant threat to the structural stability to the property, the adjacent properties, or surrounding grounds.

1.3 The Hydrological, Geotechnical and Ground Movement Assessment and Basement Impact Assessment (BIA) prepared by GEA predicts damage to the neighbouring properties would be 'negligible' (category 0 as set out in CIRIA Report 580 respectively).

1.4 Elliott Wood Partnership Ltd. (EW) will have an on-going role during the works on site to see that the structural works are being carried out generally in accordance with our design and specification. This role will typically involve weekly site visits at the beginning of the project and fortnightly thereafter.

2.0 Introduction

2.1 EW is a firm of consulting structural engineers approximately 120 strong operating from their head office in South West London, Central London and Nottingham. Residential developments of all scales have been central to the workload of the practice with many in the Greater London area. In particular Elliott Wood Partnership Ltd. has been producing designs for basements to both existing and new buildings. To date this numbers approximately 500 sites, many of which have been in the London Borough of Camden. Our general understanding of the development of London, its geology and unique features together with direct experience on many sites puts us in a strong position to advise clients on works to their buildings and in particular the design and construction of their basement.

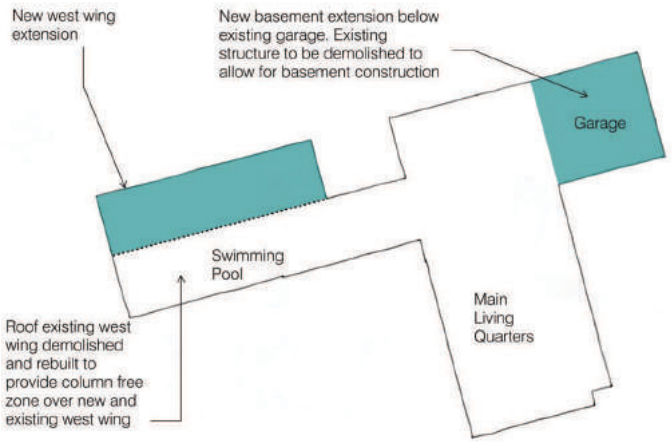
2.2 EW are appointed by the building's owner Derrick Dale to advise on the structural implications of the proposed refurbishment works to this 3 storey residential property, which is T shaped on plan. The site is located on the outskirks of Hampstead Heath on Fitrzroy Park. The works involves:
- Construction of a new basement underneath the existing existing garage at the east.
- Extending the west wing of the building currently housing the swimming pool area.

2.3 EW were the structural engineers who designed the original structure in 1999, and so have good knowledge and extensive archive drawings on the existing design.

2.4 A site investigation has been undertaken by geotechnical and environmental specialists GEA. This included 7 trial pits, 2 window samples and a cable percussion borehole. The information from this has been used to inform the structural design and GEA's Ground Movement Assessment (GMA) and Basement Impact Assessment (BIA).

2.5 This report outlines the proposed subterranean works and their construction. It should be read in conjunction with the detailed set of drawings showing the existing site, buildings and proposed works by SOUP Architects, together with the proposed structural drawings appended to this report.

Site Location Plan



Keyplan of existing building and alterations

3.0 Description of Existing Building and Site Conditions

3.1 The site is accessed by Fitzroy Park to the north. It shares a boundary with The Little House to the northeast and Fitzroy Farm Coach House to the north, Dormers to the east and The Water House to the south. The site slopes down towards the south west.

3.2 The building is not listed however it is in the Highgate Village Conservation Area in the London Borough of Camden.

3.3 The house is two storeys above ground level, with a basement (lower ground floor) partially built into to the slope of the site.

3.4 The site is understood to have originally formed part of the grounds to Fitzroy Park Farm, and appears to have been occupied by a small outhouse until 1999 whereby the current development was built.

3.5 British Geological Survey maps show the site is underlain by London Clay Formation. The borehole and window samples carried out show around 1m of made ground over generally firm-to-stiff fissured London Clay.

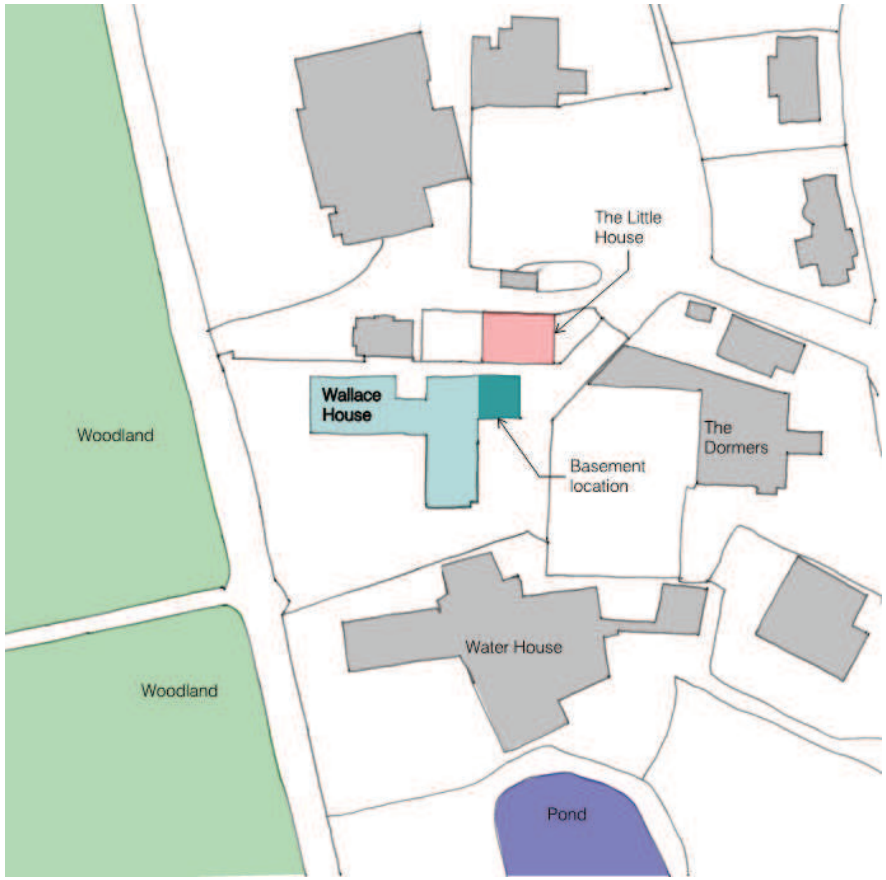
3.6 The geological maps of the area indicate that there are some areas of Claygate beds to the north east of the site. The London Clay is defined as a non-aquifer, the Claygate member is defined as a minor aquifer. The London Clay effectively acts as a barrier to flow to the lower chalk major aquifer. Perched water is therefore likely to occur at the surface in the form of springs at the boundary between the Claygate member and the impermeable London Clay. London Clay has been proved directly below the made ground on this site and therefore springs associated with the boundary condition noted above do not occur, although near surface flows could be present in the made ground. Near surface water flow will be in a down slope direction Westerly or South-Westerly towards the Highgate ponds. Water flow within the London Clay is likely to be very slow.

3.7 The site lies outside the catchment of the Hampstead Heath chain of ponds but is located close to a tributary of the Highgate Chain of Ponds formally known as Highgate Brook. There are no Environment Agency (EA) designated Source Protection Zones on the site and no listed water abstraction points within 500m. The site is also not located in an area at risk of flooding as defined by the EA.

3.8 There are a number of trees within and adjacent to the site which affect the foundation strategy. Refer to the Arboricultural Report by Crown Consultants for further information.

3.9 The building is formed of a reinforced concrete (RC) groundfloor slab, steel framed superstructure and timber suspended floors. Where the building cuts in to the ground, retaining walls are formed of RC. The structure is founded on piles to suit the local clay ground conditions, surface water flow and trees.

3.10 The overall stability is provided by the diaphragm action of the timber joisted floors carrying horizontal loads to RC shear walls and blockwork walls. The steel frame also contributes as a sway frame on the western wing.



Keyplan of existing building and adjacent properties

4.0 Proposed Works

4.1 The proposals are to install a new extension to the west wing, and form a new basement below the garage.

4.2 The existing western wing roof is to be demolished, and replaced with a new steel roof with timber infill, which extends over both the new and existing wings. The ground floor to the western wing extension is to be formed of a suspended RC slab founded on piles. Clayboard (or similar) is to be used to protect the slab from ground movements. The slab is to be tied to the existing using dowels.

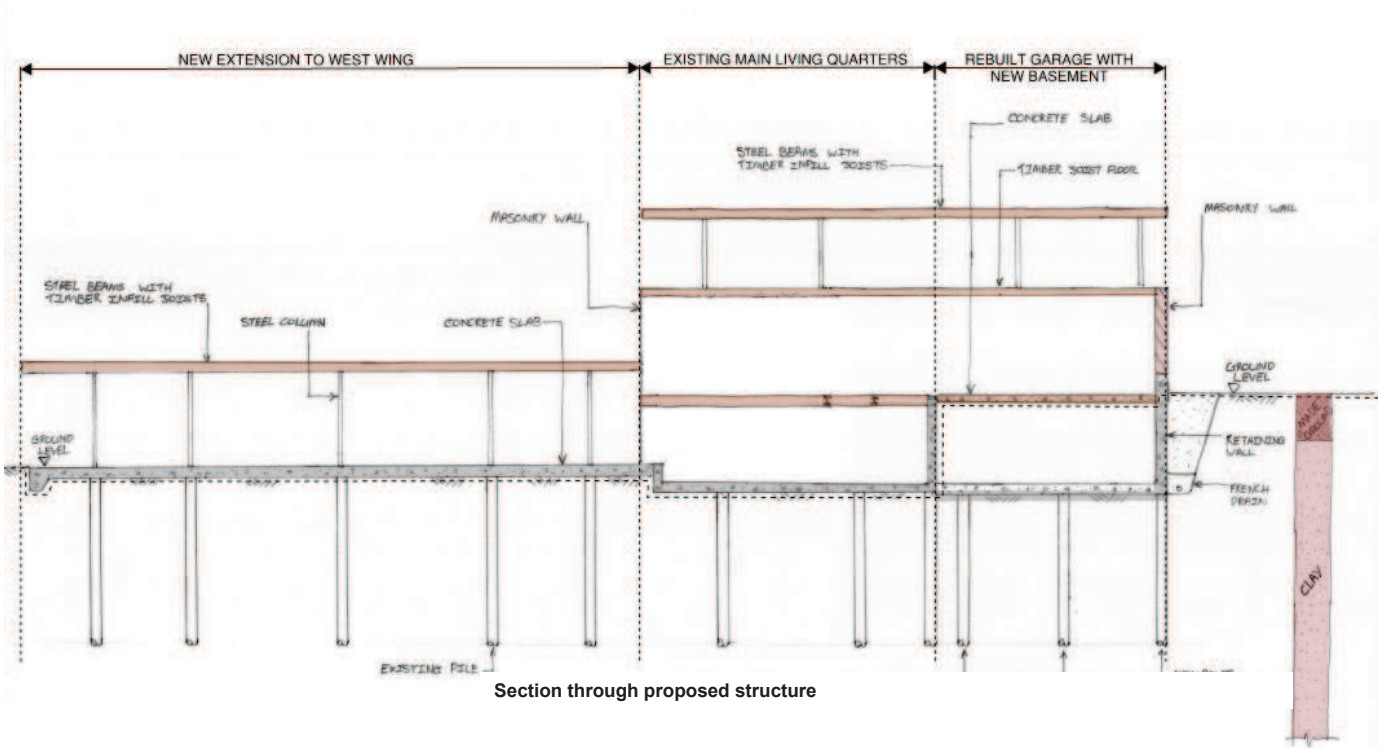
4.3 The roof to the west wing is to be formed of a grillage of steel beams with timber infill supported off steel columns. The columns are to be founded on new piles in the extension, and off existing ground beams in the existing wing. An assessment of the capacity of these ground beams is required to justify the new column loads. Strengthening works or steel transfer grillage at ground floor level may be required.

4.4 The existing garage is to be demolished to facilitate the construction of the new basement structure below. Existing piled foundations are to be broken down to accommodate the new basement, but are not to be used to support the new building because of their reduced capacity. The new basement is to be formed of an RC box founded on new piles, and is to be tied to the adjacent existing structure using dowels. Clayboard (or similar) is to be used to protect the slab from ground movements.

4.5 The superstructure to the garage is to be formed of blockwork walls and steel beams with timber infill.

4.6 A French drain is to be installed around the perimeter of the new basement to manage surface water flows. Refer to Section 5.0 for further information.

4.7 The waterproofing strategy is to be consistent with the existing construction (expected to be external tanking and waterproof concrete) to maintain continuity in the waterproof lining. It is to be designed by a specialist sub-contractor will be adopted.



Section through proposed structure

5.0 Hydrological and Hydrogeological Summary

5.1 EW were involved in the original design and construction of the existing Wallace House and as a result have a detailed and unique knowledge of the geology and hydrology of this site. This experience and knowledge backed up with the detailed site investigation that was undertaken forms the basis for our understanding the existing site conditions.

5.2 In order to build the extended reinforcement concrete basement, the surrounding ground will be battered back at an angle of 60 degrees to ensure the soil remains stable during construction. Temporary surface water flow will be dealt with via gravity drainage and temporary pumping from sumps. In the permanent case the void between the battered back ground and retaining structure will be filled with compacted hardcore to form the French drain which will allow the free passage of surface water around and beneath the basement slab.

5.3 This will be formed by replicating the existing structural arrangement and forming a three sided retaining structure with external tanking/drainage back filled with free draining material. The void below the suspended slab will allow for any near surface water percolation to flow under the building. An external drain at low level will also connect to the land drainage scheme and connect to the existing landscaped pond within the garden.

5.4 The site as a whole has a strategic Surface Water Management System that was built as part of the construction of the Wallace House c. 1999. This system included a number of surface water drains that drain into a pond with an overflow into the ditch. This replicates the original arrangement when excess water would have flowed into the ditch on Millfield Lane.

5.5 The current system has been shown to work successfully with no reported incidents from either the current or previous owners. The new extension will connect to this system using the tried and tested features and details of the previously constructed building. There is unlikely to be any significant change in the ground water regime from the extension and as a result the existing Surface Water Management System will continue to function.

6.0 Proposed Below Ground Drainage

6.1 At ground level the building is to be extended by approximately 15m² from the west wing extension. The new section of building is proposed have a flat roof with a green roof system provided, as well as over the existing west wing. The use of this form of roofing system has many benefits which include:

- Lowering the peak water runoff in lower intensity storms
- Reducing the overall annual volume of water draining from the roof
- Improve the thermal performance of the building
- Provides protection to the roofs waterproofing
- Enhances biodiversity

6.2 The rainwater will then be directed via the existing downpipes into the drainage system which passes via the existing balancing pond. It is considered that by providing a substantial element of green roof, and passing through the balancing pond that this acts as a suitable offset to the slight increase in drained roof area.

7.0 Party Wall Matters

7.1 The proposed development falls within the scope of the Party Walls Act 1996. Procedures under the Act will be dealt with in full by the Employer's Party Wall Surveyor. The Party Wall Surveyor will prepare and serve necessary Notices under the provisions of the Act and agree Party Wall Awards in the event of disputes. The Contractor will be required to provide the Party Wall Surveyor with appropriate drawings, method statements and other relevant information covering the works that are notifiable under the Act. The resolution of matters under the Act and provisions of the Party Wall Awards will protect the interests of all owners.

7.2 The designs for Wallace House will be developed so as not to preclude or inhibit any works on the neighbouring properties. This will be verified by the Surveyors as part of the process under the Act.

8.0 Sustainability

8.1 With regards to a sustainable design, in addition to the SuDS considerations already discussed, various options for the superstructure construction can be explored, such as the use of recyclable aggregates and cement replacement.

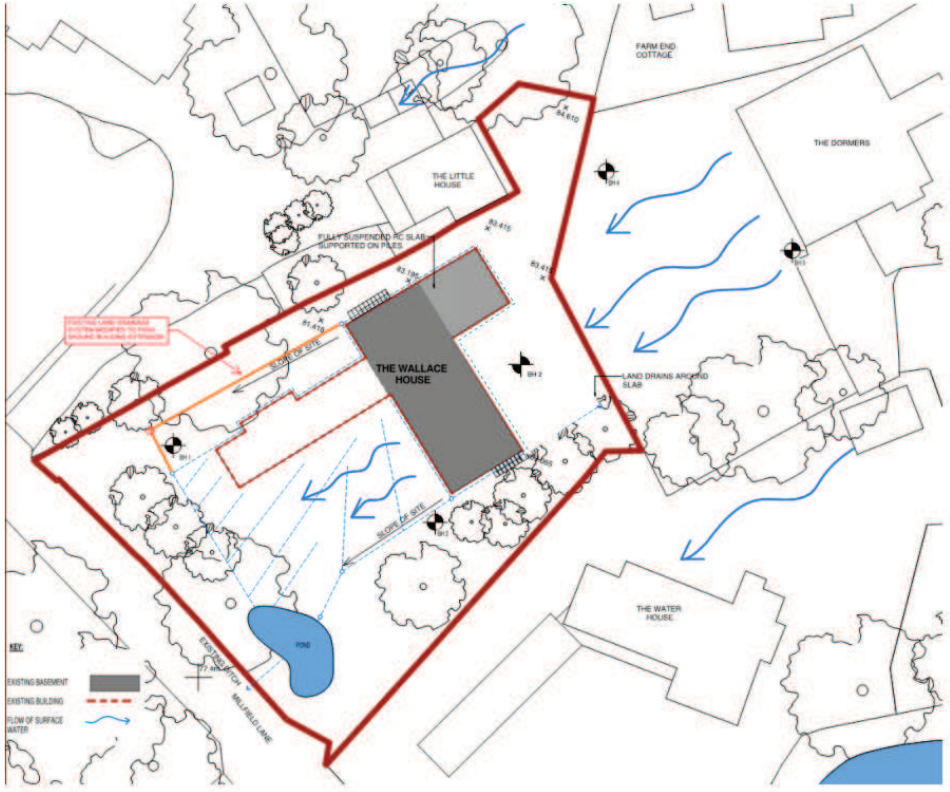
9.0 Ground Movement Assessment

9.1 Although basement construction inevitably results in some ground movement, the structural design has been developed with the safeguarding of this building and other adjacent properties in mind. The design of the RC walls; the sequence of construction and the permanent restraint to the walls have all been carefully considered and designed to control and minimise the ground movements.

9.2 Given their relative proximity to the build, a Ground Movement Assessment (GMA) has been carried out to quantify the impact of the proposals on the adjacent Little House building. Other adjacent properties are over 8m from the proposed basement works, so a GMA on has not been carried out for these properties. Refer to the report provided by GEA outlining the GMA and BIA.

9.3 We have produced a summary of the anticipated loads for the proposed works and these have been inputted into the ground movement assessment. The assessment takes into account both the long and short term effects of the proposed basement and it has shown that the settlement is within acceptable limits. Furthermore, the category of damage to The Little House in accordance with C580 is category 0 (Negligible).

9.4 GEA have concluded that with good workmanship including stiff propping/bracing to the excavations, the proposed basement to Wallace House can be constructed without imposing more than a 'negligible" level of damage to The Little House and the adjoining properties.



10.0 Structural Monitoring

10.1 It is anticipated that the Contractor shall provide monitoring to all structures and infrastructure adjacent to the basement excavation at the time of excavation and construction. However, this is to be agreed with the party wall surveyors.

10.2 Monitoring shall be completed as follows:

a) One month prior to any works being started to provide a base reading.

b) At the start and end of every shift during the excavation and until the ground floor slab has been cast.

c) On a monthly basis thereafter for a 6 month period following completion of the notifiable works.

10.3 Cumulative movement of survey points must not exceed:

	Code amber trigger values	*Code red trigger values*
Settlement	+/-4mm	+/-8mm
Lateral displacement	+/-4mm	+/-8mm

10.4 When movement approaches critical values, the following steps are to be taken:

Code amber trigger value:

All interested parties, including the Adjoining Owner's Surveyor and his Engineer should be informed and further actions immediately agreed between Surveyors and implemented by the Building Owner. Notwithstanding the Party Wall requirements, the Contractor is to appoint, and to have permanently on site, a suitably qualified Structural Engineer who will be responsible for the reviewing of the movement monitoring results at the start and end of each day and provide immediate advice, remedial works and design as necessary in the event of movement being noted. The Contractor is to ensure that he has 24 hour/7 days a week access to emergency support provision including but not limited to additional temporary props, needles, waling beams and concrete supply at the start of the excavation and prior to any likelihood of this trigger value being reached. If this value is reached the Contractor, and his Engineer, must without delay provide all interested parties with his plan to implement any emergency remedial and supporting works deemed necessary. The Contractor must be ready to carry out these works without delay if the movement continues and approaches the trigger value below.

Code red trigger value:

All interested parties including Adjoining Owner's Surveyor and Engineer will be informed immediately. Works will stop and be made safe using methods and equipment agreed at the above stage. The Contractor is to ensure that the movement has stopped as a result of the implemented remedial works designed and installed at this stage. The requirements of the Party Wall Act will also ensure that, Surveyors and their advising Engineers shall then enter into an addendum Award, setting out whether or not the Building Owner's works can re-commence and when, and if so agree additional precautions or modifications to the proposals prior to re-commencement.

11.0 Conclusion

11.1 The proposed works involve the demolition of an existing two storey garage structure and the construction of a new single storey basement under the existing footprint. A new single storey extension to the west wing is also proposed.

11.2 A GMA and BIA have been carried out by geotechnical specialists GEA, and concluded that the proposed development is unlikely to result in any specific land or slope stability issues, groundwater or surface water issues. The GMA also showed that proposals are not expected to have a significant adverse impact on the adjacent properties.

11.3 The design of substructure has been carefully considered to account for the local ground conditions, nearby trees and surface water flow.

11.4 The site is within Flood Zone 1 as defined by the EA so it is unlikely that it needs a Flood Risk Assessment.

11.5 SuDS are to be incorporated in to the drainage system, and options for sustainable construction of the structure are also to be considered.

11.6 The measures and sequence of works outlined in this report and the following Construction Method Statement are to be taken into account in the eventual design and construction of the proposed works.

11.7 Detailed method statements and calculations for the enabling and temporary works will need to be prepared by the Contractor for comment by all relevant parties including party wall surveyors and their engineers. Adequate supervision and monitoring is to be provided throughout the works particularly during the excavation and demolition stages.

11.8 EW will have an on-going role during the works on site to see that the works are being carried out generally in accordance with the design and specification. This role will typically involve weekly site visits at the beginning of the project and fortnightly thereafter. A written site visit record is to be provided to the design team, Contractor and Party Wall Surveyor following each site visit.

11.9 The undertaking of such projects to existing buildings is specialist work and EW will be involved in the selection of an appropriate Contractor who will need the relevant expertise and experience for this type of project.

Subterranean Construction Method Statement

12 Subterranean Construction Method Statement

The proposed works involves the construction of a new lower ground floor level set partially into the ground. Some of the issues that affect the sequence of works on this project are:

- The stability of adjacent buildings;
- The stability of the surrounding ground including the adjacent gardens;
- Providing a safe working environment.

Refer to the Construction Management Plan (CMP) for details of hoarding, access, holding areas and the principles for the removal of spoil.

Note that the final CMP and overall sequence is to be agreed with the Contractor after final proposals have been agreed.

Tree Protection methods are to be agreed and installed to all retained trees where required. Refer to the Arboricultural Impact Assessment Report prepared by Crown Consultants.

12.1 Assumed Sequence of Construction

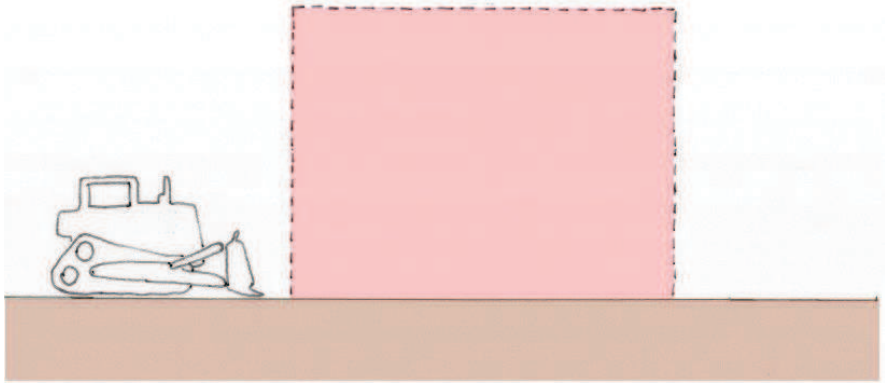
Stage 1: Site set-up and enabling works

Erect a security fence and hoarding around the site, and set up a delivery/holding area.

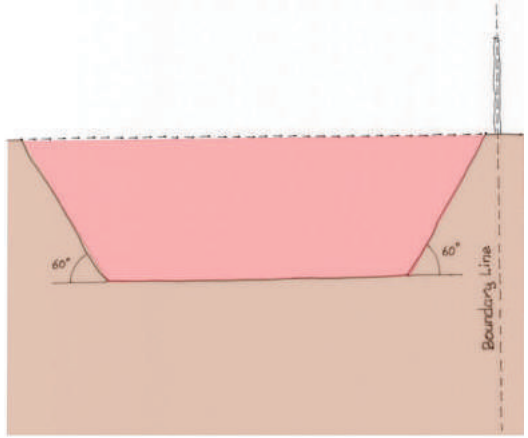
Identify and isolate all services within the site as necessary. All below ground obstructions should also be removed to allow the works to progress.

Install monitoring system to the adjoining buildings and calibrate. The adjacent properties should be closely monitored for movements and the results logged and recorded at regular intervals throughout the works.

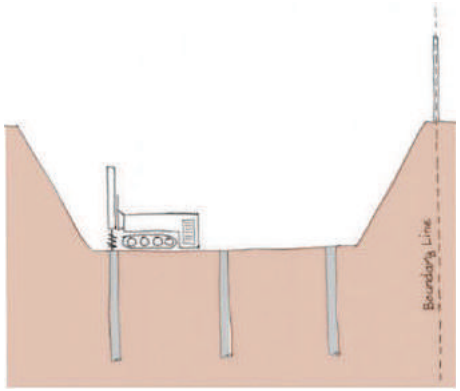
Carefully demolish the existing building whilst providing adequate temporary support to the existing garden retaining walls.



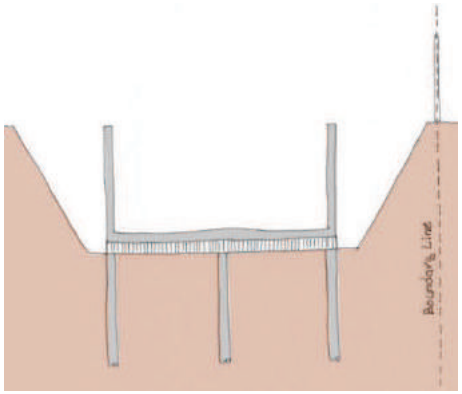
Stage 2: Excavate ground to basement level with all sides battered back.



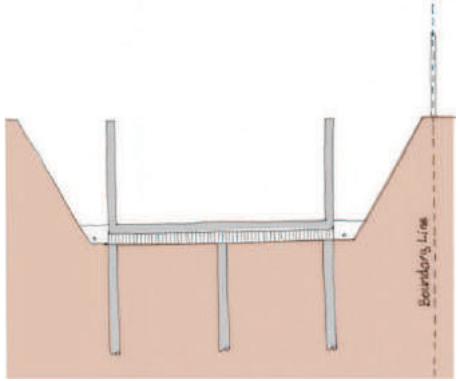
Stage 3: Install piles at basement level.



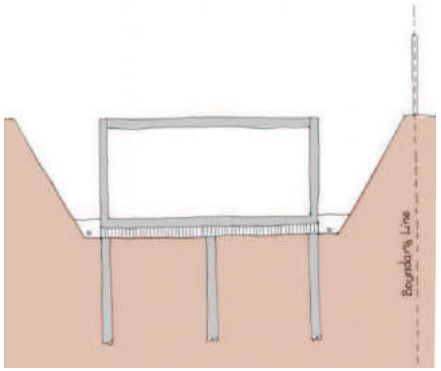
Stage 4: Install heave protection, new RC slab suspended on piles & new RC basement walls.



Stage 5: Install base to proposed French drains at new basement level.

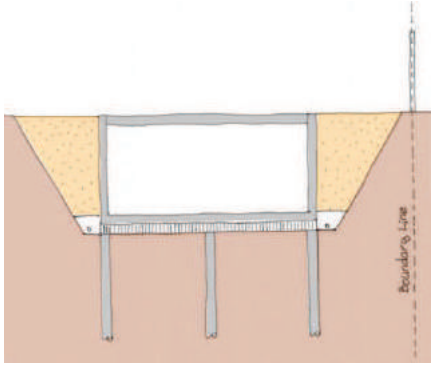


Stage 6: Install ground floor slab.

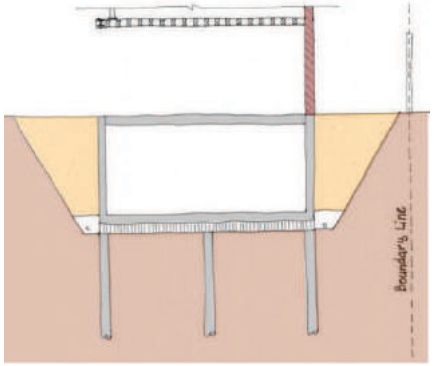


Once ground floor slab has gained sufficient strength, continue with construction of the rest of the scheme.

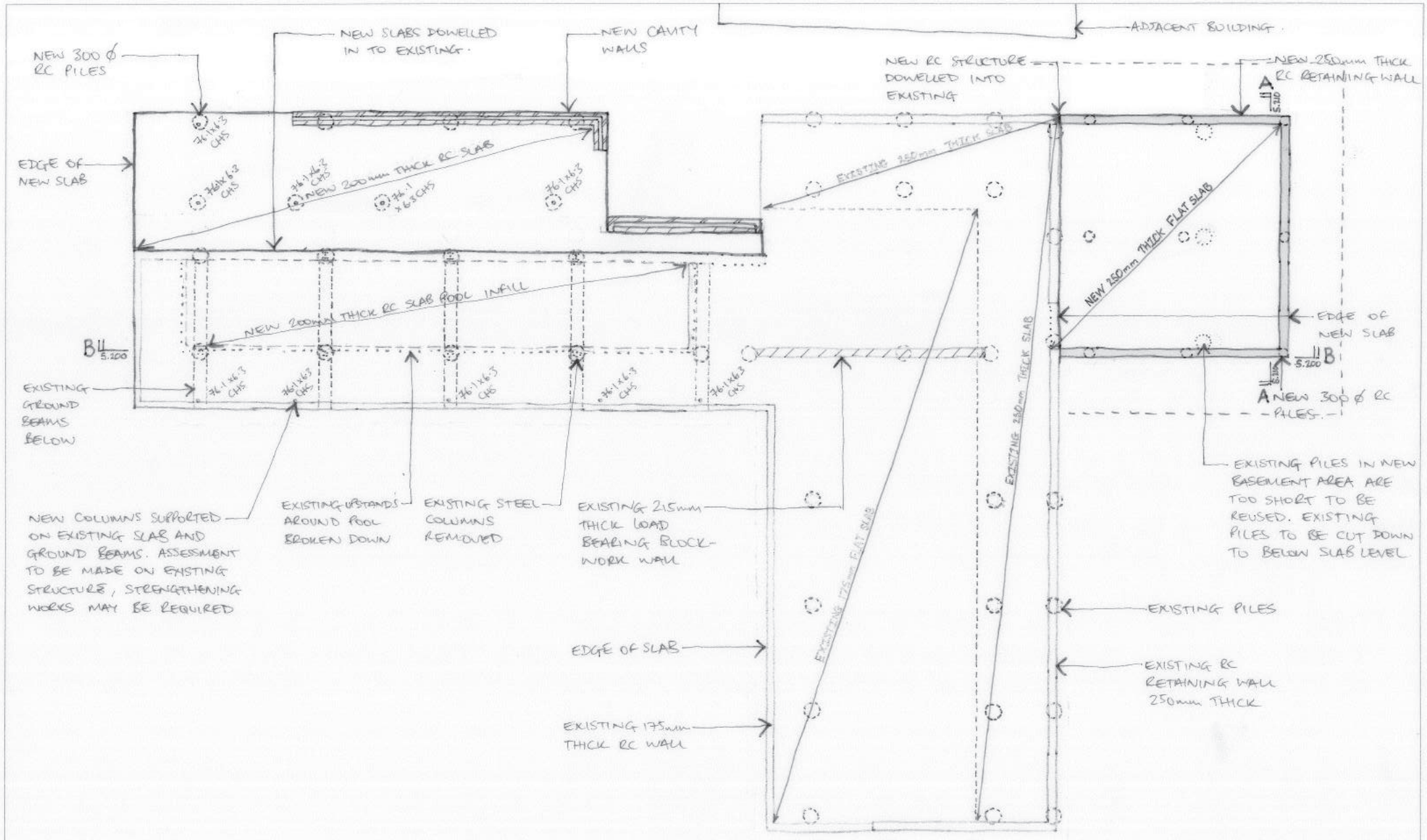
Stage 7: Back fill with hard core to form French drains and remove propping outside of basement walls



Stage 8: Install superstructure on RC basement box.



Proposed Drawings



This drawing is to be read in conjunction with all relevant architects, engineers and specialists drawings and specifications.

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drawing title

PROPOSED LOWER GROUND FLOOR PLAN

scale(s)	date	drawn
1:100@A3	JULY '17	TW1

drawing status

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job title

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job no	drawing no	revision
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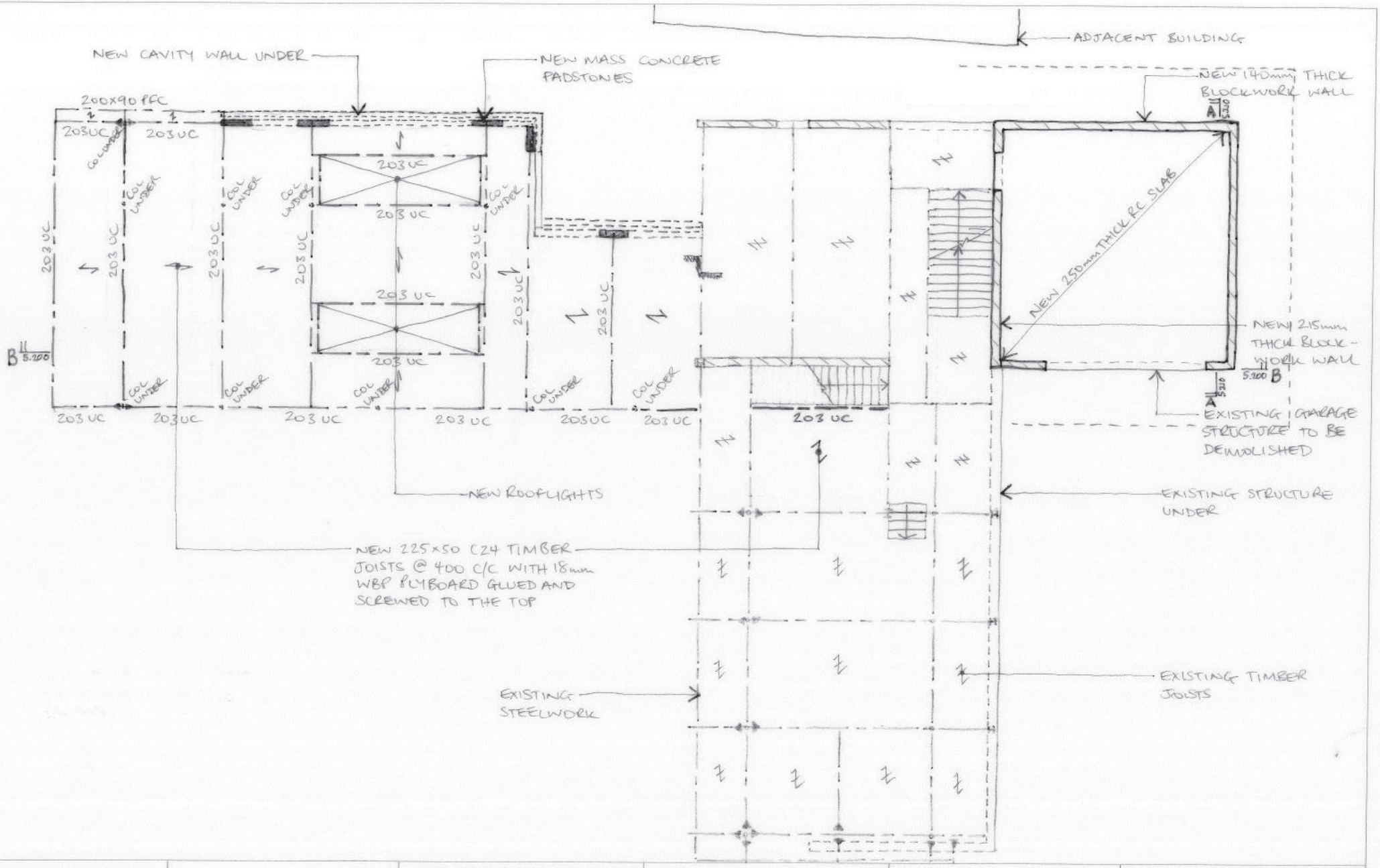

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drawing title
PROPOSED UPPER GROUND FLOOR PLAN

scale(s)	date	drawn
1:100@A3	JULY '17	TW1

drawing status
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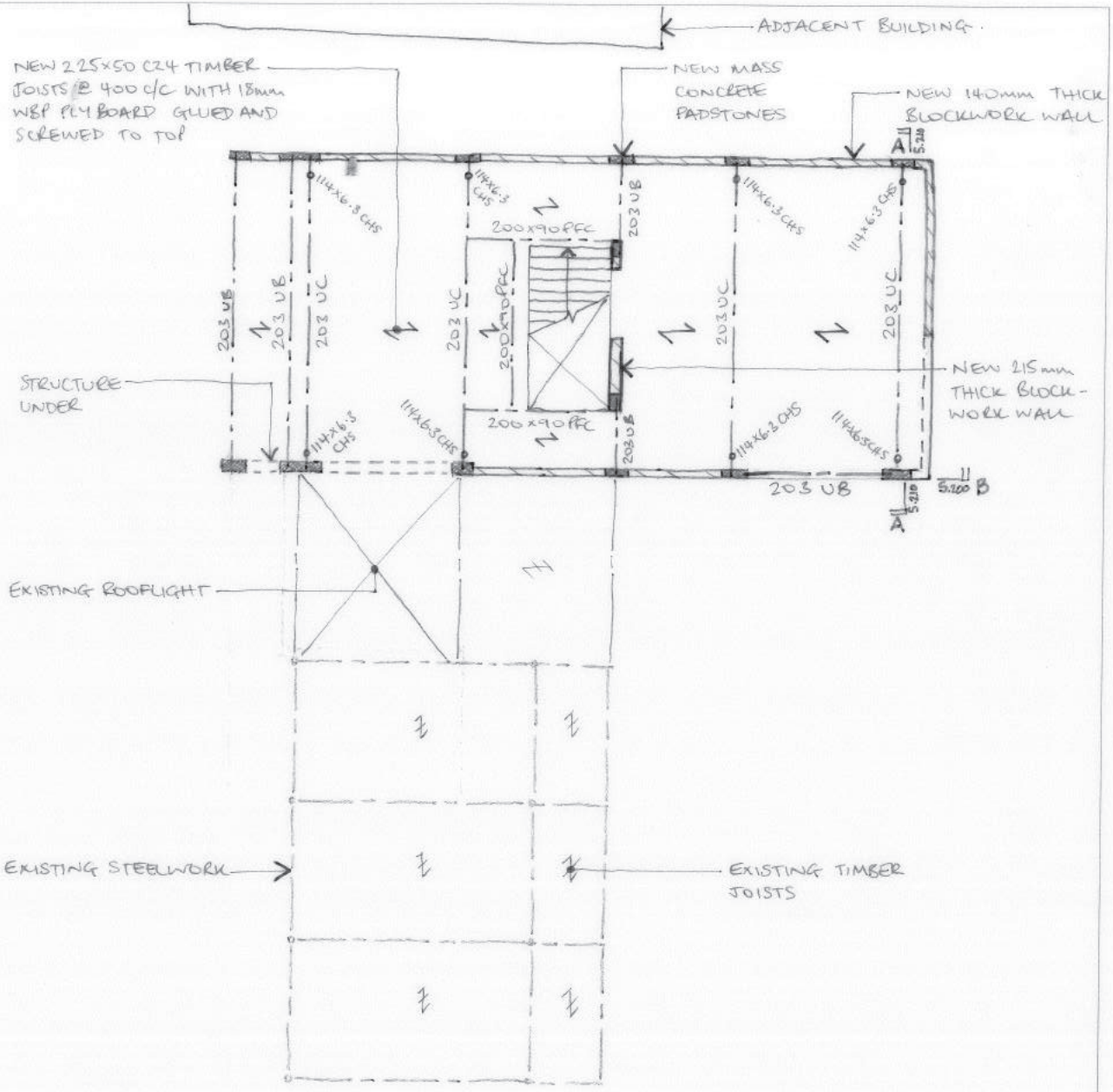

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PROPOSED FIRST FLOOR PLAN

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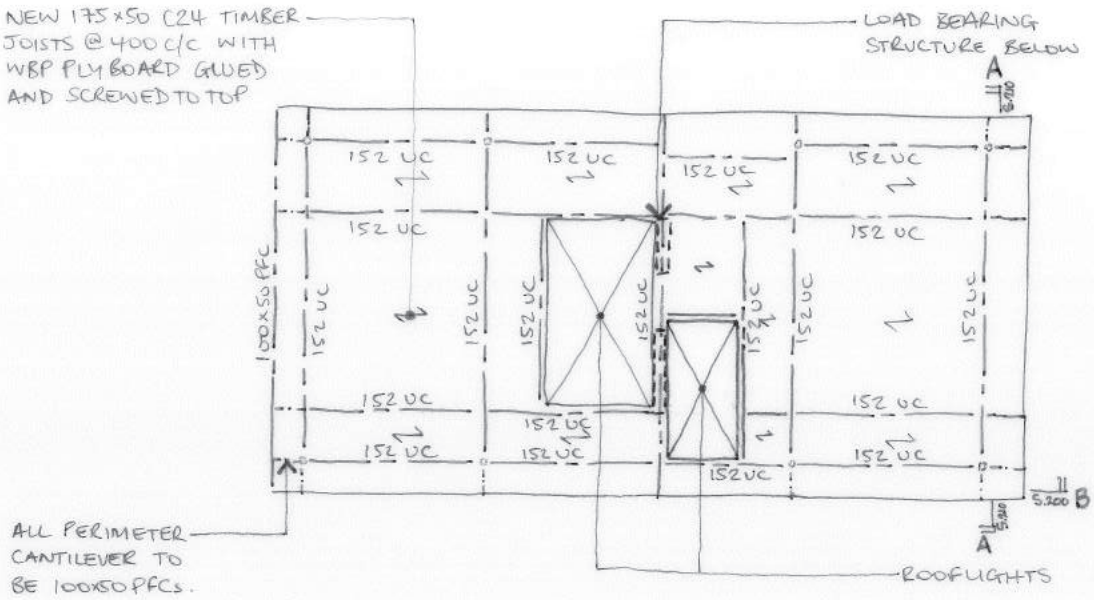

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PROPOSED ROOF PLAN

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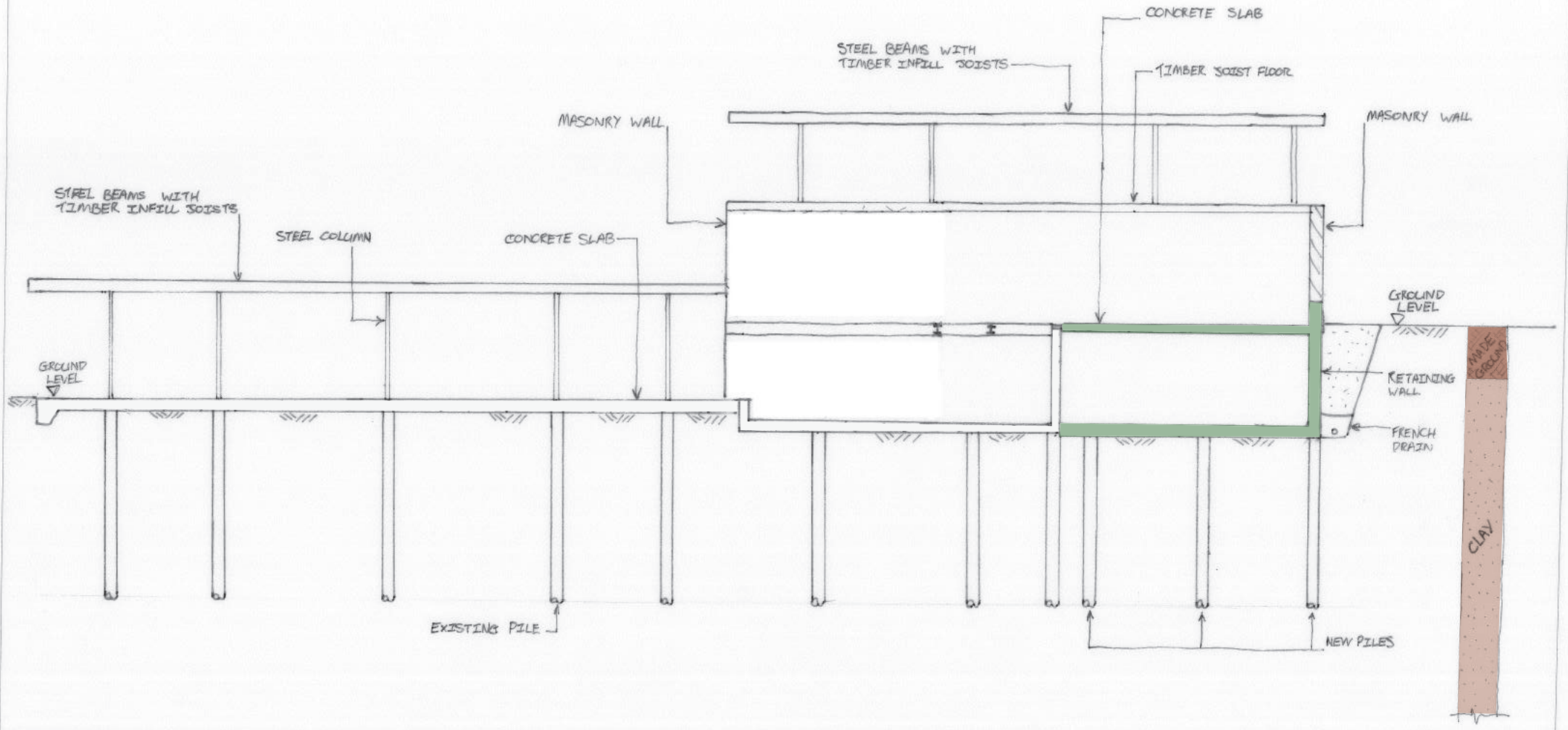

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PROPOSED LONG SECTION BB

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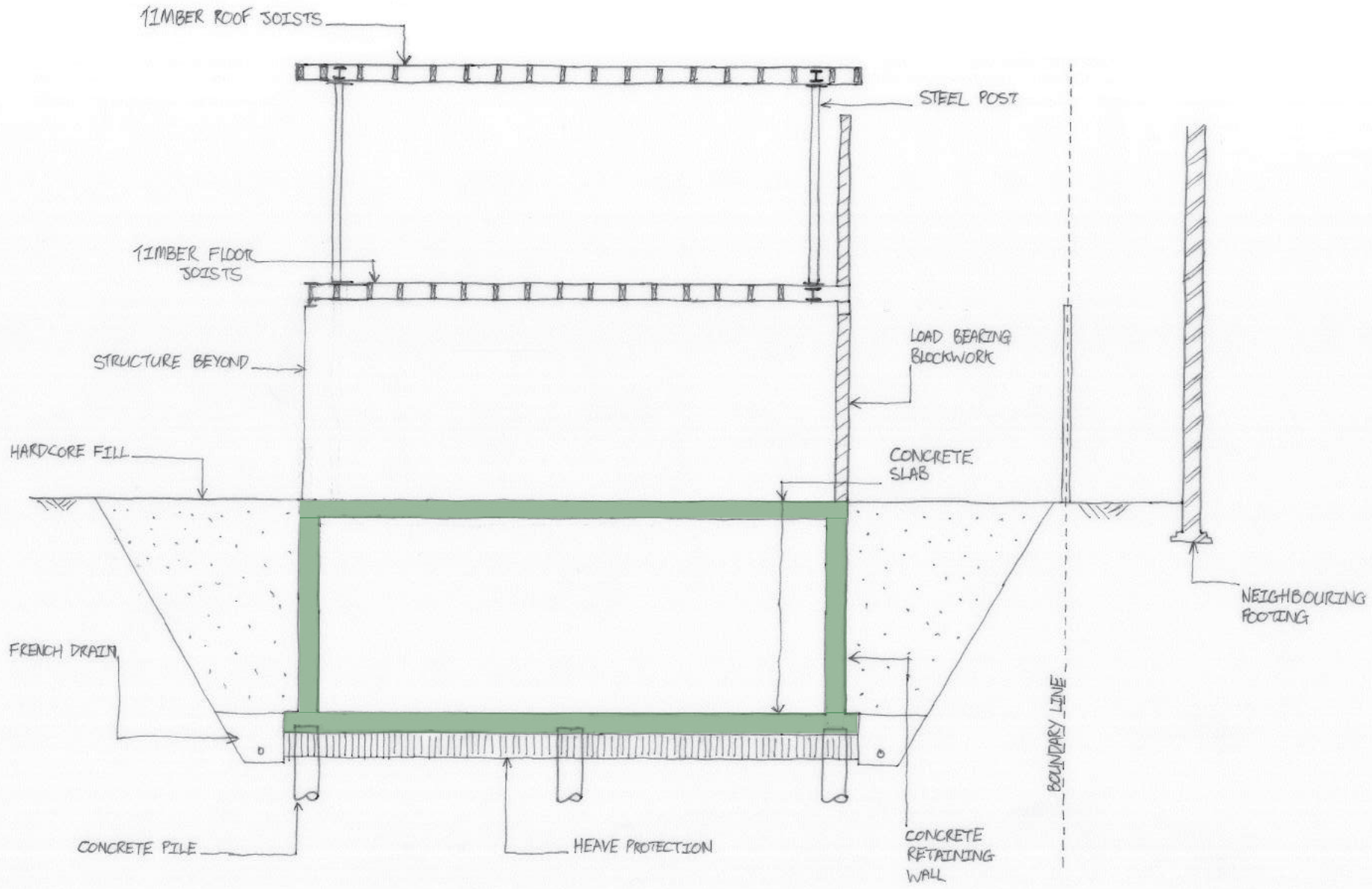

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drawing title: PROPOSED SHORT SECTION AA

scale(s): 1:50@A3 | date: AUGUST17 | drawn: TWI

drawing status: PRELIMINARY

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job title: WALLACE HOUSE FITZROY PARK LONDON N6 6HT

job no	drawing no	revision
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Site Investigation

SITE INVESTIGATION & BASEMENT IMPACT ASSESSMENT REPORT

Wallace House
Fitzroy Park
London
N6 6HT

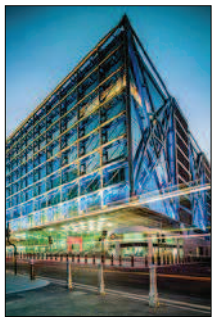
Client: Derrick and Claire Dale

Engineer: Elliott Wood

J17111

August 2017



GEA Geotechnical & Environmental Associates

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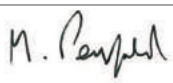
With input from			
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This report is intended as a Ground Investigation Report (GIR) as defined in BS EN1997-2, unless specifically noted otherwise. The report is not a Geotechnical Design Report (GDR) as defined in EN1997-2 and recommendations made within this report are for guidance only.

CONTENTS

Part 3: GROUND MOVEMENT ASSESSMENT

Part 4: BASEMENT IMPACT ASSESSMENT

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 Elliott Wood, on behalf of Derrick and Claire Dale. It is understood that it is proposed to construct a single-storey extension to the existing pool house building and to construct a new two-storey structure, with a basement extending to a depth of 2.80 m (80.84 m OD), in place of the existing single storey garage. The purpose of the investigation has been to research the history of the site with respect to possible contaminative uses, to determine the ground conditions and hydrogeology, to assess the extent of any contamination and to provide information to assist with the design of suitable foundations and retaining walls. The report also includes information required to comply with the London Borough of Camden (LBC) Planning Guidance CPG4, relating to the requirement for a Basement Impact Assessment (BIA), including a ground movement assessment.

DESK STUDY FINDINGS

The desk study research has indicated that the site was already developed by 1870 with a square building, of unknown but presumably residential use. By 1896, the footprint of the building had changed and an outbuilding had been constructed along the northern boundary. By 1935, another outbuilding had been constructed to the east of the site. From 1952, the main building was labelled as "Lodge", and from 1975 this building was labelled as "The Bungalow". Between 1991 and 1999 the buildings were demolished and replaced with the existing house. The desk study has not indicated any potential sources of soil gas that could affect the site.

GROUND CONDITIONS

The investigation generally encountered the expected ground conditions in that, beneath a moderate thickness of made ground, London Clay was found to the full depth investigated, although suspected Head Deposits were locally encountered overlying the London Clay. The made ground extended to depths of between 0.82 m and 1.30 m (80.58 m OD and 81.90 m OD). Directly beneath the made ground in Borehole Nos 2 and 3, suspected Head Deposits were encountered and generally comprised soft orange-brown mottled grey silty clay or firm brown or brown mottled grey silty clay, with a reworked texture; this material extended to depths of between 2.00 m and 2.70 m (81.40 m OD and 78.70 m OD) where encountered. The London Clay was found to comprise firm becoming stiff medium strength becoming high strength fissured brown mottled grey silty clay with occasional fine selenite crystals, and extended to a depth of between 7.45 m and 11.00 m (75.95 m OD and 72.20 m OD). Below this, stiff fissured high strength grey silty clay was encountered and proved to a depth of 15.00 m (68.20 m OD). Silt horizons were encountered in Borehole Nos 2 and 3 at depths of 7.23 m and 6.30 m respectively (76.17 m OD and 75.10 m OD). Groundwater was encountered during drilling within silt pockets in Borehole Nos 2 and 3, at depths of 6.20 m and 7.20 m, (75.20 m OD and 76.20 m OD) respectively. Monitoring of standpipes has subsequently been undertaken on five occasions over a period of roughly seven weeks and water has been measured in the pipes at depths of between 0.84 m and 5.55 m (82.36 m OD and 77.77 m OD). Contamination testing has revealed elevated concentrations of lead and asbestos in the made ground.

RECOMMENDATIONS

The excavation of the 2.8 m (80.84 m OD) deep basement will result in a formation level in either the Head Deposits or London Clay. Significant groundwater inflows are not anticipated and it should be possible to adopt spread foundations constructed from basement level. New spread foundations may be designed to apply a net allowable bearing pressure of 120 kN/m² below the level of the proposed basement floor, provided that any potentially desiccated clay soils can be bypassed. It is understood that piles are proposed to support the new extensions, which would provide a suitable foundation solution. Care should be taken at all times to ensure the stability of neighbouring properties and the existing foundations will need to be underpinned prior to basement excavation or supported by new retaining walls. Site workers should adopt suitable precautions with regard to the lead and asbestos contamination. It may be prudent to carry out additional testing to ensure the absence of any widespread contamination.

BASEMENT IMPACT ASSESSMENT

The BIA has not indicated any concerns with regard to the effects of the proposed basement on the site and surrounding area. It has been concluded that the impacts identified can be mitigated by appropriate design and standard construction practice.

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 of this report and Part 3 comprises a Ground Movement Assessment.

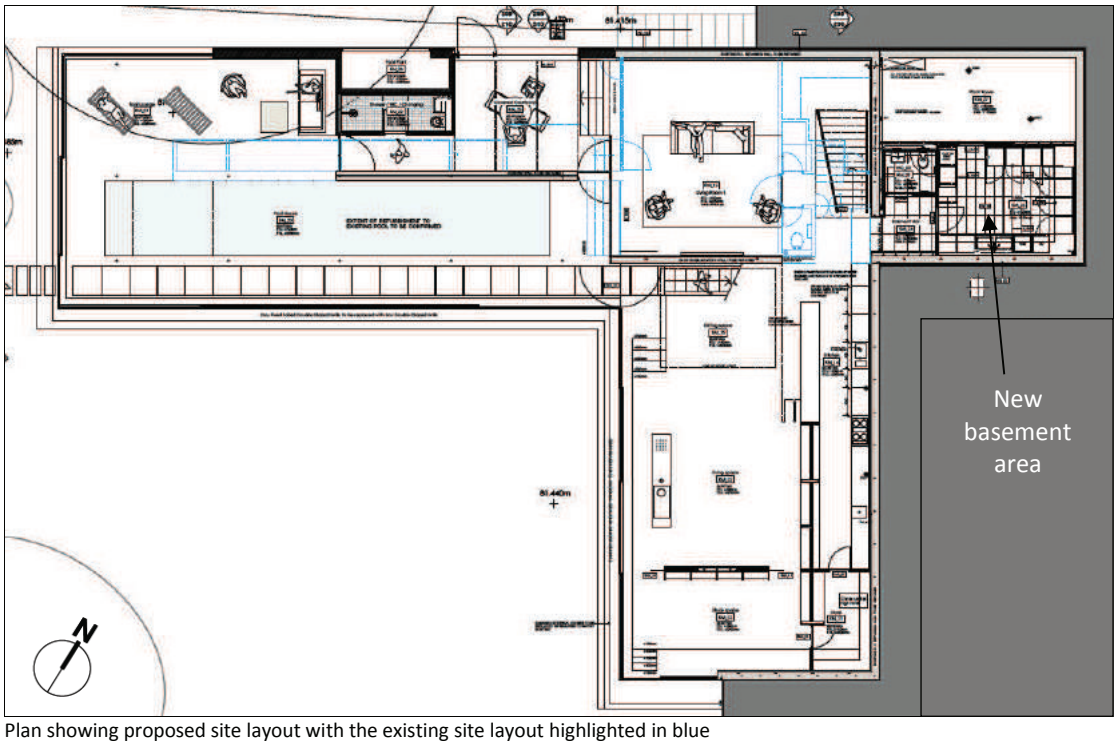
1.0 INTRODUCTION

Geotechnical and Environmental Associates Limited (GEA) has been commissioned by Elliott Wood, on behalf of Derrick and Claire Dale, to carry out a desk study and ground investigation at Wallace House, Fitzroy Park, London, N6 6HT. This report also forms part of a Basement Impact Assessment (BIA), which has been carried out in accordance with guidelines from the London Borough of Camden in support of a planning application. In addition, a ground movement analysis and building damage assessment has been completed.

1.1 Proposed Development

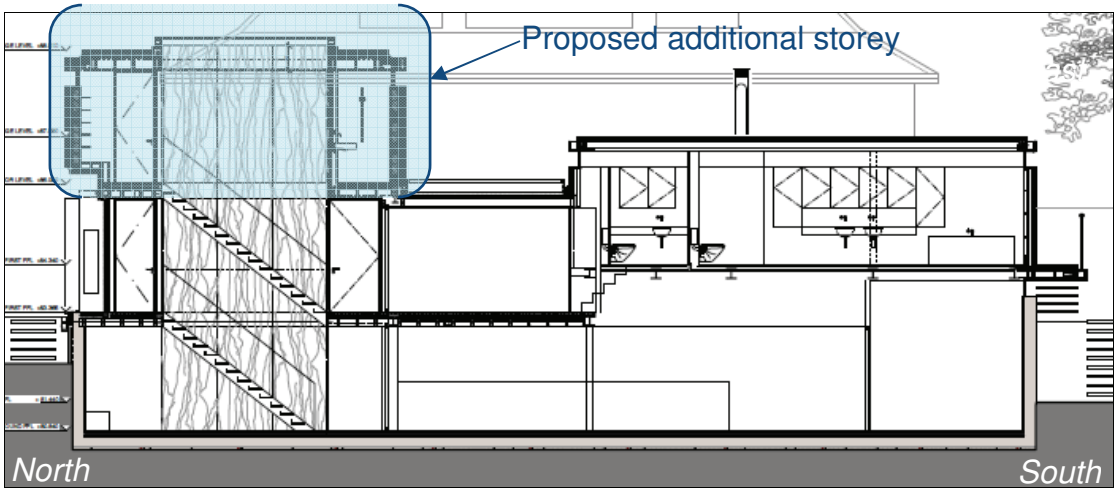
It is understood that it is proposed to construct a single storey extension along the northern elevation of the existing pool house building and to replace the existing single-storey garage with a two-storey building with a single level basement, extending to a depth of roughly 2.80 m (80.84 m OD).

A plan showing the proposed layout overlaying the existing development is shown below (drawing ref; 100, revision 00, by SOUP, dated Nov 2016), provided by the consulting engineers.



Plan showing proposed site layout with the existing site layout highlighted in blue

A section through the proposed development is shown overleaf.



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

1.2 Purpose of Work

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

- to check the history of the site with respect to previous contaminative uses;
- to assess the level of risk from Unexploded Ordnance (UXO);
- to determine the ground conditions and their engineering properties;
- to determine the configuration of the existing foundations;
- to assess the impact of the proposed basement on the local hydrogeology, hydrology and stability of the surrounding natural and built environment;
- to provide advice with respect to the design of suitable foundations and retaining walls;
- to provide an indication of the degree of soil contamination present;
- to assess the risk that any such contamination may pose to the proposed development, its users or the wider environment; and
- to assess the ground movements caused by excavation of the proposed basement and the level of damage to the surrounding structures.

1.3 Scope of Work

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

- a review of readily available geological and hydrogeological maps;
- a preliminary Unexploded Ordnance (UXO) risk assessment, commissioned by GEA and carried out by 1st Line Defence (ref EP4796-00, issue 1, dated 8 May 2017); and

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

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

- a single cable percussion borehole advanced to a depth of 15.00 m on the driveway;
- two open-drive sampler boreholes advanced to a depth of 7.45 m;
- standard penetration tests (SPTs), carried out at regular intervals in the boreholes to provide quantitative data on the strength of the soils;
- installation of three groundwater monitoring standpipes to depths of 5.00 m and 6.00 m and five subsequent monitoring visits, over a period of roughly seven weeks;
- rising head tests carried out in the standpipes at the time of the second monitoring visit;
- seven hand-dug trial pits, excavated to a maximum depth of 1.00 m, in order to determine the configuration of the existing foundations;
- laboratory testing of selected soil samples for geotechnical purposes and for the presence of contamination;
- a ground movement analysis and building damage assessment; 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.

The exploratory methods adopted in this investigation have been selected on the basis of the constraints of the site including but not limited to access and space limitations, together with any budgetary or timing constraints. Where it has not been possible to reasonably use an EC7 compliant investigation technique a practical alternative has been adopted to obtain indicative soil parameters and any interpretation is based upon engineering experience, local precedent where applicable and relevant published information.

1.3.1 Basement Impact Assessment

The work carried out includes a Hydrological and Hydrogeological Assessment and Land Stability Assessment (also referred to as Slope Stability Assessment), all of which form part of the BIA procedure specified in the London Borough of Camden (LBC) Planning Guidance CPG4[2] and their Guidance for Subterranean Development[3] prepared by Arup (the "Arup report"). The aim of the work is to provide information on surface water, groundwater and

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

land stability and in particular to assess whether the development will affect neighbouring properties or groundwater movements and whether any identified impacts can be appropriately mitigated by the design of the development.

1.3.2 Qualifications

The land stability element of the Basement Impact Assessment (BIA) has been carried out by Martin Cooper, a BEng in Civil Engineering, a Chartered Engineer (CEng), member of the Institution of Civil Engineers (MICE), and Fellow of the Geological Society of London (FGS) who has over 25 years' specialist experience in ground engineering. The subterranean (groundwater) flow assessment has been carried out by John Evans, MSc in Hydrogeology, Chartered Geologist (CGeol) and Fellow of the Geological Society of London (FGS). The surface water and flooding assessment has been carried out by Rupert Evans, a hydrologist with more than ten years consultancy experience in flood risk assessment, surface water drainage schemes and hydrology / hydraulic modelling. Rupert Evans is a Chartered Environmentalist, Chartered Water and Environmental Manager and a Member of CIWEM.

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 some 30 years' experience in geotechnical engineering and engineering geology.

All assessors meet the qualification requirements of the Council guidance.

1.4 Limitations

The conclusions and recommendations made in this report are limited to those that can be made on the basis of the research carried out. The results of the research should be viewed in the context of the work that has been carried out and no liability can be accepted for matters outside the stated scope of the research. Any comments made on the basis of information obtained from third parties are given in good faith on the assumption that the information is accurate. No independent validation of third party information has been made by GEA.

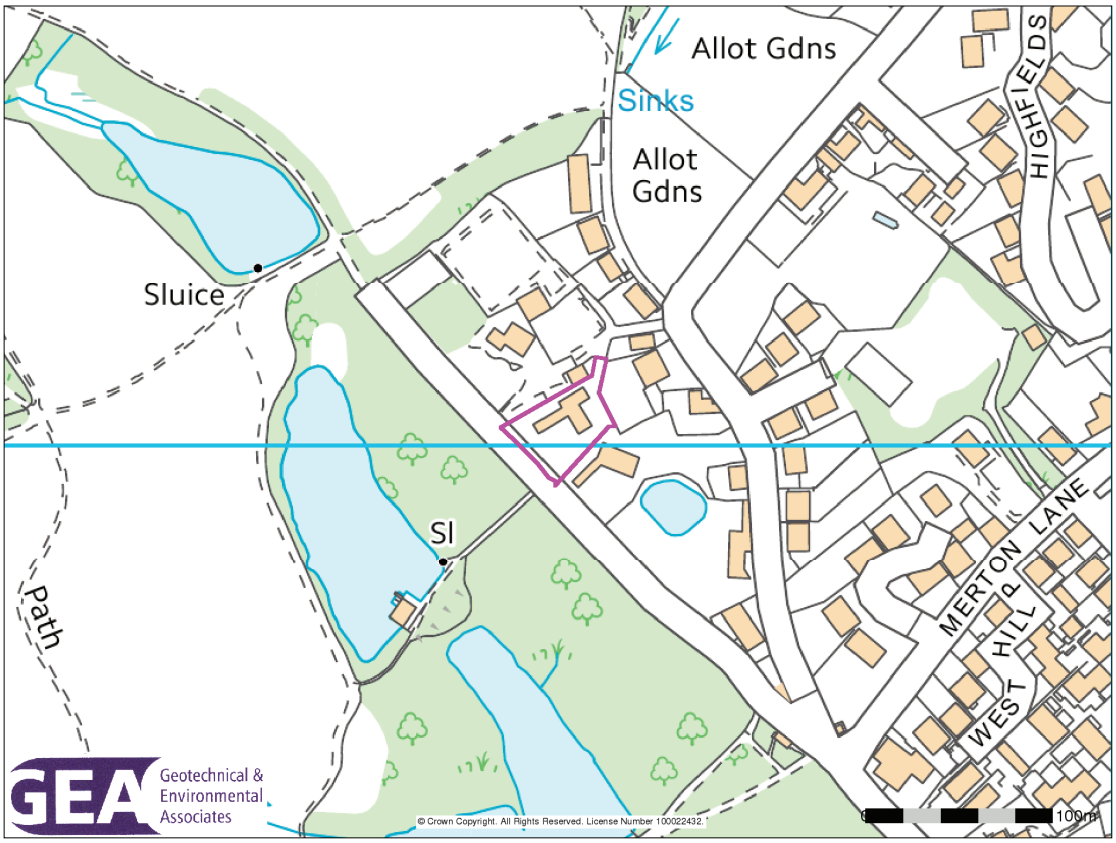
2.0 THE SITE

2.1 Site Description

The site is located in the London Borough of Camden, on the northeastern edge of Hampstead Heath, approximately 1.40 km southwest of Highgate London Underground station and roughly 1.45 km northeast of Hampstead Heath Railway station. It is located roughly 75 m to the northeast of Kenwood Ladies Bathing Pond and roughly 12 m to the south of the North London Bowling Club car park. It fronts onto Fitzroy Park to the north and is bounded to the southwest by Millfield Lane. The site further bounds The Little House, a two-storey residential structure directly to the northeast, and Fitzroy Farm Coach House, a single-storey detached structure to the north. The site is bordered to the east by the Dormers and to the south by The Water House, both of which comprise detached houses. A pond is located in the southern corner of the front garden of Wallace House. Additionally, the site may be located by National Grid Reference 527713, 187018 and is shown on the map extract overleaf.

A walkover survey of the site was carried out by a geotechnical engineer from GEA during the fieldwork and the description below is based on these observations. Selected photographs from the walk-over are included in the appendix.

The site occupies an irregularly shaped parcel of land measuring 30 m north-south by 50 m east-west in maximum dimensions. It lies at the base of a southwest facing slope, at an elevation of around 85 m OD, approximately 10 m above the level of the nearby Kenwood Ladies Bathing Pond, which is one of a line of ponds, together known as the Highgate Points, which are fed by a tributary of the old River Fleet. The site is located on a sloping plot and it appears to have been historically cut or levelled to allow for the development of the existing building. A driveway is present along the eastern boundary of the site; it slopes down from the northeast at a level of roughly 87 m OD to the southwest at a level of roughly 83 m OD. The rest of the site slopes downwards from the east at 85 m OD to the west at roughly 81.5 m OD.



The site is currently occupied by a roughly T-shaped house which is cut into the slope, such that it comprises one storey at the front and two storeys at the rear. The site is on two main levels, with steps between the two levels along the northern and southern elevations of the house. The difference is roughly 3 m between the front of the house and the rear. A single storey pool house extension is adjoined to the southwest of the main house and incorporates a swimming pool as shown in the photograph overleaf.

The main two-storey section of the house has a ground level set roughly 0.5 m below the level of the rear garden. The site reduces further in elevation in its southeastern corner beyond a small pond.

At the time of the walkover, ground level along the northern site boundary appeared raised in part by approximately 0.5 m. The elevated area comprised thick vegetation and the retaining wall appeared to be bowing towards the south. The ground along this northern boundary was noted as being significantly steep.

A number of paving slabs surrounding the existing pool house extension were noted as cracked at the time of the fieldwork.

Vegetation coverage is present primarily around the perimeters of the site. A roughly 20 m high deciduous tree and an approximately 17 m high willow tree are present to the south, as shown in the photographs below and overleaf. Other, typically deciduous trees, between roughly 10 m to 14 m high, are present to the south and to the west of the site. Shrubs are present in the northern end of the driveway as well as around the perimeter. A large deciduous tree, roughly 20 m high also borders the site to the northwest; as shown behind the pool extension in the image above.

2.2 Site History

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

The earliest map studied, dated 1870, shows the site to be located to the west of Fitzroypark Farm, with a single square building situated in the centre of the site surrounded by pathways and some trees. The immediate surrounding area is shown to comprise a number of buildings to the north of the site, which also appear to be associated with the farm. A single building is shown to the southeast of the site. A large pond is shown on this map, 35 m to the southeast of the site and the Highgate ponds were constructed by this time, roughly 75 m to the southwest of the site. Online research[4] indicates that the Highgate ponds were formed in the 17th and 18th Centuries as man-made reservoirs fed by the headwater springs of the River Fleet.

By the time of the 1896 map, the footprint of the building on site had changed, and the building appears to have been extended or rebuilt. An outbuilding was present against the northern boundary, which was extended by 1915, and what appears to be two additional buildings are shown to the southeast of the site. On the 1915 map, a miniature rifle range was present 80 m to the south of the site. Between 1915 and 1935, the buildings of Fitzroy Park Farm were demolished and replaced with what appears to be a single irregular shaped building and Bowling Green shown to the north. The building to the south of the site had also been demolished and replaced with an irregular shaped building. The outbuilding along the northern boundary on site had reduced in size by 1935. By 1935 another outbuilding had been constructed in the east of the site.

The irregular shaped building to the south of the site is labelled on the 1952 map as Fitzroy Farm Cottage and the building on site is first labelled as a lodge. A tank is shown on the 1953 map, 60 m to the northeast of the site and is not shown on any subsequent maps. On this map, the closest pond is first labelled as the Women's Bathing Pool. Between 1974 and 1975 the lodge is labelled as The Bungalow. Between the 1991 OS map and the 1999 aerial photograph the existing house was constructed. Online records[5] identify Wallace House as having been rebuilt in its present day configuration in 2000; it is inferred to have since remained unchanged.

A search of the LBC online portal found a number of planning applications that relate to the proposed development site. The main applications are detailed below.

Application Reference	Description	Date of Application	Status
HB/8570003/R2	Demolition of existing house (excluding part of existing S.E. wall) garage and west boundary walls including re-siting of existing timber entry gates. As shown in drawings numbered 1 2 3A 4A 5A 6A 7A and 1 unnumbered. Revised on 5th July and 13th August 1985.	10/09/1985	FINAL DECISION
CEX0200174	Substantial demolition of the front of the property, the erection of an extension at the front of the property and works of alteration and refurbishment As shown on drawing numbers: 13/02 Revision 4 - Proposed sheets 1, 2 & 3 and 12/01 Revision 3	20/05/2002	Grant Conservation Area Consent

4 https://en.wikipedia.org/wiki/Hampstead_Ponds. Accessed June 2017
5 http://ukmoho.co.uk/html/town/Highgate_LB.Camden.html . Accessed June 2017

Application Reference	Description	Date of Application	Status
PEX0200115	Substantial demolition of the front of the property, the erection of an extension at the front of the property and works of alteration and refurbishment. As shown on drawing numbers: 13/02 Revision 4 - Proposed sheets 1, 2 & 3 and 12/01 Revision 3	20/05/2002	Grant Full Planning Permission
2008/2004/P	Erection of new first floor extension above existing garage, and new lower ground floor extension to single family dwelling house (Class C3)	13/05/2008	Granted Subject to a Section 106 Legal Agreement
2008/1303/P	Demolition of existing 2 storey dwelling and single storey swimming pool building, and replacement with new dwelling with accommodation over basement, ground and first floor levels with single room located within roof space at second floor level.	23/05/2008	Withdrawn
2009/4345/P	Amendment to planning permission 2008/2004/P (dated 02/06/2009) comprising excavations to enlarge the lower ground level to the area beneath the existing garage, conversion of the garage at ground floor level into a habitable room and associated alterations to the dwelling house, in association with the original permission for 'Erection of new first floor extension above existing garage, and new lower ground floor'. extension to single family dwelling house (Class C3).	12/04/2010	Granted Subject to a Section 106 Legal Agreement

2.3 Preliminary UXO Risk Assessment

A preliminary UXO risk assessment has been carried out by 1st Line Defence and their report (ref EP4796-00, issue 1, dated 8 May 2017) is included in the appendix. The risk assessment has been carried out in accordance with the guidelines provided by CIRIA, which state that the likelihood of encountering and detonating unexploded ordnance (UXO) below a site should be assessed along with establishing the consequences that may arise. The first phase comprises a preliminary risk assessment, which should be undertaken at an early stage of the development planning. If such an assessment identifies a high level of risk then a detailed risk assessment should be carried out by a UXO specialist, which will identify an appropriate course of action with regard to risk mitigation.

Preliminary research has identified a minimal/low risk of encountering items of UXO at the site. It is therefore not considered likely that carrying out additional research would result in a significant change to the assessed level of risk, based on the information that is currently available to 1st Line Defence. It is therefore recommended that no further action needs to be taken for this site.

2.4 Other Information

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

The search has revealed that there are no operational or historic landfills, or any licensed waste transfer, treatment or disposal sites within 1 km of the site. No records of potentially infilled land exist within 700 m of the site.

The search has not indicated any contaminated land register entries or notices within 1 km of the site. Two accounts of pollution incidents to controlled waters are recorded within 500 m of the site, 245 m to the north and 372 m to the west of the site. A single substantiated pollution incident has been recorded 451 m to the south. No contemporary trade directory entries indicating active businesses are listed within 100 m of the site. In addition, there are no listed fuel stations within 250 m of the site.

The site is not located within a nitrate vulnerable zone or any other sensitive land use, but the site is located within the Highgate Village Conservation Area.

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

2.5 Geology

The British Geological Survey (BGS) map of the area (sheet 256) indicates that the site is directly underlain by the London Clay Formation with the site and much of the surrounding area also shown as having 'Head Propensity'. Head propensity is denoted on the BGS map as areas most likely to be covered by Quaternary Head Deposits as interpreted from digital slope analysis and confirmed by borehole data. These deposits are not mapped and have not been verified by fieldwork. These are noted as having properties similar to that of the London Clay and are shown to occur close to the boundary with the overlying Claygate Member. The geological boundary of the Claygate Member and London Clay is shown roughly 12 m to the northwest of the site shown in the appendix.

According to the British Geological Society memoir the London Clay Formation is homogenous, slightly calcareous silty clay to very silty clay, with some beds of clayey silt grading to silty fine grained sand, whereas the Claygate Member comprises alternating beds of clayey silt, very silty clay, sandy silt and glauconitic silty fine sand. The lower part of the Claygate Member is generally more bioturbated. A bed of calcareous concretions is present near the base in many places.

A borehole has been drilled by the BGS to a depth of 66.74 m (61.97 m OD) on Hampstead Lane, about 1.63 km to the west of the site at National Grid Reference 526455, 186890, and is generally referred to as the Hampstead Heath borehole. This borehole found the Bagshot Formation to extend to a level of 109.71 m OD and penetrated the full thickness of the Claygate Member. This borehole found the base of the Claygate Member at a level of 93.71 m OD, where the London Clay Formation was encountered. The highest site level is about 87.00 m OD in the north of the site and therefore some depth below the anticipated base of the Claygate in this area.

GEA has previously carried out a number of site investigations within the nearby area. An investigation undertaken to the southwest, found between 0.4 m and 1.8 m of made ground or topsoil, over London Clay to the full depth of the investigation at 15.0 m.

The BGS borehole database includes a record of a deeper borehole drilled roughly 270 m to the northeast of the site. The borehole encountered made ground over the London Clay to a depth of 127 m, below which the Thanet Sand extended to a depth of 144 m and was underlain by Chalk with flints to the full depth investigated, of 206 m.

2.6 Hydrology and Hydrogeology

According to the Envirocheck report the site is directly underlain by an Unproductive Stratum (London Clay), which refers to deposits that have low permeability and negligible significance for water supply or river base flow. The Claygate Member, which outcrops on the northwest boundary of the site, is classified as a Secondary 'A' Aquifer, which refers to permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.

A private pond is located in the southeast of the site and a private pond is located in the garden of the neighbouring site to the east. Beyond this, the nearest surface water feature is the Kenwood Ladies' Bathing Pond of the Highgate Chain of Ponds. The Highgate Ponds are manmade and it is assumed any other private ponds within the London Clay are also man-made.

The site is located close to a tributary of the Highgate Chain of Ponds, formerly known as the Highgate Brook, which historically[6] formed one of the sources of the River Fleet, one of London's "lost rivers". The Fleet originated to the northwest and southwest of the site and flowed in a southeasterly direction towards Clerkenwell, beyond which it joined with the River Thames. Today the Fleet is entirely covered and culverted and forms part of the surface water sewerage system.

Within Hampstead Heath, three of the more than 25 ponds exist within relatively close proximity to the site. The nearest is the Kenwood Ladies Bathing Pond, situated approximately 75 m southwest of the site. The ponds on the Heath are fed by springs which drain the Bagshot Formation sands which cap the higher ground beneath Hampstead Heath. Some of the ponds are natural but the Hampstead and Highgate Chains are artificial and were created in the 18th Century by damming tributaries of the Fleet, to provide drinking water for London.

The site lies outside the catchment of the Hampstead Heath chain of ponds, although it does lie within the Highgate Chain catchment area.

There are no EA designated Source Protection Zones (SPZs) on the site and there are no listed water abstraction points within 500 m of the site.

With reference to the Envirocheck database and Figure 11 of the Arup report, the nearest surface water feature is a pond located 38 m to the southeast of the site within a private garden.

The site itself is not located in an area at risk of flooding from rivers or the sea, as defined by the EA. It is also shown on Figure 15 of the Arup report[7] and the EA surface water flood maps, as not being in an area with the potential to be at high risk from surface water flooding.

The London Clay is cohesive and therefore has a negligible permeability. The permeability will be predominantly secondary (ie not intergranular), through fissures in the clay. Published data for the permeability of the London Clay indicates the horizontal permeability to generally range between 1 x 10^{-10} m/s and 1 x 10^{-8} m/s, with an even lower vertical permeability. Head Deposits also have low permeability rates in the range of 1 x 10^{-8} m/s.

6 Nicholas Barton and Stephen Myers (2016) *London's Lost Rivers. Revised Edition.* Historical Publications Ltd
7 Ove Arup & Partners (2010) *Camden geological, hydrogeological and hydrological study. Guidance for Subterranean Development.* For London Borough of Camden November 2010

The London Clay comprises predominantly clay soils that cannot support groundwater flow and as such do not support a "water table" or continuous piezometric surface. Boreholes constructed within clays do fill with water due to the often high water content of shallow clays or by the collection of surface water drainage which is unable to drain through the clay. However, this is not reflective of the type of groundwater flow that would occur in a porous and permeable saturated stratum. Although shallow Head Deposits are more sandy than the in-situ London Clay, they comprise predominantly transported clay material and therefore have a cohesive matrix which would not be able to sustain groundwater flow to support water courses or other water features. The local ponds have been constructed within the clay dominated Head Deposits and are therefore able to prevent the collected water from draining.

2.7 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.

2.7.1 Source

The desk study research has indicated that the site was already developed by 1870 with a square building, of unknown but presumably residential use. By 1896, the footprint of the building had changed and an outbuilding had been constructed along the northern boundary. By 1935, another outbuilding had been constructed to the east of the site. From 1952, the main building was labelled as lodge, and from 1975, this building was labelled as The Bungalow. Between 1991 and 1999 the buildings were demolished and replaced with the existing house.

Demolition of the previous buildings on the site is likely to have resulted in the presence of a moderate thickness of made ground. This would mostly be inert rubble, but is likely to include small quantities of contaminants such as lead, present in paintwork, other metals and potentially asbestos containing materials.

A tank was located 60 m to the northeast of the site in 1953. The contents of the former tank are not known, but are unlikely to have impacted upon the site.

There are no historical or existing landfill sites within 1 km of the site and no infilled land has been identified within 700 m of the site. Made ground associated with demolition of the house previously present on the site is likely to be predominantly inert demolition rubble without a potential for soil gas generation.

2.7.2 Receptor

The continued use of the site for residential purposes represents a relatively high sensitivity end-use and end users are considered to be sensitive receptors. Buried services are likely to come into contact with any contaminants present within the soils through which they pass and site workers are likely to come into direct contact with any contaminants present in the soil and through inhalation of vapours during basement excavation and construction. The site is likely to be directly underlain by unproductive strata, therefore groundwater is not considered to be a receptor.

2.7.3 Pathway

The presence of negligibly permeable London Clay will limit the potential for groundwater percolation into the underlying chalk, and thus a pathway is not considered likely to exist to the major aquifer.

Within the site, end users will be largely isolated from direct contact with any contaminants present within the made ground by the continued presence of the buildings and the extent of the hardstanding. However, in proposed areas of soft landscaping potential contaminant exposure pathways exist with respect to end users.

Except for the pathway of direct contact for site workers, no new pathways will be created by the basement excavation and services will come into contact with any contamination within the soils in which they are laid.

There is thus considered to be limited potential for a significant contaminant pathway to be present between any potential contaminant source and a target for the particular contaminant beneath the new building and extent of any hardstanding. A moderate potential exists within any proposed soft landscaped or garden areas.

2.7.4 Preliminary Risk Appraisal

On the basis of the above it is considered that there is a LOW risk of there being a significant contaminant linkage at this site, which would result in a requirement for major remediation work. Furthermore, there is not considered to be a significant potential for hazardous soil gas to be present on or migrating towards the site; there should thus be no need to consider soil gas exclusion systems.

3.0 SCREENING

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

3.1 Screening Assessment

A number of screening tools are included in the Arup document and for the purposes of this report reference has been made to Appendices E1, E2 and E3, which include a series of questions within screening flowcharts for surface flow and flooding, subterranean (groundwater) flow and land stability. The flowchart questions and responses to these questions are tabulated below.

3.1.1 Subterranean (groundwater) Screening Assessment

Question	Response for Wallace House
1a. Is the site located directly above an aquifer?	No. The site is directly underlain by the London Clay which is classified by the EA as an unproductive stratum. The site is located close to the boundary with the Claygate Member in the northwest and is located within an area of Head Propensity.
1b. Will the proposed basement extend beneath the water table surface?	*Unlikely.* The London Clay and Head Deposits cannot support groundwater flow and do not have a water table consistent with a permeable water bearing strata.

2. Is the site within 100 m of a watercourse, well (used/ disused) or potential spring line?	*Yes. A private pond is present in the southwest of the site, and another is located 38 m to the southeast. Additionally, Kenwood Ladies Bathing Pond and associated headwaters of the River Fleet are located roughly 75 m to the southwest of the site.*
3. Is the site within the catchment of the pond chains on Hampstead Heath?	*Yes. Figure 14 of the Camden geological, hydrogeological and hydrological study – Guidance for subterranean development dated 2010, confirms that the site is located within the Highgate Chain Catchment area.*
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	*Yes. Although the basement will be constructed entirely beneath the footprint of the existing garage structure, the extension of the existing pool house building to the northwest will result in a reduction in soft landscaped area.*
5. As part of the site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or SUDS)?	No. Given that the site is underlain by clay soils and is unlikely to be suitable for a soakaway or similar SUDS based system, the site drainage will be directed to public sewers. Site drainage will therefore be designed to generally maintain the existing situation.
6. Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to or lower than, the mean water level in any local pond or spring line?	No. Based on the contour levels shown in the Geological Plan Figure.

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

Q2 The site is located within 100 m of a watercourse
Q3 The site exists within the Highgate Chain Catchment area.
Q4 The proposed extension will slightly increase the proportion of hard surfaced/paved areas to the north of the existing pool house.

3.1.2 Stability Screening Assessment

Question	Response for Wallace House
1. Does the existing site include slopes, natural or manmade, greater than 7°?	No. Topographical maps, Figures 16 and 17 of the Arup report and the site walkover indicate slopes of between 0°-7° on the site. The site plan imposed over Figure 16 of the Arup report is shown in the appendix of this report.
2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7°?	No. The details of the proposed development provided do not include the re-profiling of the site to create new slopes.
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	No. Topographical maps, Figures 16 and 17 of the Arup report and the site walkover indicate the neighbouring sites to be in areas with slopes of between 0°-7°.
4. Is the site within a wider hillside setting in which the general slope is greater than 7°?	No. Topographical maps, Figures 16 and 17 of the Arup report and the site walkover confirm this.
5. Is the London Clay the shallowest strata at the site?	*Yes. Geological maps show the site to be directly underlain by London Clay. The site is also shown to be in an area with potential Head Deposits, and therefore reworked soils of the London Clay may be encountered. The geological boundary defining the presence of the Claygate Member is further shown to exist within roughly 12 m southwest of the site.*
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?	No. It is understood that no trees will be felled as part of the proposals.
7. Is there a history of seasonal shrink-swell subsidence in the local area and / or evidence of such effects at the site?	*Yes. The area is prone to these effects as a result of the presence of shrinkable clay soils. At the time of the fieldwork, cracking was noticed within slabs surrounding the pool extension, potentially caused due to the movement of the*

Question	Response for Wallace House
	underlying clay soils.
8. Is the site within 100 m of a watercourse or potential spring line?	*Yes.*
9. Is the site within an area of previously worked ground?	No. Geological maps and Figures 3, 4 and 8 of the Arup report confirm this.
10a. Is the site within an aquifer?	No. Aquifer designation maps acquired from the Environment Agency as part of the desk study and Figures 3, 4 and 8 of the Arup report, confirm this. The site is directly underlain by unproductive stratum.
10b. Will the proposed basement extend beneath the water table such that dewatering may be required during construction?	*Unlikely.* The London Clay cannot support groundwater flow and does not have a water table consistent with a permeable water-bearing stratum. The Head Deposits have a cohesive clay matrix and will behave hydraulically as a clay. Therefore these deposits cannot support groundwater flow, even if they are slightly more permeable in lab tests than the in situ London Clay. Localised bodies of perched groundwater may be encountered which are likely to be controllable via sump pumping.
11. Is the site within 50 m of Hampstead Heath ponds?	*Yes. The proposed basement development is within the Highgate Chain catchment.*
12. Is the site within 5 m of a highway or pedestrian right of way?	*Yes. The site is within 5 m of a highway of Fitzroy Park and Millfield Lane. However, the proposed basement excavation is located in excess of 5 m from the highways.*
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	*Possibly. The configuration of the foundations to The Little House to the north of the site is not known and should be confirmed.*
14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	No.

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

Q5 The site is directly underlain by London Clay.
Q7 The area is prone to seasonal shrink-swell subsidence.
Q8 The site is within 100 m of a watercourse.
Q11 The site is located within the Highgate Chain Catchment.
Q12 The site is within 5 m of two highways.
Q13 The proposed basement may increase the differential depth of foundations relative to neighbouring properties.

3.1.3 Surface Flow and Flooding Screening Assessment

Question	Response for Wallace House
1. Is the site within the catchment of the pond chains on Hampstead Heath?	*Yes. Figure 14 of the Camden geological, hydrogeological and hydrological study – Guidance for subterranean development dated 2010, confirms that the site is located within the Highgate Chains catchment area.*
2. As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route?	No. The proposed basement will be entirely beneath the footprint of the existing garage, therefore the 1m distance between the roof of the basement and ground surface as recommended by the Arup report and para 2.16 of the CPG4 does not apply.

Question	Response for Wallace House
	Any additional surface water from the increase in hardstanding area associated with the 1.8m single-storey extension will be attenuated and discharged into the Thames Water sewers to ensure the surface water flow regime will be unchanged.
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	*Yes. There will be an increase in impermeable area in the area of the 1.8m single storey extension to the existing pool house.*
4. Will the proposed basement development result in changes to the profile of the inflows (instantaneous and long term) of surface water being received by adjacent properties or downstream watercourses?	No. The proposed basement will be entirely beneath the footprint of the existing garage, therefore the 1m distance between the roof of the basement and ground surface as recommended by the Arup report and para 2.16 of the CPG4 does not apply. Any additional surface water from the increase in hardstanding area associated with the 1.8m single-storey extension will be attenuated and discharged into the Thames Water sewers to ensure the surface water flow regime will be unchanged.
5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	No. The proposed development is very unlikely to result in any changes to the quality of surface water being received by adjacent properties or downstream watercourses. It is proposed to allow for new SUDS measures to control how water is dealt with from additional hardstanding areas and it will be unpolluted roof water or low pollution hazard land uses draining from the site.
6. Is the site in an area identified to have surface water flood risk according to either the Local Flood Risk Management Strategy or the Strategic Flood Risk Assessment or is it at risk of flooding, for example because the proposed basement is below the static water level of nearby surface water feature?	No. The findings of this BIA together with the Camden Flood Risk Management Strategy dated 2013 and Figures 3iii, 4e, 5a and 5b of the SFRA dated 2014, in addition to the Environment Agency online flood maps show that the site has a very low flooding risk from surface water, sewers, reservoirs (and other artificial sources), groundwater and fluvial/tidal watercourses. It is possible that the basement will be constructed within a perched water table and the recommendations outlined in the BIA with regards to water-proofing and tanking of the basement will reduce the risk to acceptable levels. In accordance with paragraph 5.11 of the CPG a positive pumped device will be installed in the basement in order to further protect the site from sewer flooding. The site is located within the Critical Drainage Area Group3_001, but not in a Local Flood Risk Zone as identified in the Camden SWMP and Updated SFRA Figure 6/Rev 2.

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

Q1 The site is located within the pond chains on Hampstead Heath.
Q3 The proposed basement development may result in a change in the proportion of hard surfaced / paved areas.

4.0 SCOPING AND SITE INVESTIGATION

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

4.1 Potential Impacts

The following potential impacts have been identified by the screening process.

Potential Impact	Consequence
The nearest surface water feature is 38 m southeast of the site	A new basement development may impact the current catchment regime maintaining the nearby surface water feature.
The site exists within the Highgate Chain Catchment area and there is a private pond on site.	The proposed pool may affect the groundwater flow regime. Flow from a spring if diverted or restricted could affect flow elsewhere.
The proposed extension will slightly increase the proportion of hard surfaced/paved areas to the north of the existing pool house	An increase in hard surfaced cover may potentially impact the current surface drainage regime.
London Clay is the shallowest stratum on the site	The London Clay is prone to shrink and swell at ground level, which gives rise to subsidence and heave.
The site is within an area likely to be affected by seasonal shrink-swell	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 development is within 5 m of a public highway	Excavation of a basement may result in structural damage to the road or footway.
The proposed basement may increase the differential depth of foundations relative to neighbouring properties	Differential depths in foundations relative to neighbouring properties may cause significant damage to nearby structures.

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

4.2 Exploratory Work

In order to meet the objectives described in Section 1.2, a single cable percussion borehole was advanced to a depth of 15.0 m (68.20 m OD) on the front driveway, and supplemented by two open-drive sampler boreholes advanced to a depth of 7.45 m (73.95 m OD and 75.95 m OD). Standard Penetration Tests (SPTs) were carried out at regular intervals in the boreholes in order to provide quantitative data on the strength of soils encountered. Disturbed and undisturbed samples were also recovered for subsequent laboratory examination and testing.

In addition, a total of seven shallow trial pits were excavated by hand to expose the configuration of the existing foundations.

Three groundwater monitoring standpipes were installed to depths of 5.00 m and 6.00 m (76.40 m OD and 77.40 m OD) and have been monitored on five occasions to date, over a period of roughly seven weeks.

At the time of the second groundwater monitoring visit, rising head tests were carried out in each of the boreholes to provide preliminary information on inflow rates of groundwater.

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

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

The Ordnance Datum (OD) levels on the borehole and trial pit records have been interpolated

from drawings provided by the consulting engineers (drawing ref; Construction Sequence, SK/001, by SOUP, dated 5 June 2017).

4.3 Sampling Strategy

The borehole and trial pit locations were specified by the consulting engineers and positioned on site by GEA whilst avoiding known buried services.

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

Three samples of 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. All three of these samples were also subject to asbestos screening analysis as a precautionary measure.

The soil samples were selected to provide a general view of the chemical conditions of the soils that are likely to be involved in a human exposure or groundwater pathway and to provide advice in respect of re-use or for waste disposal classification. The contamination analyses were carried out at an MCERTs accredited laboratory with the majority of the testing suite accredited to MCERTS standards. Details of the MCERTs accreditation and test methods are included in the Appendix together with the analytical results.

5.0 GROUND CONDITIONS

The investigation has encountered a moderate thickness of made ground, overlying the London Clay, which has been encountered to the full depth investigated, of 15.00 m (68.20 m OD). Soils interpreted as Head Deposits locally overlie the London Clay.

5.1 Made Ground

Below the existing surfacings, the made ground generally comprised brown silty sand or brown mottled orange-brown clay with flint, rootlets, shell fragments, concrete, brick and ash, which extended to depths of between 0.82 m and 1.30 m (80.58 m OD and 81.90 m OD). A 0.20 m thickness of black silty clay with fine rootlets, decaying wood and fragments of red brick was also encountered at a depth of 0.52 m (82.88 m OD) in Borehole No 3.

With the exception of occasional fragments of extraneous material, no visual or olfactory evidence of significant contamination was observed within the made ground. However, three samples of the made ground have been subject to contamination testing as a precautionary measure and the results are presented in Section 5.5.

5.2 Head Deposits

Directly beneath the made ground in Borehole Nos 2 and 3, soils interpreted as Head Deposits were encountered and extended to depths of between 2.00 m and 2.70 m (81.40 m OD and 78.70 m OD). The material generally comprised soft orange-brown mottled grey silty clay or firm brown or brown mottled grey silty clay, with a reworked texture.

5.3 London Clay

Directly beneath the made ground in Borehole No 1 or Head Deposits in Borehole Nos 2 and 3, the London Clay was found to comprise firm becoming stiff fissured brown mottled grey silty clay with occasional fine selenite crystals, rare fine claystones and rare partings of silt and fine sand, extending to a depth of 11.0 m (72.20 m OD). Below this depth, stiff fissured grey silty clay with occasional carbonaceous material and occasional partings of light grey sand and silt was encountered and proved to a depth of 15.00 m (68.20 m OD). Live rootlets were observed to a maximum depth of 2.70 m (80.70 m OD) and decayed rootlets to a maximum depth of 4.70 m (78.50 m OD).

In Borehole No 3, grey silt was encountered between depths of 7.23 m and 7.28 m (76.17 m OD and 76.12 m OD), and, in Borehole No 2, a pocket of brown silt was encountered between depths of 6.30 m and 6.32 m (75.1 m OD and 75.08 m OD). These coincided with groundwater strikes encountered during drilling, resulting in the material being recovered as soft.

The fieldwork did not identify desiccation within any of the shallow soils sampled and subsequent laboratory testing has affirmed this.

The results of laboratory Atterberg Limit tests have indicated the clay to be of high volume change potential.

The results of undrained triaxial tests indicate shear strengths of medium strength becoming high strength.

These soils were found to be free from evidence of contamination.

5.4 Groundwater

Groundwater was encountered during drilling in Borehole Nos 2 and 3, at depths of 6.20 m and 7.20 m (75.20 m OD and 76.2 m OD) respectively. Monitoring of the standpipes installed in each of the boreholes has been carried out on five occasions over a period of roughly seven weeks since the date of the fieldwork. The results are shown in the table below.

Date	Borehole No	Depth to water (m)	Level of water (mOD)
10/05/2017	1	Not installed	
	2	3.63	77.77
	3	5.55	77.85
17/05/2017	1	3.75	79.45
	2	1.85	79.55
	3	2.64	80.76
01/06/2017	1	1.16	82.04
	2	Not monitored	
	3	3.28	80.12
14/06/2017	1	0.84	82.36
	2	1.73	79.67
	3	2.61	80.79
27/06/2017	1	1.14	82.06
	2	1.79	79.61

Date	Borehole No	Depth to water (m)	Level of water (mOD)
	3	2.27	81.13

Rising head tests were also carried out in each of the three boreholes at the time of the second monitoring visit to provide a preliminary assessment of the permeability of the nearby soils, and of potential groundwater inflows into the basement excavation. The results of the tests are appended. The testing indicated inflow rates of 7.58 x 10^{-6} m/s and 1.15 x 10^{-5} m/s in Borehole Nos 1 and 2 respectively, with no groundwater inflow recorded in Borehole No 3 over a period of 80 minutes. Despite the anticipated impermeable nature of the soils, it is inferred by the results that isolated and perched groundwater exists throughout the site, and that inflows and elevated permeability values probably arise from localised silt and sand partings within the London Clay. It is also possible that higher than anticipated readings represent reworked head material present on site.

5.5 Soil Contamination

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

Determinant	BH2: 0.40 m	TP2: 0.40 m	BH3: 0.60 m
pH	9.3	8.5	8.0
Arsenic	21	11	30
Cadmium	<0.2	0.3	0.9
Chromium	32	21	30
Copper	39	31	76
Mercury	0.3	0.5	0.8
Nickel	20	16	26
Lead	**310**	97	**690**
Selenium	<1.0	<1.0	<1.0
Zinc	140	140	510
Total Cyanide	<1	<1	<1
Total Phenols	<1.0	<1.0	<1.0
Sulphide	1.4	7.2	**79**
Total PAH	12.4	17.2	37.9
Benzo(a)pyrene	1.1	1.7	3.5
Naphthalene	0.08	0.10	0.25
TPH (C8 - C10)	<0.1	<0.1	<0.1
TPH (C10 - C12)	<2.0	<2.0	8.2
TPH (C12 - C16)	<4.0	7.7	26
TPH (C16 - C21)	4.6	53	83

Determinant	BH2: 0.40 m	TP2: 0.40 m	BH3: 0.60 m
TPH (C21 - C35)	18	230	220
Total organic carbon %	1.6	0.9	3.6

5.5.1 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 generic human health risk based guideline values which are either those of the CLEA[8] Soil Guideline Values where available, or are Generic Screening Values calculated using the CLEA UK Version 1.06[9] software assuming a residential end use with plant uptake, or are based on the DEFRA Category 4 Screening values[10]. 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 building type equates to a two-storey small terraced house; and
- that the critical exposure pathways will be direct soil and indoor dust ingestion, consumption of home grown produce, consumption of soil adhering to home grown produce, skin contact with soils and dust, and inhalation of dust and vapours.

It is considered that these assumptions are considered acceptable for this generic assessment of this site, with the exception of that made on groundwater, which is considered to be a sensitive receptor at this site. The tables of generic screening values derived by GEA and an explanation of how each value has been derived are included in the Appendix.

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

[8] *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.
[9] Contaminated Land Exposure Assessment (CLEA) Software Version 1.06 Environment Agency 2009
[10] CL:AIRE (2013) *Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination* Final Project Report SP1010 and DEFRA (2014) *Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination* Policy Companion Document SP1010

- soil remediation or risk management to mitigate the risk posed by the contaminant to a degree that it poses an acceptable risk.

The contamination testing has revealed elevated concentrations of lead in Borehole Nos 2 and 3 in the made ground. In addition, asbestos screening in the laboratory under electron microscope identified asbestos in the form of Chrysotile in samples of the made ground taken from Trial Pit 2 and Borehole No 3 in the form of loose fibres and bitumen.

A single elevated concentration of sulphide was recorded within Borehole No 3. However, concentrations of sulphide are not considered a risk to human health and will therefore be discussed in Section 8.6 of this report, with regard to their impact on structures.

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

5.6 Existing Foundations

The trial pit findings are summarised in the table below and the trial pit records and associated site plan can be found in the appendix.

Trial Pit No	Structure	Foundation detail	Bearing Stratum
1	Western elevation of house	Concrete Base – extends to a depth of at least 0.60 m No lateral projection Pit abandoned due to drainage trench	Not known
2	Northern elevation of house Section A – A'	Concrete Base – extends to a depth of at least 0.90 m No lateral projection Pit abandoned due to numerous service pipes	Not known
	Northern elevation of house Section B – B'	Concrete Base – extends to a depth of at least 0.46 m No lateral projection Pit abandoned due to numerous service pipes	Not known
2A	Northern elevation of garage	Concrete Base 0.55 m No lateral projection	MADE GROUND
3	Eastern elevation of garage	Concrete Base 0.42 m No lateral projection	MADE GROUND
4	Northern elevation of pool house	Concrete Base – extends to a depth of at least 0.18 m No lateral projection Pit abandoned due to numerous service pipes	Not known
4A	Northern elevation of pool house	Concrete Base – extends to a depth of at least 0.10 m No lateral projection Pit abandoned due to numerous service pipes	Not known
5	Northern edge of paving slabs around pool house	Concrete Base 0.18 m Lateral projection 130 mm	TOPSOIL