No.11 Rosslyn Hill, Hampstead

Basement Impact Assessment

Prepared for

Mr & Mrs A Jeffreys

March 2015

1693/10/FN/fn 24 March 2015

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1.0 Introduction

The owners of the site at No.11 Rosslyn Hill, Mr and Mrs Jeffreys are proposing to extend their Grade II listed Georgian house by introducing new extensions to the front and rear of the existing property. The proposal also involves two new basements, one which will accommodate a swimming pool and a double storey section to accommodate plant at a lower level. The works will also amalgamate the building with the adjacent studio building.

This Basement Impact Assessment (BIA) sets out the existing site and history, the proposed structural concept design, an overall construction sequence and considers the impact the basement construction has on the building on the site and adjacent neighbouring properties. It also explores the surface and ground water flows on and near the site as well as slope stability.

This report has been based on the following information:

- Historical maps and in house desk study
- Geological survey maps and BGS borehole records
- Proposed layout drawings by Thomas Croft Architects
- Site visits
- A site investigation carried out by Ground Engineering during January 2015 (Appendix E)

In preparing the BIA reference has been made to the following London Borough of Camden documents:

- Camden Local Development Framework (LDF) Policy DP27
- Camden Planning Guidance – Basements and Lightwells CPG4
- Camden Geological, Hydrogeological and Hydrological Study – Guidance for Subterranean Development prepared by ARUP

The BIA has been prepared by the following persons, holding the stated qualifications:

Alan Baxter & Associates	Robert Walton MEng Fred Nyberg MEng MIStructE CEng Adam Sewell MEng MIStructE CEng
Ground Engineering Ltd	S. J. Fleming MSc MCSM CGeol FGS J. E. M. Davies BSc(Hons) MSc CGeol FGS

1.1 Site

The site of No.11 Rosslyn Hill is in Camden, London, and is located on the site of the hill which forms Hampstead Heath. The property is set back from Haverstock and Rosslyn Hill, which are to the east, by means of a narrow drive. Directly to the north is Lyndhurst Hall, a former chapel building, but now used as a music studio. To the west, the site is bounded by Waterhouse Close and to the south by the rear gardens of Belsize Lane. See Appendix A and C for an overall map of the area.

The site is irregularly shaped; see Appendix C for a site plan. The site is 60m long, east to west, and the width of the site tapers towards the west boundary. The main house is located toward the east boundary.

There are a number of out buildings located around the site, most noticeable the studio, a single storey dwelling in the south east corner. The other structures on the site comprise single storey sheds.

Along the south boundary there are a number of mature Horse Chestnut, London Plane and Oak trees.

1.2 Site History

The site is located in the London Borough of Camden in the Fitzjohn and Netherhall Conservation area. Refer to drawing 1693/01/02 in Appendix C for a site plan and Appendix A for photos of the site.

No.11 Rosslyn Hill was built in 1770 in the landscaped grounds of the former Wilde's House, a large manor house built circa 1560. No.11 Rosslyn Hill was located to the south east of the former location of Wilde's House, close to an infilled landscaped pond.

In the late 1890's Hampstead developed rapidly. During this period both the terrace and semi-detached houses, to the east of the site, and Lyndhurst Chapel, to the north, were built, forming the distinct plot where No.11 Rosslyn Hill now resides.

In the 1900s, Lyndhurst Chapel was extended to the west, to form an additional hall space for the Chapel.

In the 1960's a row of garages were built directly adjacent to the east boundary, replacing one of the Victorian townhouses on Haverstock Hill. At a similar time the single storey studio building, and the timber shed were constructed.

The site and the adjacent properties have remained materially unchanged since the 1970's.

1.3 Site Geology

Based on the Geological map of the area, the ground conditions on the site comprise made ground over London Clay. The geological map indicates that the Claygate member is present above the London Clay stratum at the south end of the site. Refer to drawing 1693/01/03 in Appendix B for details of this. A site investigation was undertaken in

January 2015, which included three boreholes and nine window samples. Refer to Appendix E for the Interpretative Site Investigation Report. This showed that the Claygate member is not present and the ground conditions are as follows:

- Made ground (1 to 2.6m thickness)
- London Clay (approx. at 1m depth to an unknown depth. Borehole 3 extended to 20m and the London Clay was still present)

The window samples were undertaken to investigate the profile of the top of the London Clay stratum on the site to aid the understanding of the ground water flows. This showed that the Clay stratum is located deeper at the south end of the site beneath approximately 3.5m of made ground. The findings of the site investigations and the geological profiles are summarised on drawings 1693/01/S03 and S04 in Appendix C.

1.4 Form and condition of the existing structures

The existing building on the site was constructed in 1770 and is listed Grade II. The building has three storeys above ground and a lower ground floor with lightwells to the front and rear of the building. The second floor has a reduced footprint and covers the central part of the building only. The building is of loadbearing masonry construction with timber floors. The roof structure comprises a timber pitched roof over the central part of the building. The north east and south west ends of the building have timber pitched roofs with hipped ends. There are bay windows located on the east and north elevations. On the north west side of the building, there is a cellar with a vaulted masonry roof and this is accessed via the lower ground floor and also an external stair on the north west elevation.

The two masonry spine walls running north to south in the building contain the fireplaces that originally used the heat the spaces although radiators have since been added into the rooms. The eastern spine wall contains back to back fireplaces.

The loadbearing masonry walls are founded on corbelled strip foundations. The foundations were exposed as part of the site investigations and details of the findings are summarised on drawings 1693/01/S03 and S04 in Appendix C. Based on site observations, generally the existing structure is in reasonable condition for its age and type of construction.

There are two timber sheds located in the garden area, which will be removed as part of the proposals. There is also a single storey building at the south east corner of the site, which is of loadbearing masonry construction (likely to be cavity walls) with a flat timber roof structure. The studio building is of average quality for its age and type

To the north of the site, by the forecourt of the house, the neighbouring gardens are approximately 0.5m lower the forecourt. The two sites are separated by a brickwork wall, which is approximately 2.2m tall. The wall is generally in a reasonable condition for its age and type of construction.

1.5 The Proposals

The proposed scheme involves the following:

- Amalgamation of the main house with the adjacent studio dwelling and conversion of the studio dwelling in course of combining with the main house.
- Construction of a single storey extension at the rear of the house (West side)
- Construction of a new single storey basement beneath the forecourt to the house with a swimming pool. A double basement is to be provided locally in the south east corner for plant equipment. This basement is to be linked to the single storey extension at the rear of the house by a new lightwell.
- Construction of a new single storey basement at the south west corner of the existing house adjacent to the Lyndhurst Hall
- Construction of a new single storey basement to the west of the existing lightwell along the west elevation to the building for plant

This report relates to the proposed construction of the basements. The approach to the design of the new basements includes consideration of the following key items:

- Ground conditions
- Groundwater regime
- Surface flow and flooding
- Slope and ground stability
- The structure of the existing adjacent buildings
- The effects on surrounding and adjoining properties
- An appropriate design and construction methodology

1.6 The Characteristics of the project

The structural form of the proposed basements will be a combination of contiguous and secant bored piled walls, with reinforced concrete walls in some areas where the basement faces the existing lightwells. Some underpinning will be carried out at the north east corner of the house where the new basement abuts it. The proposals also include forming a double storey basement adjacent to neighbouring gardens and a swimming pool underneath the forecourt to the house.

2.0 Screening

The purpose of the screening stage of the BIA is to identify any matters of concern which should be investigated further through the BIA process. The screening process has be undertaken as outlined in the Camden Planning Guidance – Basement and Lightwells CPG4 and the Camden geological, hydrogeological and hydrological study prepared by ARUP.

The screening flow charts given in CPG4 have been used and are provided in Appendix C. Several items in the screening checklists were identified as being relevant to this proposal and therefore a BIA is necessary. Those that have been identified as being relevant are discussed in the following Scoping Stage.

3.0 Scoping (Stage 2)

The purpose with the scoping stage of the assessment process is to define further the potential impacts identified in the screening stage in section 2.0, as a device to define what further investigations are needed in order to assess the impacts. This stage has been undertaken as set out in the following documentation:

- Camden Planning Guidance – Basements and lightwells CPG 4
- Camden Geological, hydrogeological and hydrological study prepared by ARUP

3.1 Conceptual Ground Model

To assist the scoping stage a conceptual ground model has been produced to show how the site works, which encompasses hydrological, hydrogeological and the geological information of the site. The conceptual ground model is based on the following information:

- Information obtained during the screening stage of the BIA
- The site investigation undertaken in January 2015
- Readily available published data
- Application of hydrogeological principles

This is as follows.

Site location	11 Rosslyn Hill, Hampstead, London
Local geology	The geology of the locality comprises made ground over London Clay. Based on the geological map, the Claygate member is present at the western end of the site beneath the layer of made ground. Beneath the thick London Clay is the Lambeth Group, Thanet Sand formation and Chalk which together make up the lower Aquifer.
Local ground levels	The site gently slopes to the south east
Local surface water or below ground water features	There are no local surface or below ground water features close to site.
Local groundwater level	The London Clay is sufficiently thick that it isolates the strata of the Lower Aquifer from the secondary aquifer on top of the London Clay
Local surface finishes	The surrounding area to the house is mostly soft landscaping. The front and sides of the house is covered in gravel and the garden at the rear (west side) is mainly covered in grass. A small area at the rear of the house is covered in paving slabs and separated from the garden by a low level garden wall.

	There are three sheds on the north side of the site and an Annexe building at the south east corner of the site.
Current local surface water pathway	A proportion of local rainfall will be retained in the near surface soil (made ground and topsoil) with a proportion evaporating into the atmosphere or being taken up by plant and tree root systems and some may percolate down and enter the secondary groundwater system on top of the London Clay/Claygate member. The top of the London Clay is likely to dip in the same direction as the local topography and the shallow groundwater is likely to follow the natural topography of the site in the south east direction. A further proportion of local rainfall will run off the hard surfaced areas (existing buildings on the site) into the main surface water sewers.

Using the above conceptual ground model, the potential issues identified during the screening stage are discussed further.

3.2 Hydrology (surface water flow and flooding)

3	Will the proposed basement development result in a change in the proportion of hard surfaced/paved external areas?	Yes, the area of hard landscaping will be slightly increased from the small lightwell that is introduced at the lower ground floor level along the south elevation to the existing house	Y

The area of hard landscaping on the site will be increased slightly and the impact this will have is likely to be negligible as the increase is small in comparison to the size of the site.

3.3 Hydrogeology (groundwater flow)

1a	Will the proposed basement extend beneath the water table surface?	Unsure	Y
	Will the proposed basement development result in a change in the proportion of hard surfaced/paved external areas?	Yes, the hard landscaping will slightly increase on the site from the introduction of the new lightwell along the south elevation to the existing house	y

The level of groundwater will need to be measured as part of the site investigation using a standpipe monitored over a period of time after installation. This will determine if there is a perched water table within the ground below the basement and on top of the London Clay and whether the basement will extend within it and therefore affect the groundwater regime and the effect of groundwater on neighbouring properties.

The amount of hardstanding surfaces will be slightly increased as the new lightwell along the south elevation will replace a soft landscaped area. This will reduce the volume of rainfall seeping into the ground below and subsequently into underground aquifers. This is a small area and will have a negligible effect on the volume of surface water infiltrating into the groundwater below as the underlying stratum is relatively impermeable and the ground water is likely to flow downhill in the direction of the topography on the site. The top of the London Clay stratum will need to be determined on the site in order to develop an understanding of the groundwater flows on and near the site.

3.4 Slope and ground stability

5	Is the London Clay the lowest strata at the site?	Yes, the London Clay is the lowest strata on the site. Refer to Figure 3 of the Arup Hydrogeological report – Camden Geology Map.	Y
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?	A small section of the basement and the new single storey dining room extension encroaches into the root protection zone of the trees along the south boundary. Refer to Arboriculturalist's reports for more details.	Y
13	Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Yes, the basement is being formed adjacent to neighbouring buildings. These include garages to the south east and Lyndhurst Hall on the north side and these foundation are likely to be shallower than the proposed basement	Y

The site investigation is to confirm the strata on the site. The proposed basement is likely to result in differential depths of the foundations relative to neighbouring buildings. The depths of the foundations surrounding the site will be investigated during a site investigation and a ground movement assessment carried out to determine the extent of any effects on neighbouring properties.

3.5 Conclusions

The scoping has identified a few matters that need to be investigated further. A site investigation must therefore be undertaken and include the following in order to gain enough information to address the potential issues identified in the scoping stage.

- Boreholes and window sampling to determine the ground conditions on the site and the contours of the London Clay stratum
- Standpipe to monitor groundwater levels in the borehole over an extended period

- Trial pits adjacent to the surrounding walls to determine the type, size and condition of the foundations to adjacent structures.

4.0 Site Investigations and study (Stage 3)

From the scoping stage of the BIA, a site investigation has been designed and implemented by Ground Engineering Limited. A copy of their report can be found in Appendix E, which includes a desk study, factual and interpretative reports.

The ground conditions on the site comprise made ground over London Clay. The Claygate member was not encountered on the site as suggested by the geological maps. The top of the London Clay is located approximately 1.5m below the ground level on average on the site with the exception of the south side of the site. Based on the boreholes and window sampling undertaken on the site, the top of the London Clay follows broadly the topography of the site in the south east direction. The site investigations confirmed that the London Clay along this boundary dips down and is located approximately 3.2m below the ground level. This is discussed in the Interpretative Site Investigation Report by Ground Engineering and this local depression in the London Clay is believed to be associated with an infilled pond.

Groundwater was encountered during the site works at a depth of 0.95m to 3m below the ground level on the site. Monitoring in January to March 2015 found a slight fluctuation in the groundwater level. The levels recorded showed the water level to be between 0.5m and 2.95m below the ground level.

The level of the groundwater is therefore within the depth of the basement or slightly above the basement roof slab at the rear of the site, which need to be considered in the proposed design of the basements. This is discussed in more detail in section 5.7.

The site investigation indicated the made ground contained elevated concentrations of lead, which exceeded the residential soil screening criteria. Ground Engineering Ltd propose that remediation of the soils beneath the site is only considered necessary in relation to the creation of new areas of gardens and soft landscaping as any new hardstanding, and building floors will prevent contact between any contaminated ground and the site end users. For any soft landscaping, soils will need to be removed to a depth of 0.6m and fresh topsoil used of the same thickness.

5.0 Impact Assessment (Stage 4)

The impact assessment stage of the BIA describes the impacts of the proposed basement development on the environment and how this will be mitigated in the design and construction. For the factual and interpretative site investigation reports refer to Appendix E.

5.1 Updated Ground Model

The ground model from the scoping stage has been updated to reflect the findings from the site investigation and shall be used to inform the design of the basement, its construction and assess its effects on the potential issues highlighted in the scoping stage.

Site location	11 Rosslyn Hill, Hampstead, London
Local geology	The geology of the locality comprises approximately 0.8m to 1.6m of made made ground over London Clay. The Claygate member was not encountered on the site. The thickness of the made ground layer was deeper at the southern end of the site in the garden area. This is likely to be associated with a previous pond as discussed in the site investigation report by Ground Engineering Ltd. The thickness of the London Clay stratum exceeds 20m in thickness.
Local ground levels	The site gently slopes to the south east
Local surface water or below ground water features	There is a feature underground along the southern boundary as discussed above under 'local geology'
Local groundwater level	The London Clay is sufficiently thick that it isolates the strata of the Lower Aquifer from the secondary aquifer on top of the London Clay
Local surface finishes	The surrounding area to the house is mostly soft landscaping. The front and sides of the house is covered in gravel and the garden at the rear (west side) is mainly covered in grass. A small area at the rear of the house is covered in paving slabs similar to the existing arrangement.
Current local surface water pathway	A proportion of local rainfall will be retained in the near surface soil (made ground and topsoil) with a proportion evaporating into the atmosphere or being taken up by plant and tree root systems and some may percolate down and enter the secondary groundwater system on top of the London Clay/Claygate member. The top of the London Clay dips in the same direction as the local topography and the groundwater follows the natural topography of the site in the south east direction and the basement design will be detailed to maintain the status quo of the ground water flows. A further proportion of local rainfall will run off the hard surfaced areas (existing buildings on the site) into the main surface water sewers.

5.2 Design of basement

The proposed structure drawings are included in Appendix H. There are two basements that are to be constructed on the site to provide additional facilities for the owners of No 11 Rosslyn Hill. At the front of the house (east side), a new basement structure is to be provided with a swimming pool. This basement is to include a small double storey section in the south west corner. This space is to be linked to the lower ground floor level of the house and the new dining room extension at the rear of the house at ground level. This link will be created by a new lightwell at lower ground floor level that extends along the south elevation of the building. From the lightwell, the basement then wraps around the south west corner of the house, which will provide a new plant room for the ground source heating system. A new timber framed annexe building is to be constructed above the basement at the south eastern corner of the site.

The second basement is to be provided at the north western corner of the house and is to accommodate a new cinema.

Two local areas of the existing footings to the existing building will be underpinned with mass concrete underpins to allow the new lightwell and the basement on the north west corner of the house to be constructed as shown on the proposed drawings.

The retaining walls to the new basements will generally be formed with bored contiguous piles. As discussed in section 4.0, the site investigations encountered an infilled pond beneath the southern edge of the site. In this area, the water table was recorded to be approximately 3.2 metres above the London Clay stratum. Because of the this large head of water the new basement along the southern boundary of the site will be adopt a bored secant pile wall without any gaps between the piles. The piled walls will be faced with a reinforced concrete lining wall.

Water in the ground will exert a hydrostatic pressure on the basement structures. The piled retaining walls will be designed to resist a worst case situation of the water level rising to within a half a metre of ground level. Refer to Appendix J for preliminary design calculations for the piled retaining wall.

The roof slab will generally be set at 1 metre below the ground level for the basement on the east side of the site. This meets the desired depth set out in Camden Council's planning policy CPG 4. The roof slab for the basement at the north west corner of the house, will be set at 0.5m below the ground level, which is in in accordance with the minimum depth specified in the CPG 4. The roof slabs are to be supported on the piled walls at their edges. The basement floor slab is to be supported on the piled walls and internal pile caps and ground beams. All piles will extend into the London clay. The basement roof and floor slab are to provide permanent propping to the piled retaining walls.

A void former is to be provided underneath the new basement slabs to allow for heave as discussed further in section 5.6. A drainage layer is also to be provided beneath the basement slab to allow any small quantities of water percolating up through the London Clay to be drained away from the basement into the local surface water sewers. This is to avoid a hydrostatic pressure building up underneath the basement slab.

The new piled walls have been set back from neighbouring buildings and the house on the site to provide the necessary working room to allow them to be installed. The sequence of construction of the basements is discussed in section 5.3.

The swimming pool tank is to be supported on the basement slab, which in turn will be supported on internal ground beams and piles. At the interface of this basement with the east elevation of the building, a short section of the 20th century retaining wall to the lightwell will be replaced in order to install the new piled retaining wall. The lightwell wall will be reinstated above the piled wall once the basement construction is complete.

The waterproofing strategy detailed by the architect will comprise of a drained cavity. Any small amounts of water that seep through the concrete structure will be collected and discharged into the drainage system.

5.3 Sequence of construction for the basement

A construction sequence of the basement has been carefully considered and has been developed to suit conventional techniques that reduce, as far as is practicable, the impact on ground movements and disturbance to neighbours.

The contractor is to adopt Considerate Contractors Standards and should comply with the requirements set out in the Camden Council Planning Policy CPG 4. He will be required to mitigate noise and dust throughout the construction works. This will be achieved through the use of screens, hoarding and appropriate construction techniques. A sequence of construction for the basement is summarised below and illustrated in Appendix I.

5.4 Programme

Based on basement developments of a similar scale and considering the site constraints and construction access, the construction of the basement structures is expected to last around 7-8 months.

5.5 Construction Management Plan

A Construction Management Plan has been prepared by Paul Mew Associates. For further details on this, refer to Paul Mew Associates Report. The Contractor will be required to submit his own Construction Management Plan and Site Waste Management Plan prior to work commencing on site. The contents of this plan must be in accordance with The London Borough of Camden's guidance and be agreed by them.

5.6 Ground Movements and Structural Damage

A ground movement assessment in accordance with CIRIA C580 has been carried out and the impact of ground movements on nearby structures assessed in accordance with the Burland Categories of damage. Refer to Appendix J for details of this assessment.

The assessment shows that the impact on the surrounding buildings should be no greater than 'Damage category 2' in accordance with the Burland Category of Damage. These are within the acceptable limits set out by Camden's planning guidance on basements in CPG4. This form of assessment is conservative and in reality any damage is likely to be less than identified in this assessment.

The structural proposals have been designed to provide stiff restraint to the basement retaining walls in the permanent cases. During the construction phase, temporary stability of the piled retaining walls will be provided by lateral propping to allow the excavations to extend to the basement formation level. In the permanent case the in-situ reinforced concrete basement floor and basement roof slabs will provide the propping action to the piled retaining walls.

During construction the contractor will be required to undertake monitoring of the groundwater levels and ground conditions encountered to ensure that the assumptions and findings from the BIA remain valid.

To allow for heave of the London Clay because of a reduction of the loading on it when the basement is excavated, a compressible void former will be incorporated below the basement slab. This material acts as permanent shuttering and is able to support the construction weight of the slab but will compress under the pressure from the heave movements and transmit a relatively small load to the permanent structure. The site investigation confirms this and gives an indication of the likely swelling pressures beneath the basement slab. For details refer to the site investigation report in Appendix E.

5.7 Impact of basement on groundwater, surface water and soil

The measured ground water levels during the monitoring period in January and February 2015 shows that the water table is located between 0.5 and 3 metres below the ground level. The top of the London Clay stratum was confirmed during the site investigation in 12 locations across the site. The existing ground water flows on the site are shown in Appendix F. Lyndhurst Hall, situated on the north side of the site has foundations that bear onto the London Clay stratum. These foundations prevent ground water in the secondary aquifer from flowing directly onto the site. Ground water from the north will therefore be directed around Lyndhurst Hall as shown in Appendix F. The groundwater flows on the site is principally as a result of these diverted flows, that flow onto the site at its western end and flows in the south east direction across the site. The effect of Lyndhurst Hall blocking the groundwater flows onto the site means that ground water in the secondary aquifer over much of the site is generated from rainfall that falls directly on the site only. In these areas only small flows towards the south east of the site have been found.

The proposal is, as far as practicable, to maintain the status quo of the ground water flows on the site. This will be achieved by setting the new basement roof slab at the top of the clay layer on the east side of the house. A minimum of 1.0m depth of topsoil over the top of the new basement construction will be reinstated to allow the ground water to flow as existing and be absorbed by vegetation.

The basement roof slab will be set at a depth of 0.5 metres below ground level in the gap between the existing house and the new annexe building. Based on the existing ground water flow patterns above the London Clay in this area, the ground water does not get channelled into this gap and therefore the impact this will have on the ground water flows is negligible.

Along the west elevation of the building, the London Clay is located at a deeper level. Where the new basement is positioned at the north west corner of the house, there are no ground water flows present apart from the rainfall that falls on the footprint of the basement itself. The roof slab is to be set at 0.5m depth below the ground level and will allow ground water to flow as existing in this area and be absorbed by vegetation. It is proposed to extend the roof slab up to the face of Lyndhurst Hall to avoid rainwater falling into the gap between the new basement and the Hall’s footings.

The proposed new basement at the south west corner of the house extends into the area of the depression in the top surface of the London Clay along the south side of the site. Here, the top of the clay is in the order of 3.2 metres below ground level. In this location, the retaining walls will be formed by a secant piled wall. Elsewhere, where there is a small amount of perched water only on top of the London Clay, a contiguous piled wall will be adopted.

The strategy for the ground water flows described above are summarised in Appendix G.

5.8 Comparison of existing and proposed site

In accordance with the Camden Policy Guidance, the table below summarises the existing situation and the effect on this of the proposals.

Attribute	**Existing situation**	**Proposed**
Groundwater levels	Perched groundwater was found approx. 0.5 to 3m below the ground level	This is unchanged in the proposed scheme
Structural integrity of surrounding structures	As existing	Burland Category 2 or less (within acceptable limits outlined in CPG4) hence no further mitigation measures needed
Contamination	Elevated concentrations of lead in the made ground	Contaminated soil to be replaced in areas of soft landscaping as discussed in section 4.0
Surface water run offs	Surface water that falls on the site will infiltrate into soft landscaping and flow through the secondary aquifer following the topography of the site in the south east direction	Unchanged, the surface water flows follow the existing patterns on the site

5.9 Impact of the proposal development on existing trees

There are several trees on the site along the southern boundary of the site as shown on the site plan in Appendix C. The proposed basement at the front of the house in the south east corner of the site is partly located within a tree protection zone. An air spade investigation has been undertaken at the early stage of the project to determine the presence of tree roots along the southern boundary. The results of these investigations are included in Appendix K. The air spade investigations showed that there were no significant tree roots present (trench 3) in the area by the house where the new basement is proposed.

The new single storey dining room extension at the south west corner of the house is also partly located within the tree protection zone. This structure is to be raised above the ground level and involves a suspended ground floor slab that is supported on small diameter piles in order to reduce the excavation and consequently impact on tree roots. The pile caps are to project above the ground level to reduce the excavation needed locally for the pile caps. An air gap is to also be provided beneath the ground floor slab to allow air to access the tree roots.

For more information refer to Arboroculturalist's report in Appendix K.

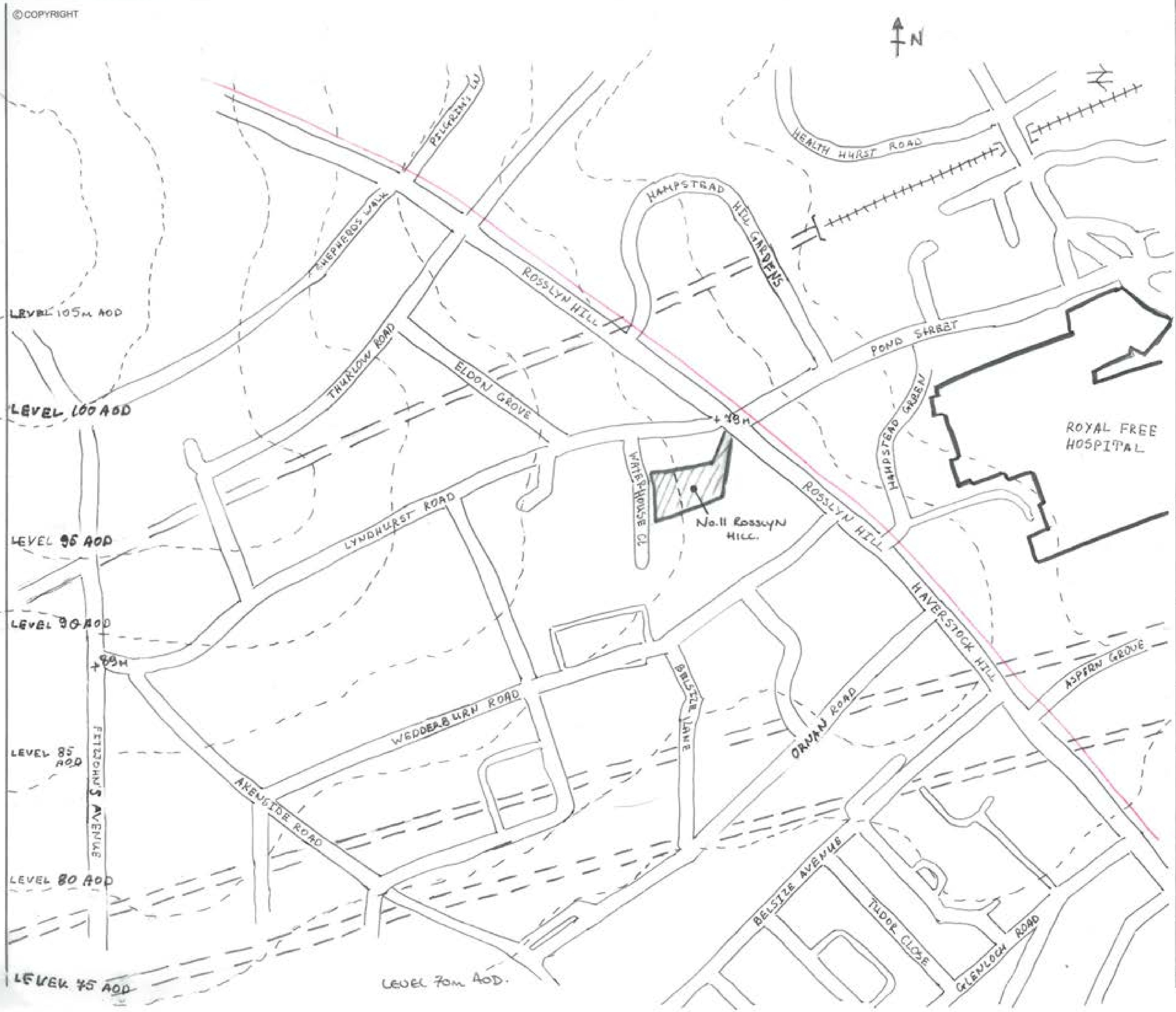
5.10 Conclusions

A basement impact assessment, as required for planning by the London Borough of Camden has been undertaken by Alan Baxter & Associates and Ground Engineering Limited for the proposed basements on the No. 11 Rosslyn Hill site.

Issues requiring further consideration were highlighted in the screening stage and the scope of the subsequent site investigation was defined in order to investigate the identified issues in more detail. These works were undertaken by Ground Engineering Ltd in January 2015.

The engineering rationale and construction issues associated with the proposed construction of the new basements have been explored and summarised in this report. A structural scheme design has been prepared, which aims as far is practicable to maintain the status quo for the existing local groundwater regime, slope stability, surface water regime and adjacent structures. The buildability of the proposed scheme has also been explored and the principles for the sequence of construction defined.

Appendix A Site location, historical development, topography and photos



notes

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND THE SPECIFICATION.

2. KEY:

SITE – No.11 ROSSLYN HILL

RAILWAY

RAILWAY IN TUNNEL

LU – NORTHERN LINE

RAILWAY STATION

–	24/3/15	ISSUED FOR PLANNING	FW

job

11 ROSSLYN HILL, NW3

title

OVERALL CONTOUR MAP

drawn	checked
RK	RWa.
date	scale (original - A1)
FEB '15	1:2500

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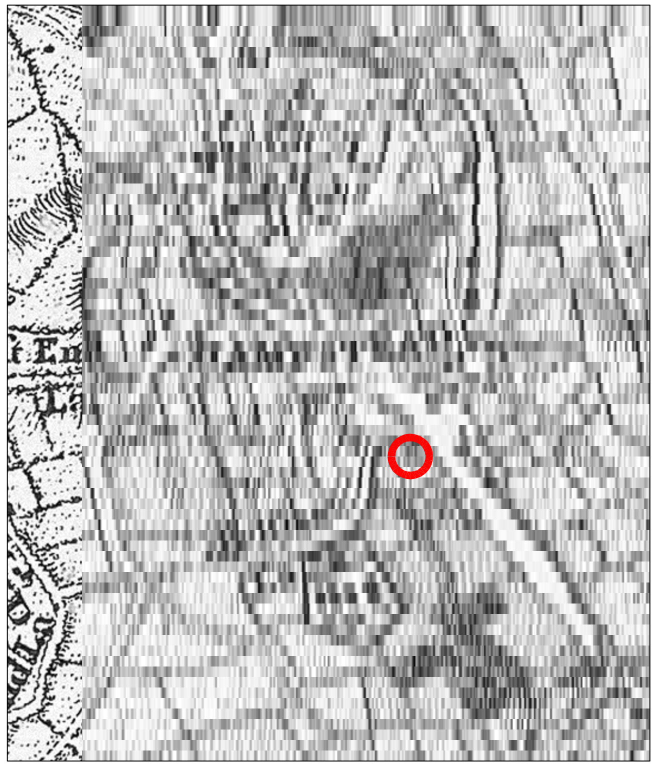
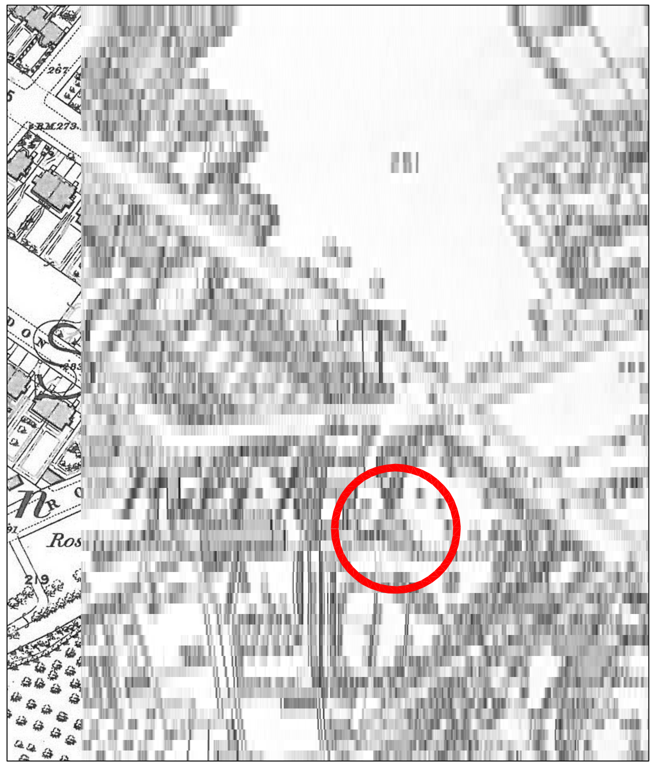
1693/01/02	-



LARGE MANOR WILDE'S HOUSE WAS BUILT CIRCA 1560. SITE OF NO. 11 ROSSLYN HILL WAS NOT DEVELOPED YET.

1766

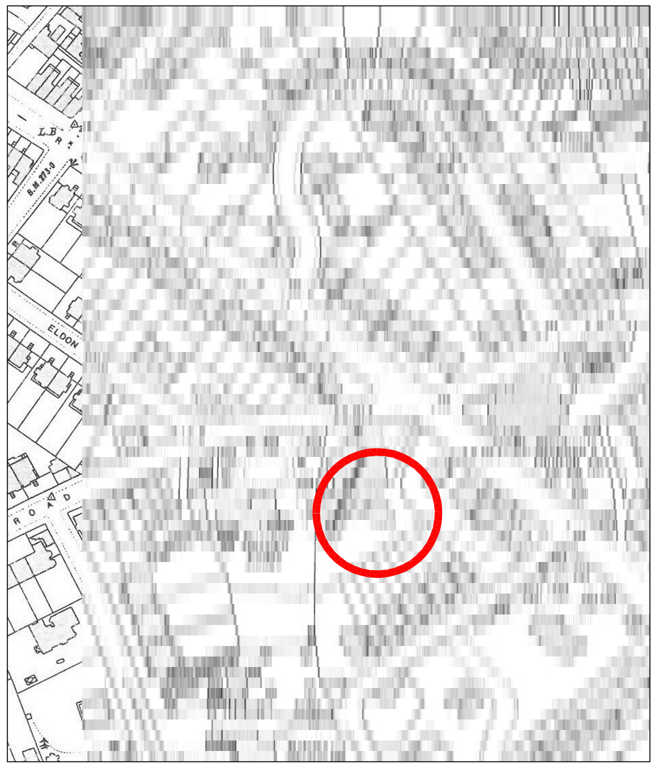


No. 11 ROSSLYN HILL WAS BUILT IN 1770 IN THE LANDSCAPED GROUND OF FORMER WILDE'S HOUSE. NO. 11 ROSSLYN HILL WAS LOCATED TO THE SOUTH EAST OF THE LOCATION OF THE WLDE'S HOUSE CLOSE TO AN INFILLED LANDSCAPED POND.

1866

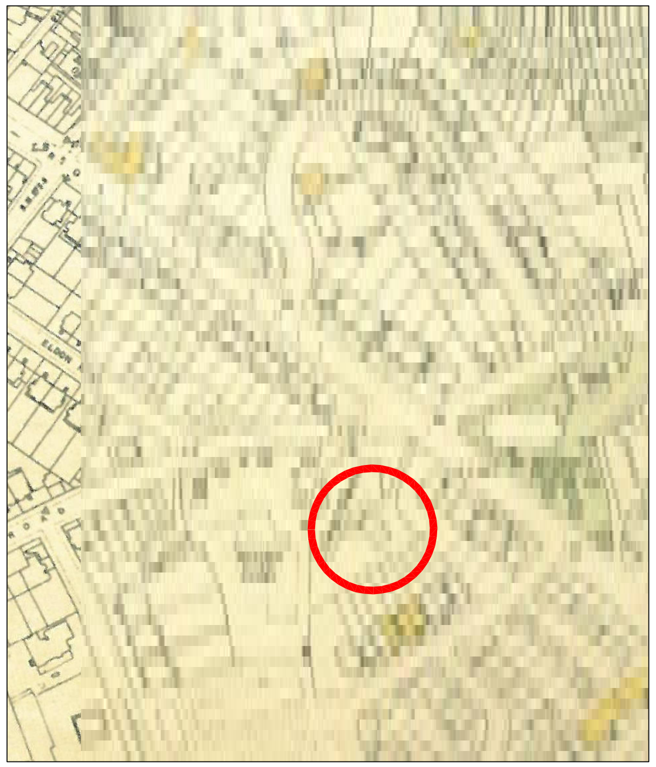
HAMPSTEAD RAPIDLY DEVELOPED. DURING THIS PERIOD BOTH TERRACE AND SEMI-DETACHED HOUSES TO THE EAST OF THE SITE, AND LYNDHURST CHAPEL TO THE NORTH WERE BUILT, FORMING THE DISTINCT PLOT THAT NO. 11 ROSSLYN HILL RESIDES.

1894



LYNDHURST CHAPEL WAS EXTENDED TO THE WEST TO FORM AN ADDITIONAL HALL SPACE FOR THE CHAPEL.

1915



BOMB DAMAGE MAP SHOWS THE SITE WASN'T EFFECTED. FEW HOUSES TO SOUTH OF THE SITE WERE DAMAGED MINOR IN NATURE.

1939–1945

IN THE 1960's A ROW GARAGES WERE BUILT DIRECTLY ADJACENT TO THE EAST BOUNDARY, REPLACING ONE OF THE VICTORIAN TOWNHOUSES ON HAVERSTOCK HILL. AT A SIMILAR TIME THE SINGLE STOREY STUDIO BUILDING AND THE TIMBER SHED WERE CONSTRUCTED. THE SITE AND THE ADJACENT PROPERTIES HAVE REMAINED MATERIALLY UNCHANGED SINCE THE 1970's.

1974–2015

notes

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND THE SPECIFICATION.

	24.3.15	Issued for information	FN

job
11 ROSSLYN HILL, NW3

title
HISTORICAL DEVELOPMENT OF SITE

drawn: RG
checked:
date: MAR'15
scale (original - A1): N.T.S.

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drg. no. **1693/01/04**
rev. -

Photo Sheet

Project	Job no.		Sheet	
Name of Site/Project 11 Rosslyn Hill, NW3	1693/01		1	Alan Baxter 75 Cowcross Street London EC1M 6EL tel 020 7250 1555 fax 020 7250 3022 email aba@alanbaxter.co.uk www.alanbaxter.co.uk
	Taken by RWa	Date 19/03/2015		

03

04

Photo Sheet

Project	Job no.		Sheet	
Name of Site/Project 11 Rosslyn Hill, NW3	1693/01		2	Alan Baxter 75 Cowcross Street London EC1M 6EL tel 020 7250 1555 fax 020 7250 3022 email aba@alanbaxter.co.uk www.alanbaxter.co.uk
	Taken by RWa	Date 19/03/2015		

05

06

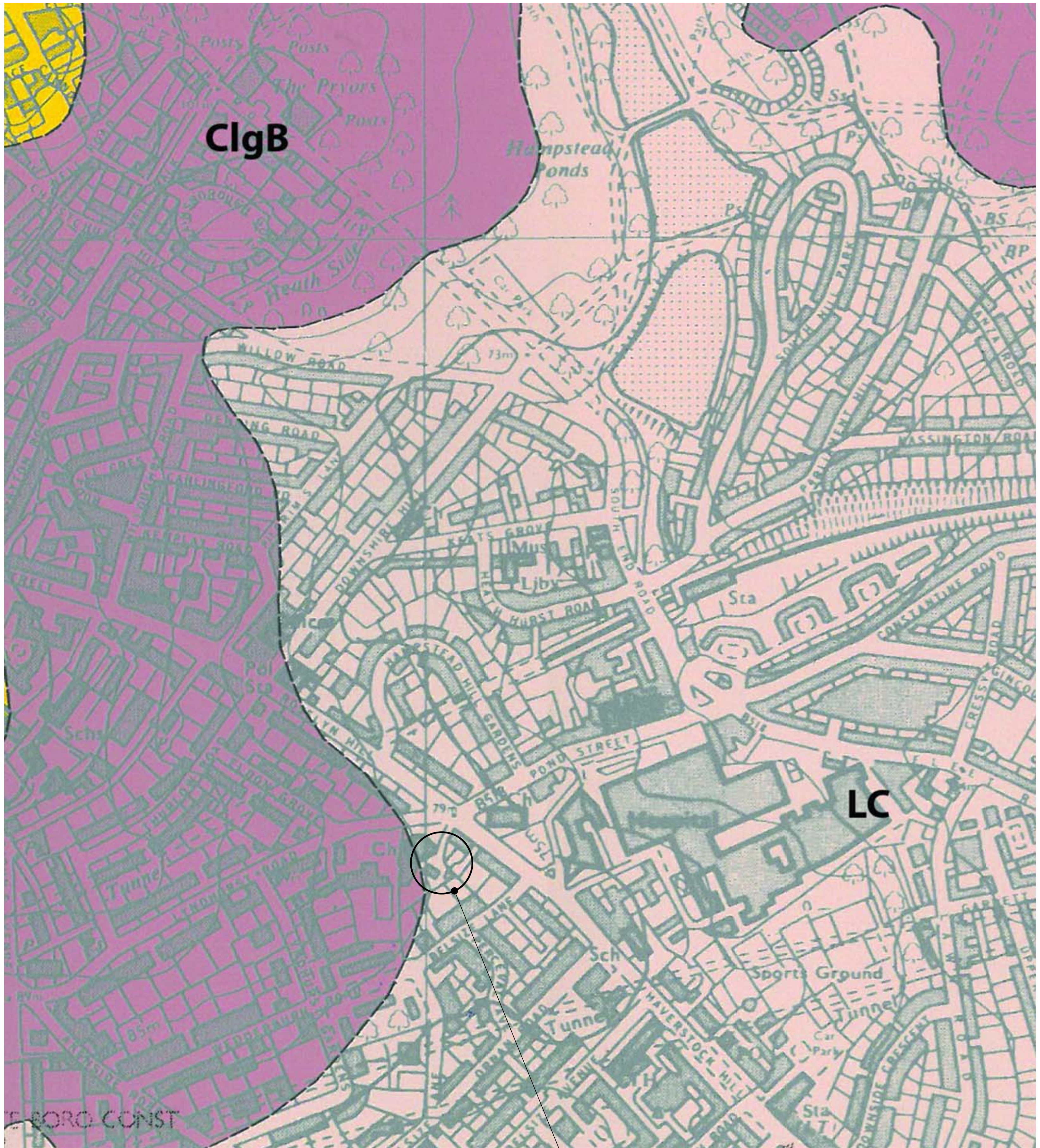
Photo Sheet

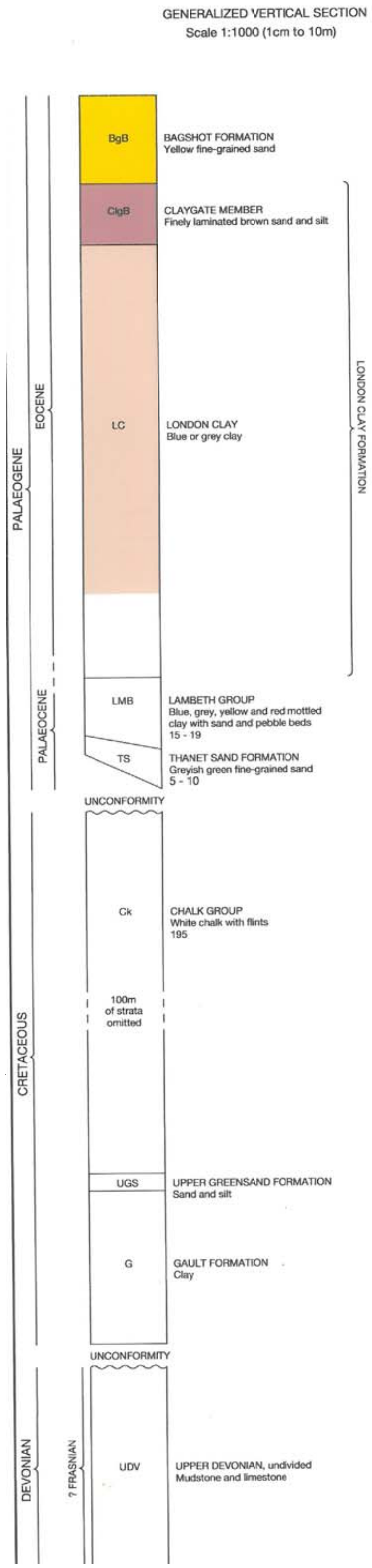
Project	Job no.		Sheet	
Name of Site/Project 11 Rosslyn Hill, NW3	1693/01		3	Alan Baxter 75 Cowcross Street London EC1M 6EL tel 020 7250 1555 fax 020 7250 3022 email aba@alanbaxter.co.uk www.alanbaxter.co.uk
	Taken by RWa	Date 19/03/2015		

07

08

Appendix B – Geology map





notes

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	24.3.15	Issued for information	FN

job

11 ROSSLYN HILL, NW3

title

GEOLOGICAL MAP

drawn	checked
RG	
date	**scale (original - A3)**
MAR'15	N.T.S

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1693/01/03	-

Appendix C – Screening flowcharts

Hydrology (Surface water flow and flooding) screening

Screening Question No.	Screening Question	BIA response	Carried forward to Scoping (Y or N)
1	Is the site within the catchment of the pond chains on Hampstead Heath?	No, the site is well removed from these ponds, and outside the catchment area shown on Figure 14 of Arup's Hydrogeological study – Hampstead Heath Surface Water Catchments and Drainage.	N
2	As part of the proposed site drainage, will surface water flows (e.g. volume of rainwater and peak run-off be materially changed from the existing route?	No, the water flows from run-offs and rainfall will be materially unchanged following the construction of the basement.	N
3	Will the proposed basement development result in a change in the proportion of hard surfaced/paved external areas?	Yes, the area of hardstanding surfaces will be slightly increased	Y
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 water courses?	There will be no changes in the profile of the inflows of surface water being received by the adjacent properties or downstream watercourses.	N
5	Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream water courses?	There will be no change in the quality of the surface water being received by the adjacent properties or downstream watercourses as the use of land remains unchanged.	N
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 static water level of a nearby surface water feature?	No, refer to figure 15 of Arup's Hydrogeological study – Hydrology and Hydrological Study Floor Map	N

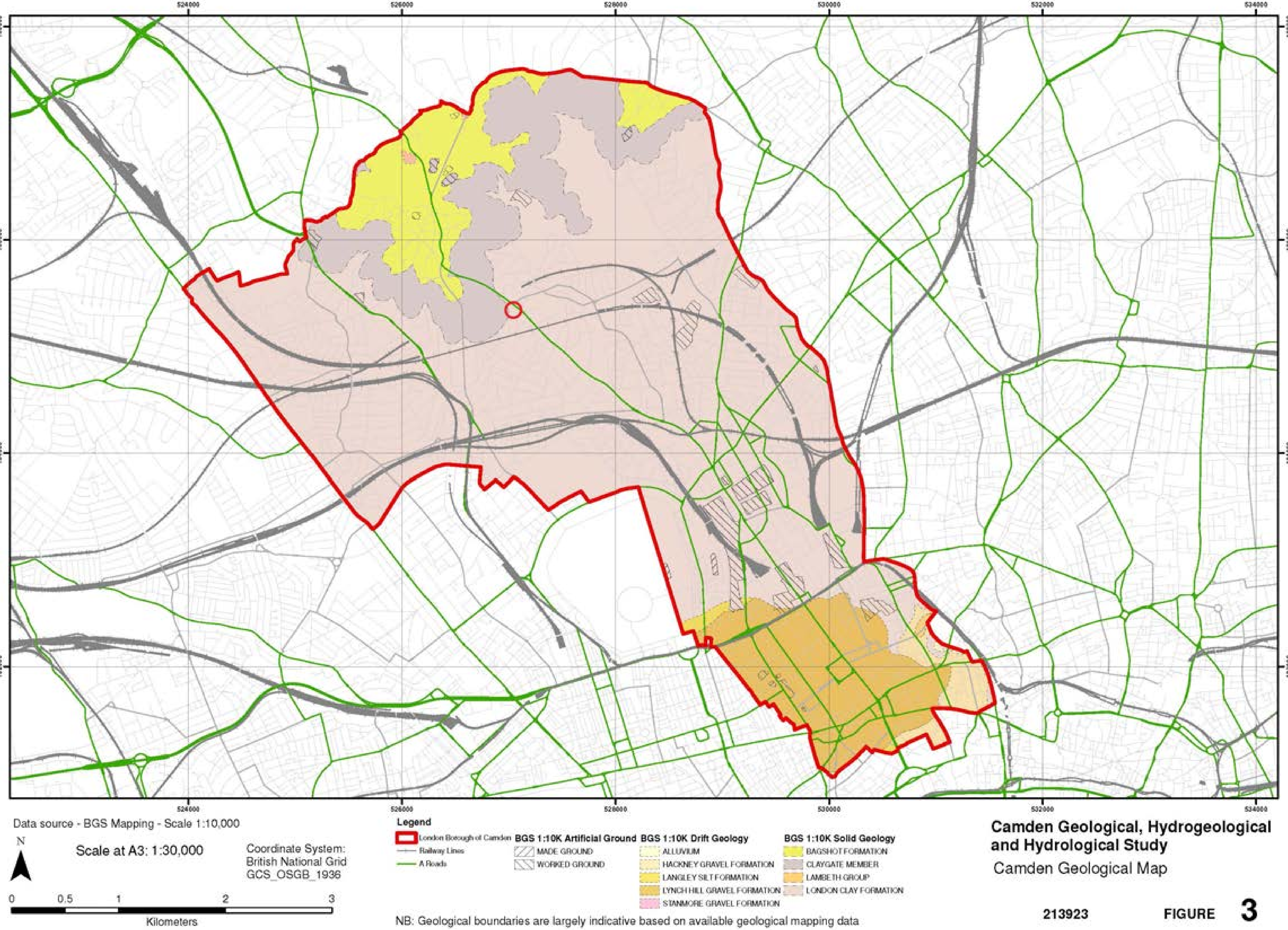
Hydrogeology (Groundwater) flow screening

Screening Question No.	Screening Question	BIA response	Carried forward to Scoping (Y or N)
1a	Is the site located directly above an aquifer?	The maps in Appendix (TBC) show the site is not located above an aquifer. This is shown in figure 8 of Arup's Hydrogeological study. The closest aquifer is the secondary A aquifer, approximately 500m north west of the site.	N
1b	Will the proposed basement extend beneath the water table surface?	It is unclear whether the basement will extend below the water table.	Y
2	Is the site within 100m of a watercourse, well (used/disused) or potential spring line?	No, the site is not within 100m of a watercourse, well (used/disused) or potential spring line. The closest known watercourse is a large culvert, formerly the River Fleet, approximately 180m to the east.	N
3	Is the site within the catchment of the pond chain on Hampstead Heath?	No, the site is well removed from these ponds, and outside the catchment area shown on Figure 14 of Arup's Hydrogeological study – Hampstead Heath Surface Water Catchments and Drainage	N
4	Will the proposed basement development result in a change in the proportion of hard surfaced/paved areas?	Yes, the area of hard standing will increase as a result of the proposed development.	Y
5	As part of the site drainage, will more surface water (e.g. rainfall and run-off) than present be discharged into the ground (e.g. via soakaways and/or SUDS)?	No, the status quo of the surface water will be maintained	N
6	Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to, or lower than, the mean water level in any local pond (not just the pond chain on Hampstead Heath) or spring line?	No, the elevation of the site is approximately 80m AOD and there are no ponds or spring lines hydraulically connected to the site	N

Slope and ground stability screening

Screening Question No.	Screening Question	BIA response	Carried forward to Scoping (Y or N)
1	Does the existing site include slopes, natural or manmade greater than 7^o (approx. 1 in 7)?	No, Figure 16 of Arup's Hydrogeological report – Slope angle map shows the site has a gradient of less than 7degrees. Site observations have confirmed this	N
2	Will the proposed re-profiling of landscaping at site change slopes at the property boundary to more than 7^o (approx. 1 in 7)?	No, the proposal does not include landscaping that affected the boundaries or create gradients on the site greater than 7degrees	N
3	Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7^o (approx. 1 in 7)?	No, the site is not adjacent to any cuttings or landscaping with a slope greater than 7degrees. Figure 16 of Arup's Hydrogeological report and site observations have confirmed this is the case	N
4	Is the site within a wider hillside setting in which the general slope is than 7^o (approx. 1 in 7)?	No. Figure 16 of Arup's report – Slope angle map, shows the site is located on a hill with a wider gradient of less than 7 degrees.	N
5	Is the London Clay the lowest strata at the site?	Yes, the London Clay is the lowest strata on the site. Refer to Figure 3 of the Arup Hydrogeological report – Camden Geology Map.	Y
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?	Yes, a small section of the basement encroaches into the root protection zone of the trees along the south boundary. Refer to Arboriculturalist's reports for more details.	Y
7	Is there a history of seasonal shrink-well subsidence in the local area, and/or evidence of such effects on site?	There are no signs on the site of such effects	N

8	Is the site within 100m of a watercourse or a potential spring line?	No, the site is not within 100m of a watercourse, well (used/disused) or potential spring line. The closest known watercourse is a large culvert, formerly the River Fleet, approximately 180m to the east.	N
9	Is the site within an area of previously worked ground?	Historical records and Figure 3 of Arup's Hydrological report – Camden Geological report indicate the site is not on worked ground.	N
10	Is the site within an aquifer? If so, will the proposed basemen extend beneath the water tale such that dewatering may occur during construction?	The maps in Appendix (TBC) show the site is not located above an aquifer. This is shown in figure 8 of Arup's Hydrogeological study. The closest aquifer is the secondary A aquifer, approximately 500m north west of the site.	N
11	Is the site within 50m from the Hampstead Heath ponds?	No, Figure 14 of Arup's Hydrogeolgical report –Hampstead Heath Surface Water Catchment and Drainage – and Figure 13 Hampstead Heath Map – show that the site is well removed from the Hampstead Heath Pond Chain.	N
12	Is the site within 5m of a highway or pedestrian right of way?	No, the proposed basement is not within 5m of a highway or public right of way, however, the overall site does have an entrance onto Haverstock Hill.	N
13	Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Yes, the basement is being formed adjacent to neighbour's garages. The garages are likely to be founded at a similar level to the east boundary wall, given that they post date the boundary wall.	Y
14	Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	No, based on our in-house information the site is outside of any exclusion zones. The LU Northern Line runs approximately 100m to the east, under Haverstock road.	N

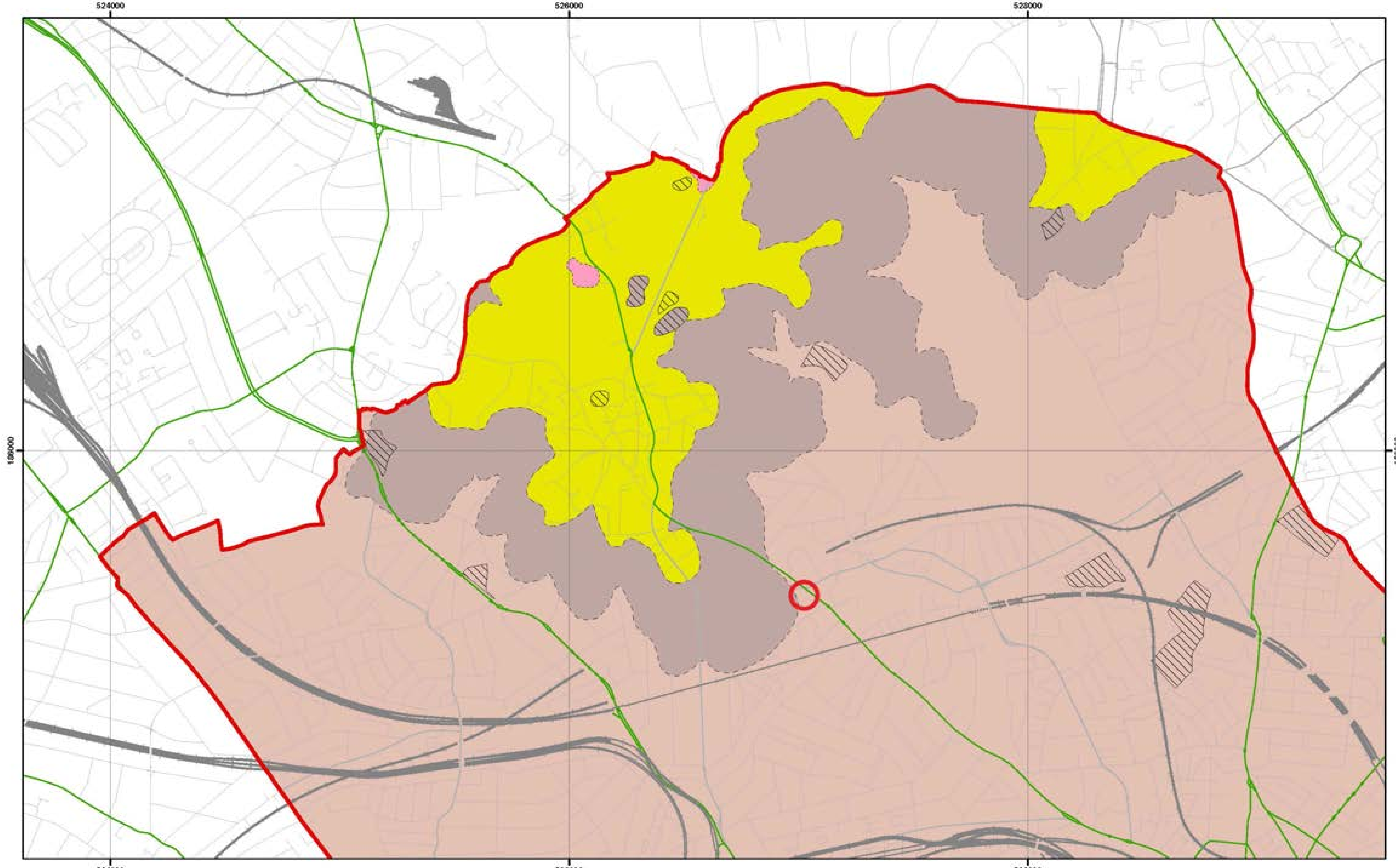


Camden Geological, Hydrogeological and Hydrological Study

Camden Geological Map

213923

FIGURE 3



Data Source: BGS Mapping - Scale 1:10,000

N

Scale at A3: 1:15,000

Coordinate System:
British National Grid
GCS_OSGB_1936

0 0.25 0.5 1 1.5

Kilometers

Legend

London Borough of Camden

Railway Lines

A Roads

BGS 1:10K Artificial Ground

MADE GROUND

WORKED GROUND

BGS 1:10K Drift Geology

ALLUVIUM

HACKNEY GRAVEL FORMATION

LANGLEY SILT FORMATION

LYNCH HILL GRAVEL FORMATION

STANMORE GRAVEL FORMATION

BGS 1:10K Solid Geology

BAGSHOT FORMATION

CLAYGATE MEMBER

LAMBETH GROUP

LONDON CLAY FORMATION

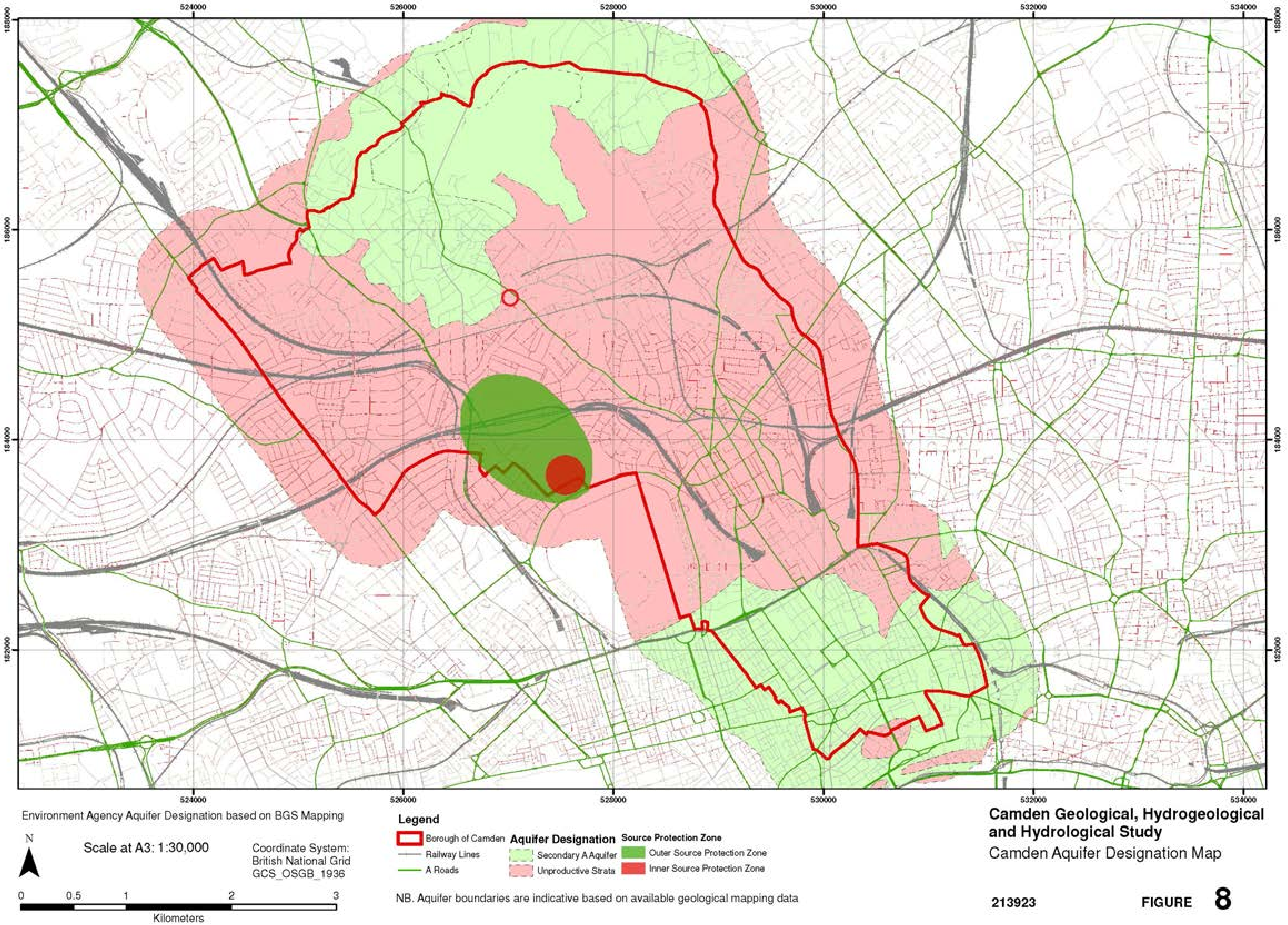
NB. Geological boundaries are largely indicative based on available geological mapping data

Camden Geological, Hydrogeological and Hydrological Study

North Camden Geological Map

213923

FIGURE 4

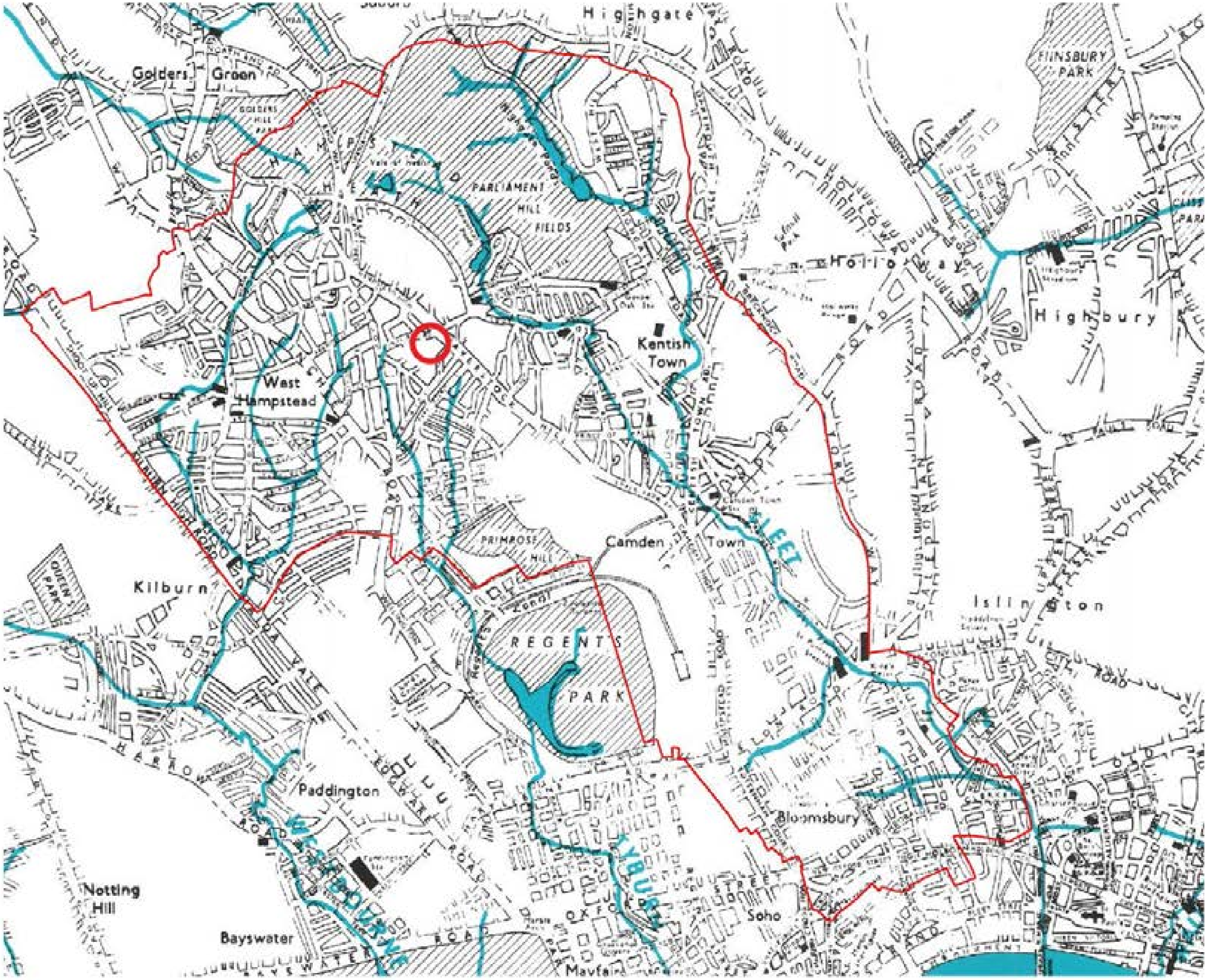


Camden Geological, Hydrogeological and Hydrological Study

Camden Aquifer Designation Map

213923

FIGURE **8**

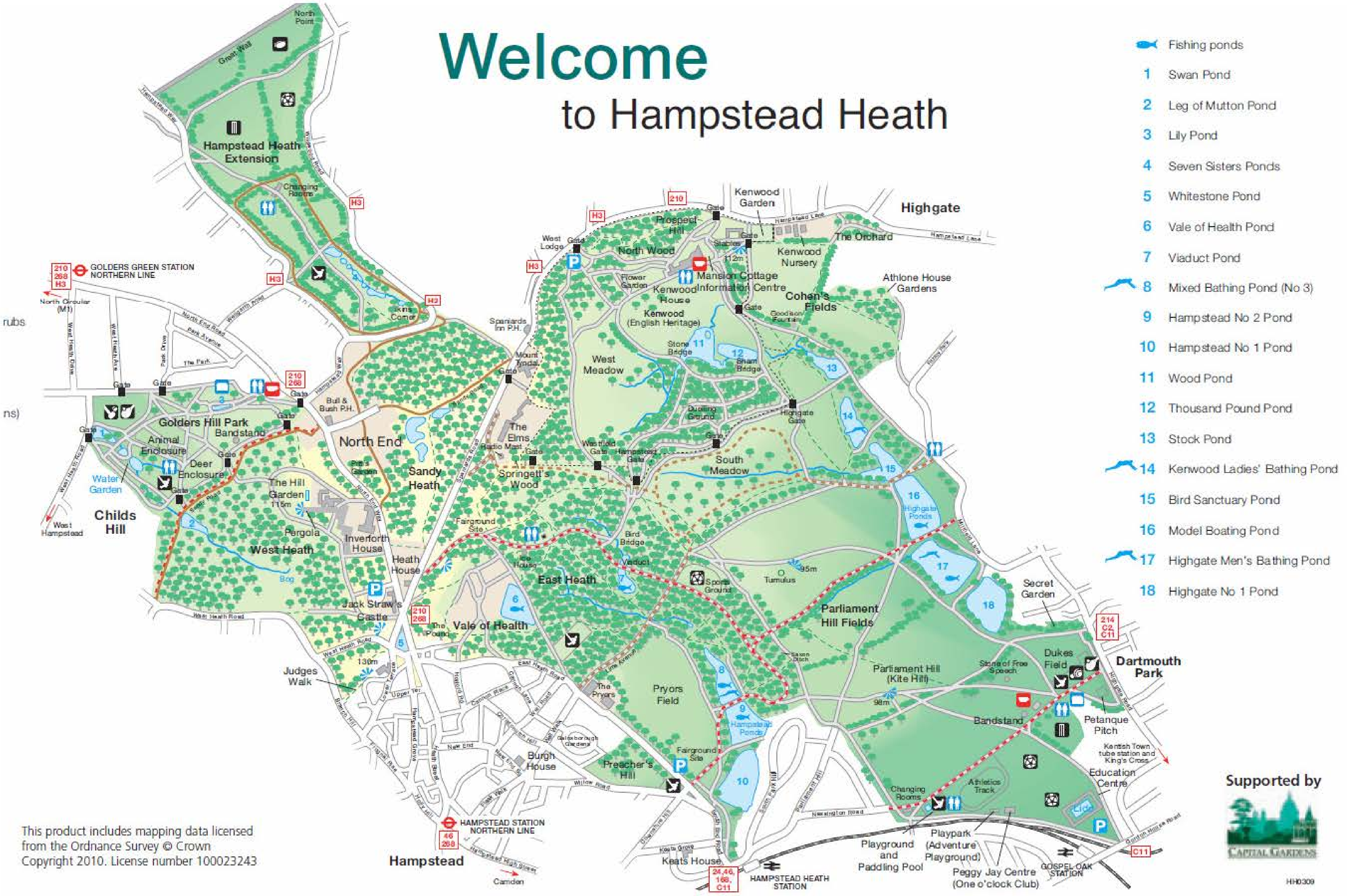


Source – Barton, Lost Rivers of London

Camden Geological, Hydrogeological and Hydrological Study
Watercourses

213923

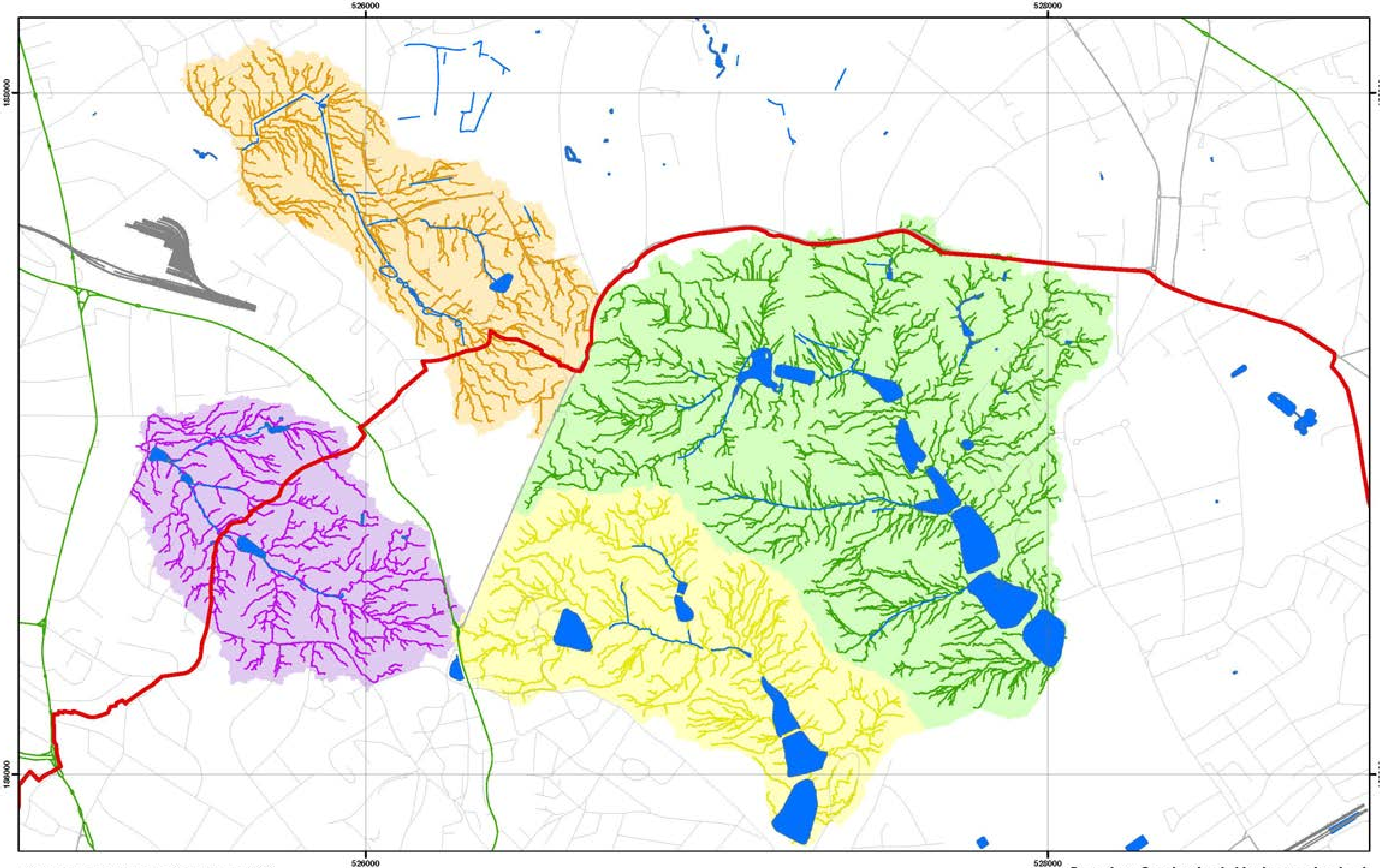
FIGURE **11**



Source – City of London, 2010, Welcome to Hampstead Heath Leaflet

Camden Geological, Hydrogeological and Hydrological Study
Hampstead Heath Map

213923 **FIGURE 13**



Catchments and Drainage after Haycock, 2010

N

Scale at A3: 1:10,000

0 0.125 0.25 0.5 0.75 1

Kilometers

Coordinate System:
British National Grid
GCS_OSGB_1936

Legend

- London Borough of Camden
- Railway Lines
- A Roads
- Surface Water
- Highgate Chain Catchment
- Golders Hill Chain Catchment
- Hampstead Chain Catchment
- Hampstead Heath Extension Chain Catchment

Camden Geological, Hydrogeological and Hydrological Study

Hampstead Heath Surface Water Catchments and Drainage

213923

FIGURE 14

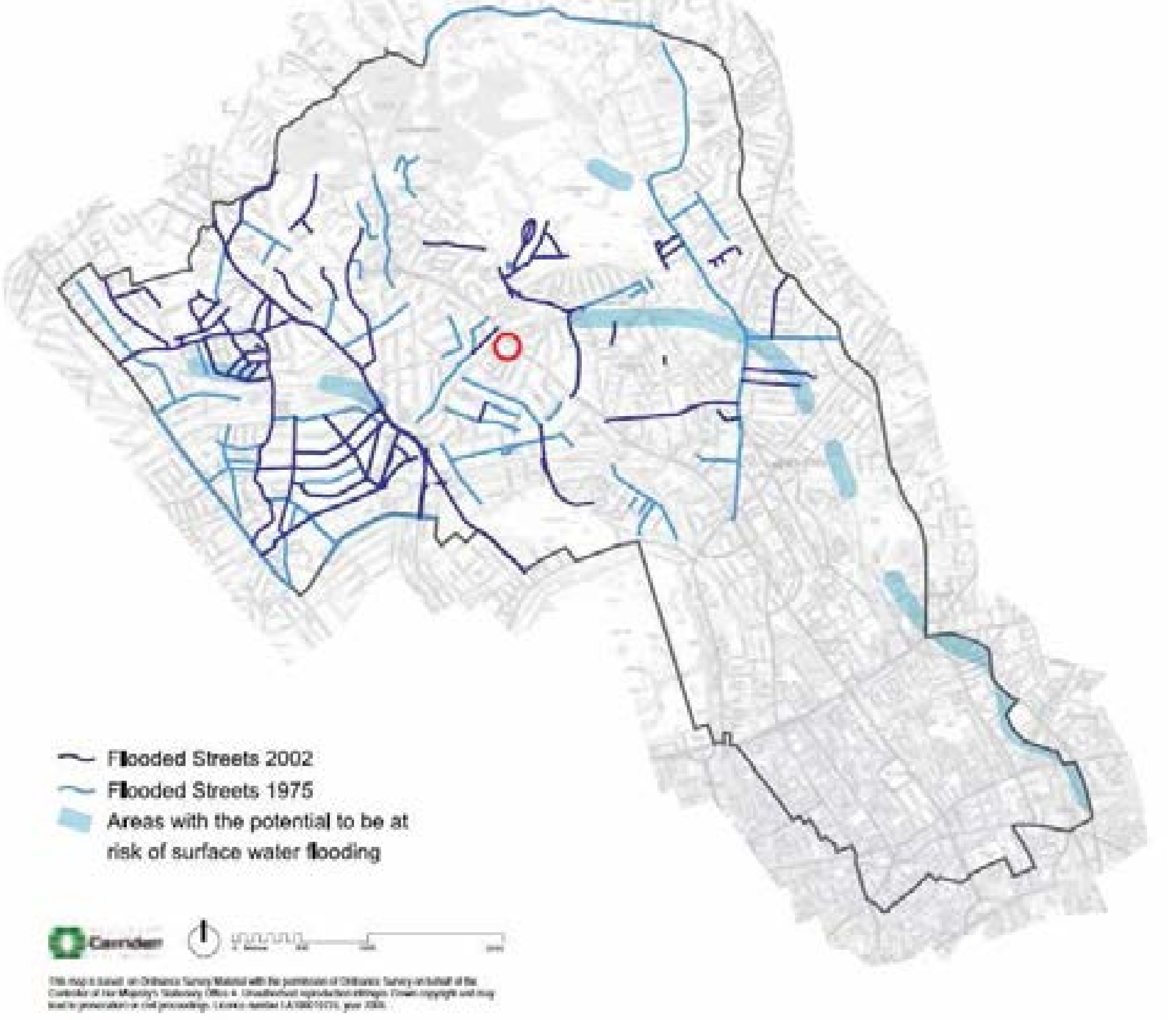
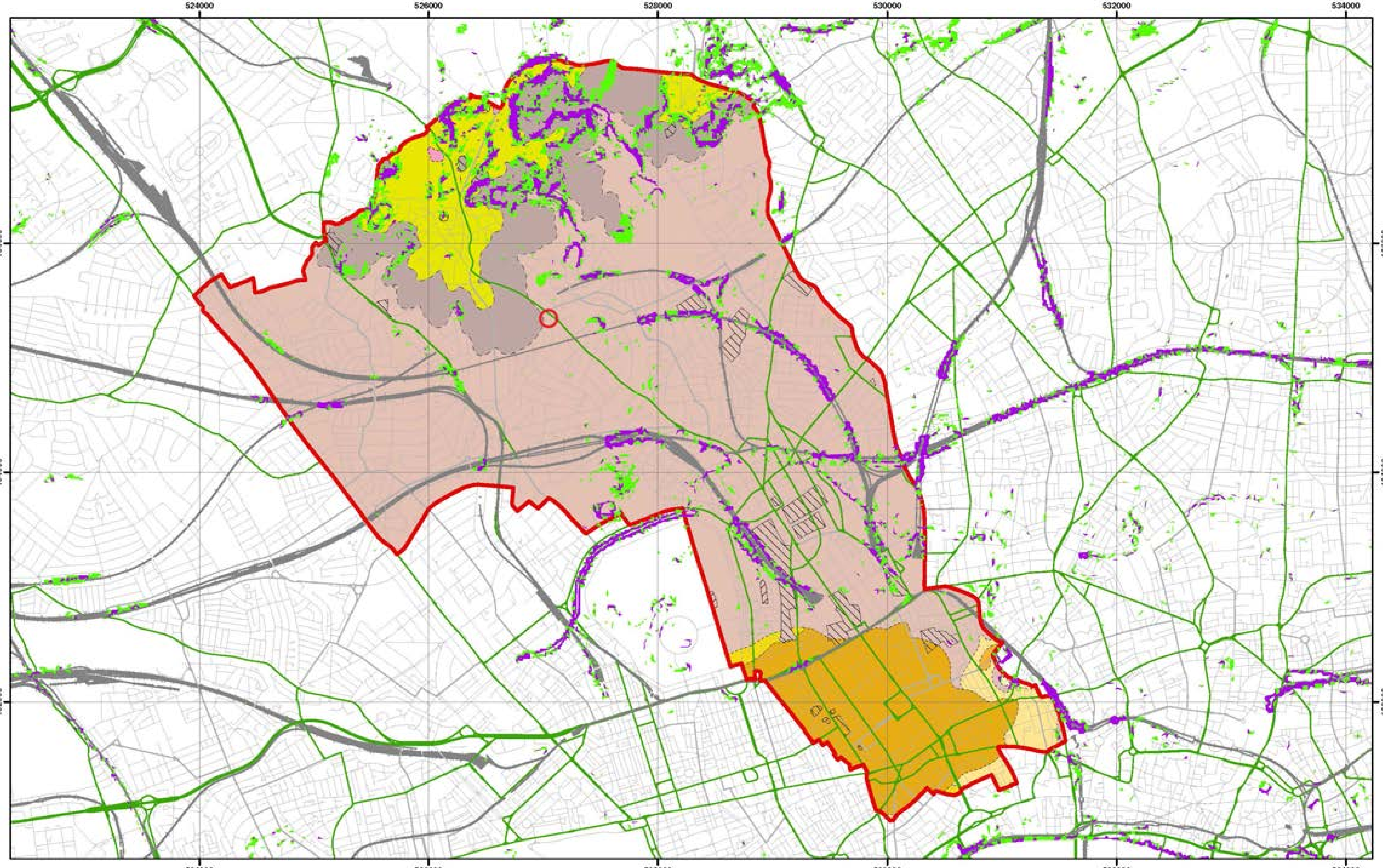


Figure 5 from Core Strategy, London Borough of Camden

Camden Geological, Hydrogeological and Hydrological Study
Flood Map

213923

FIGURE 15



Slope Angles calculated from Digital Terrain Model Provided By Camden Bourough Council

N

Scale at A3: 1:30,000

0 0.5 1 2 3

Kilometers

1:10,000 BGS Mapping
Coordinate System:
British National Grid
GCS_OSGB_1936

Legend

Slope		BGS 1:10K Artificial Ground	BGS 1:10K Drift Geology	BGS 1:10K Solid Geology
0° - 7°	London Borough of Camden	MADE GROUND	ALLUVIUM	BAGSHOT FORMATION
7° - 10°	Railway Lines	WORKED GROUND	HACKNEY GRAVEL FORMATION	CLAYGATE MEMBER
> 10°	A Roads		LANGLEY SILT FORMATION	LAMBETH GROUP
			LYNCH HILL GRAVEL FORMATION	LONDON CLAY FORMATION
			STANMORE GRAVEL FORMATION	

NB. Geological boundaries are largely indicative based on available geological mapping data

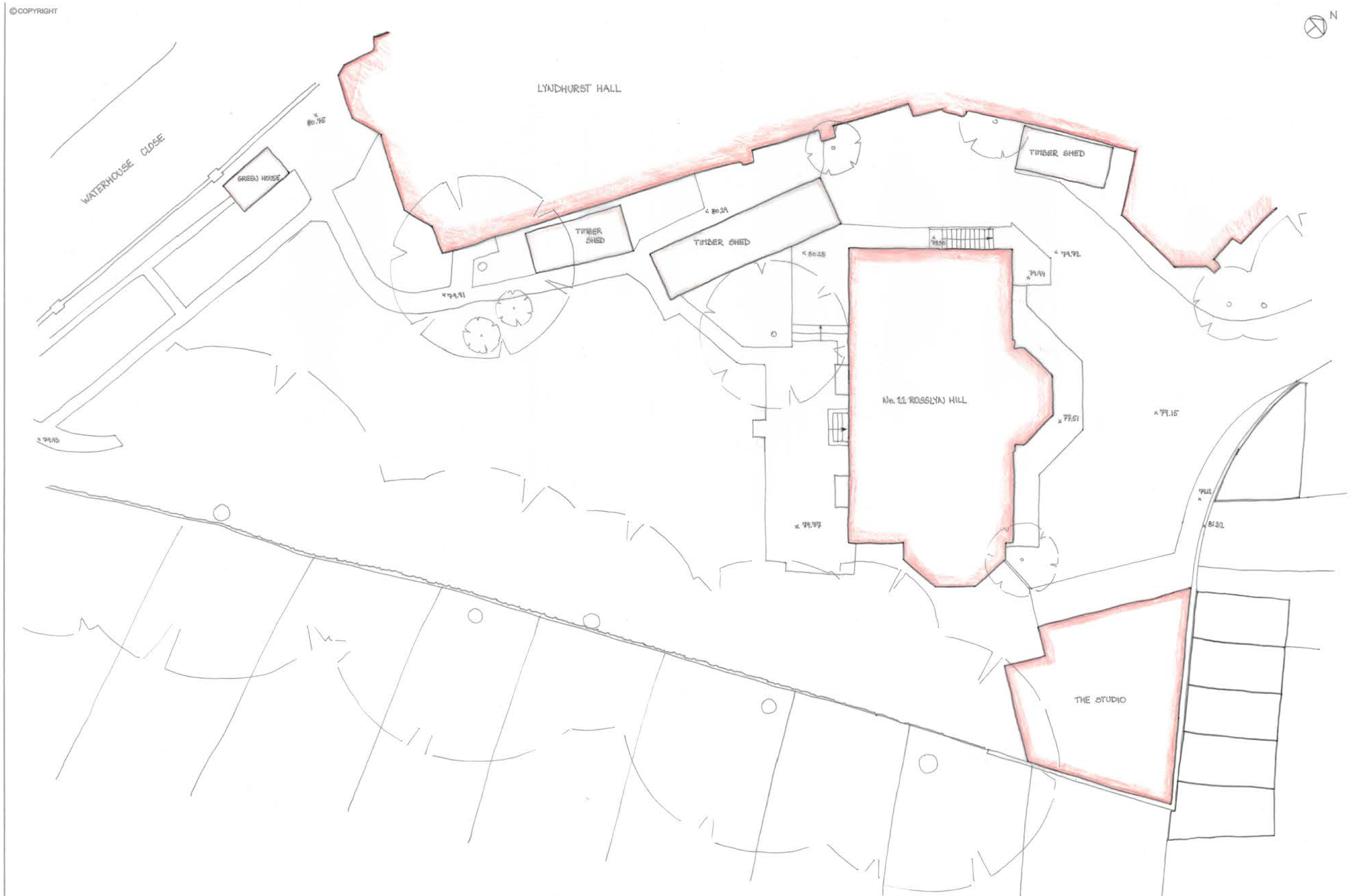
Camden Geological, Hydrogeological and Hydrological Study

Slope Angle Map

213923

FIGURE **16**

Appendix D The existing site and structures



notes

job
11 ROSSLYN HILL, NW3

title
EXISTING SITE PLAN

drawn	checked
RG	
date	scale (original - A1)
OCT '14	1:100

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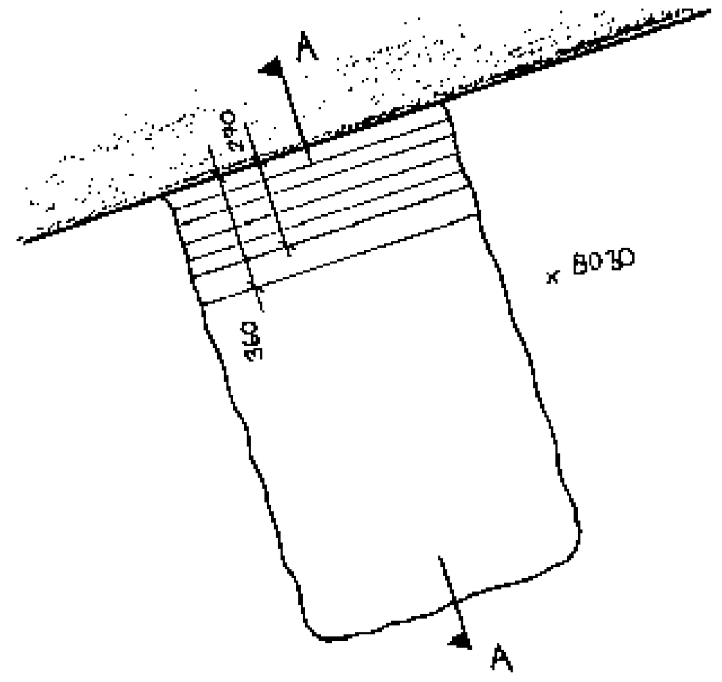
1693/01/01	-



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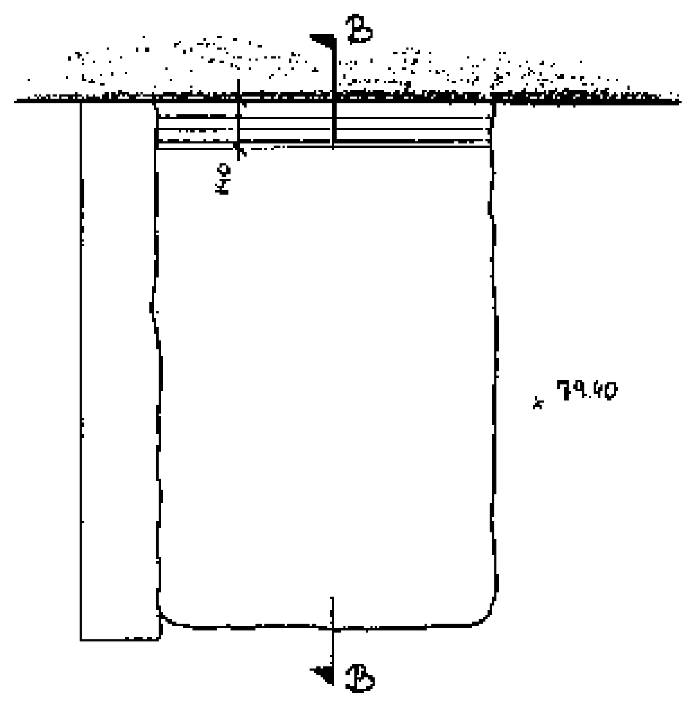

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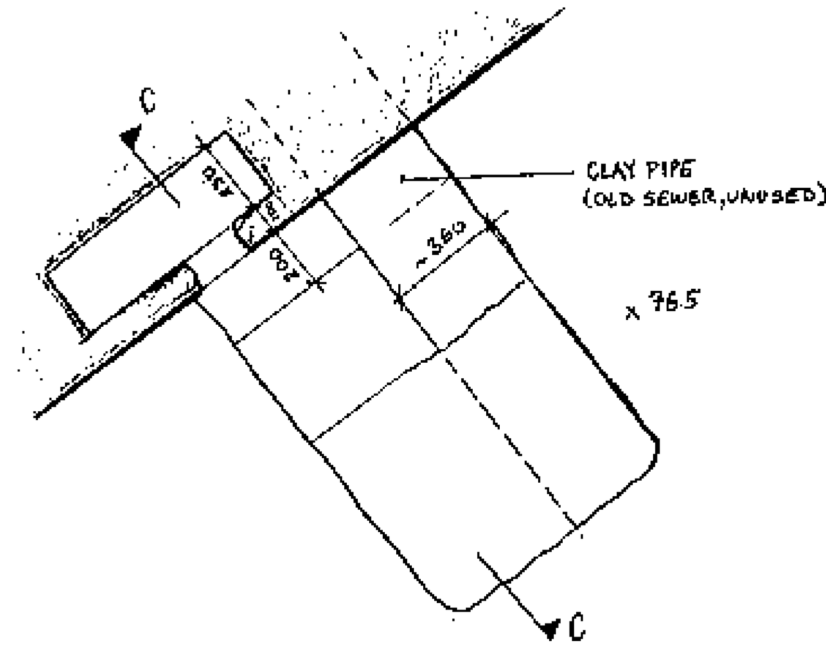

TRIAL PIT TP3A - PLAN
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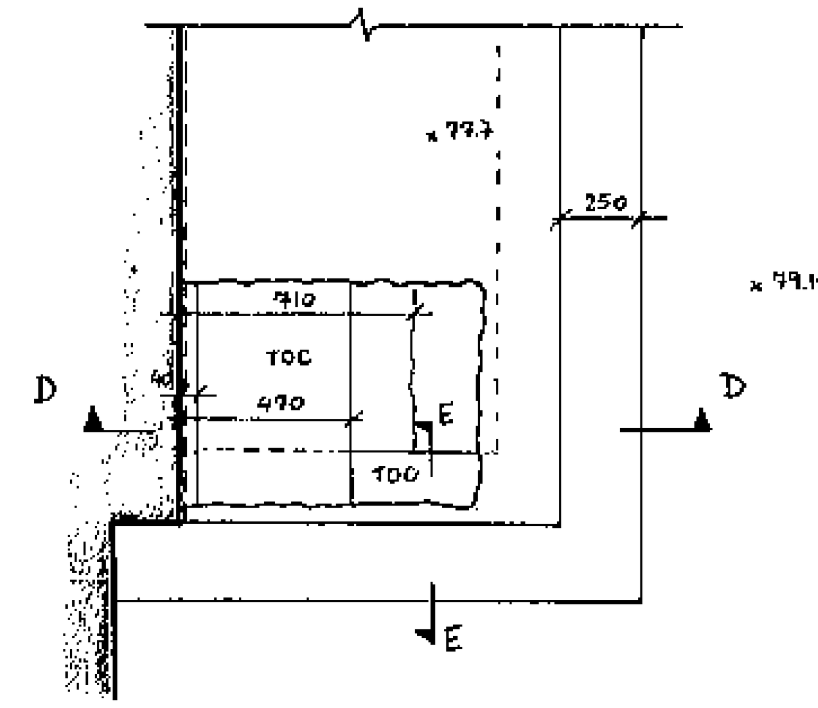

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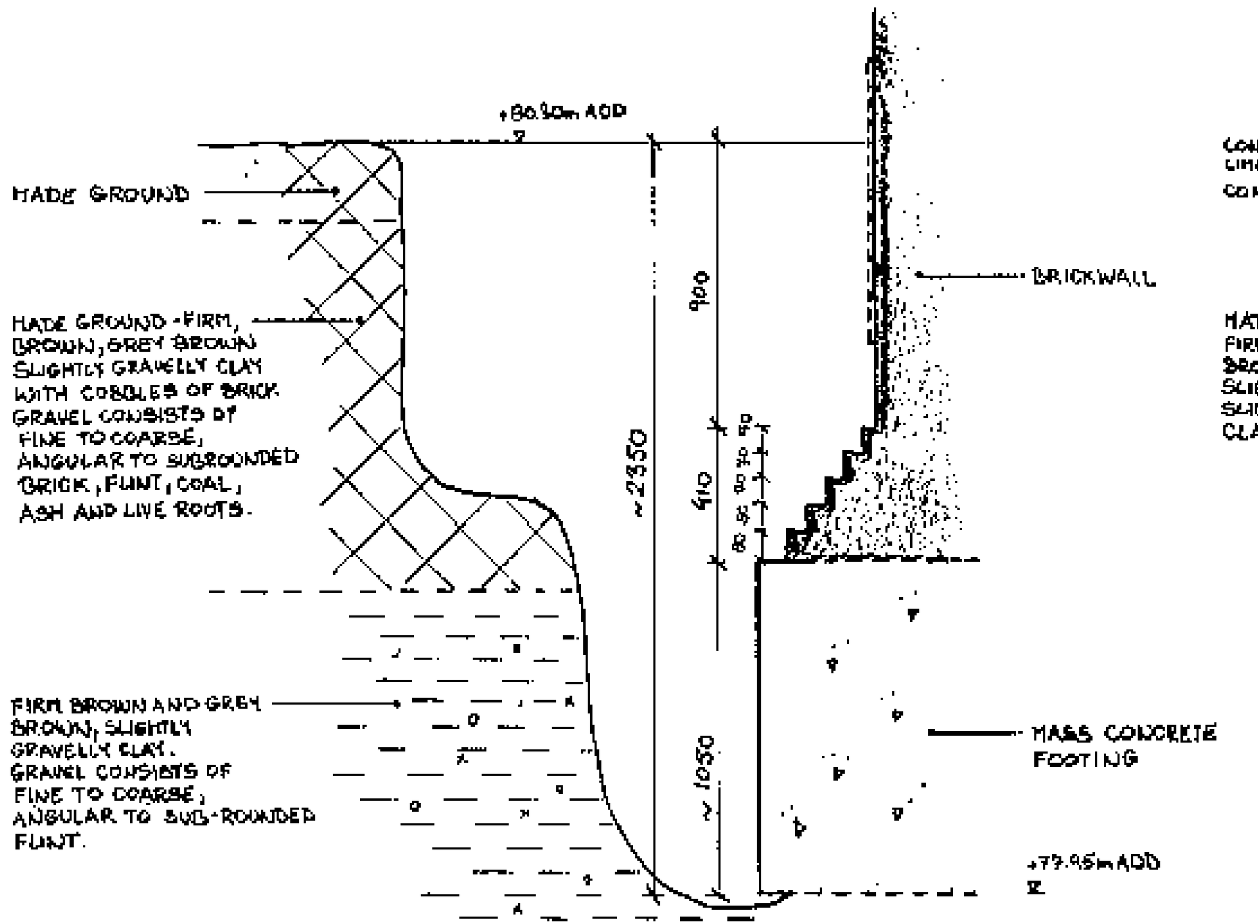

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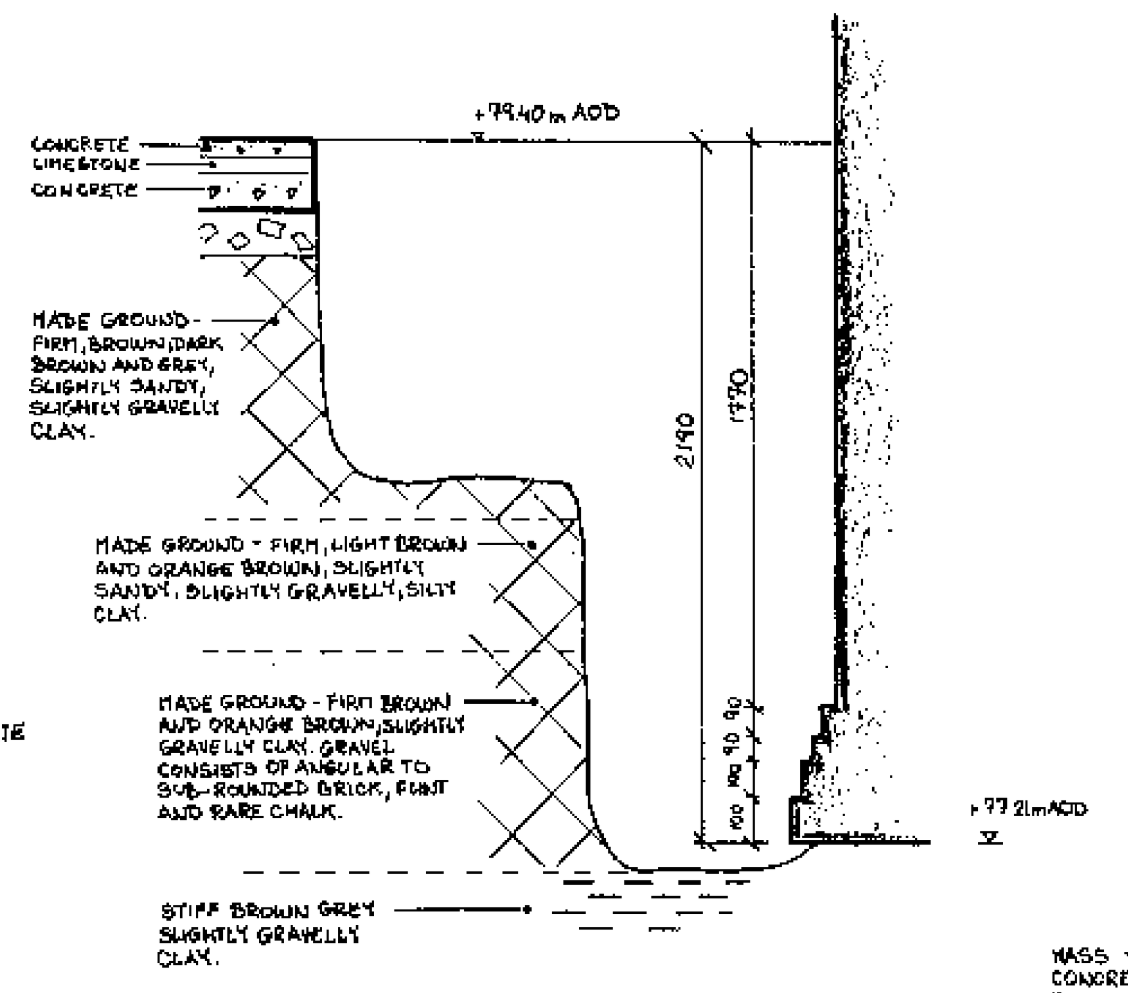

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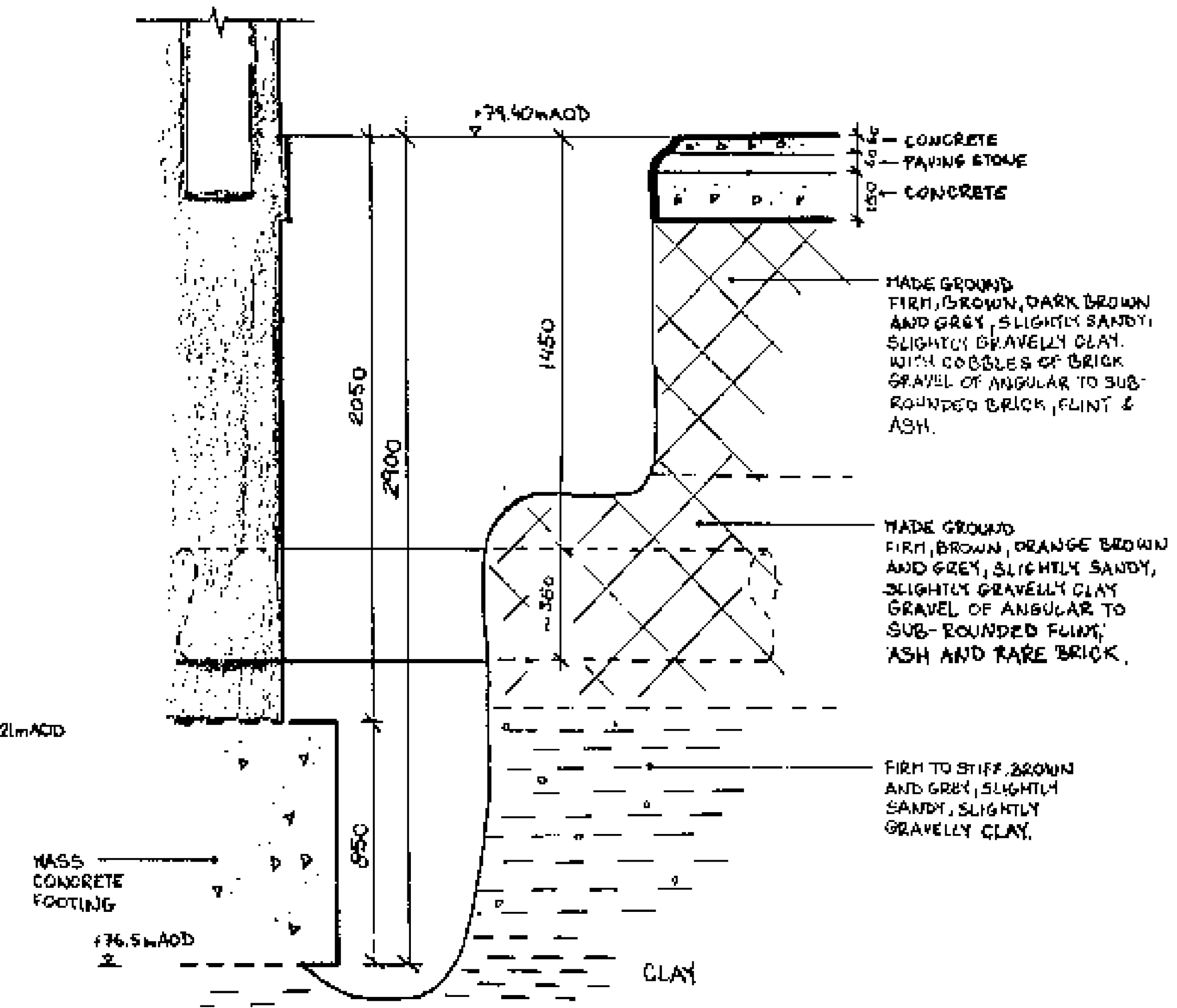

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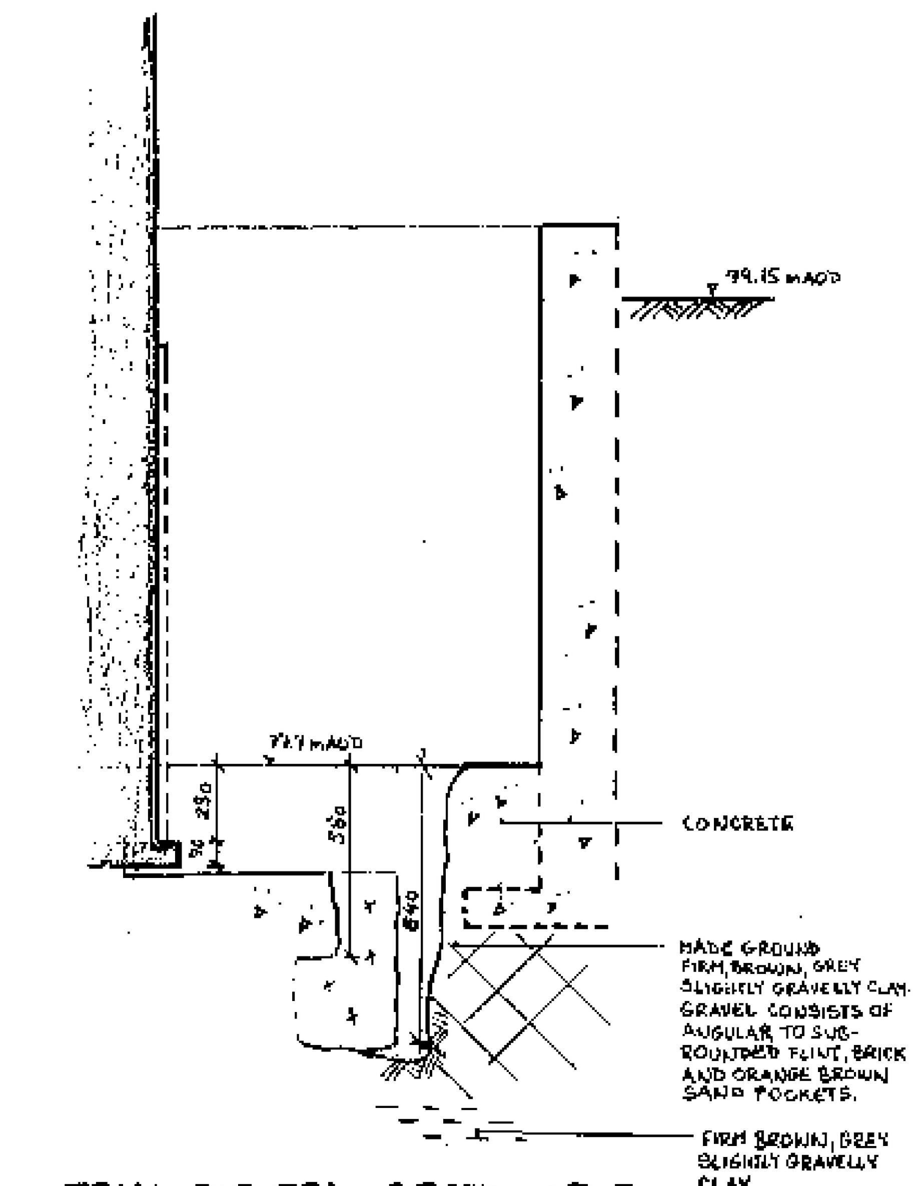

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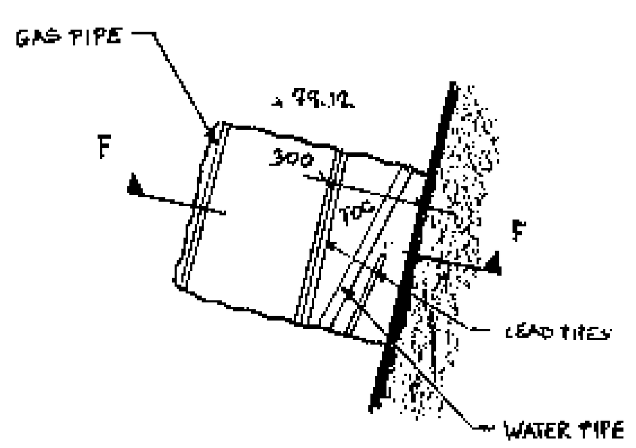

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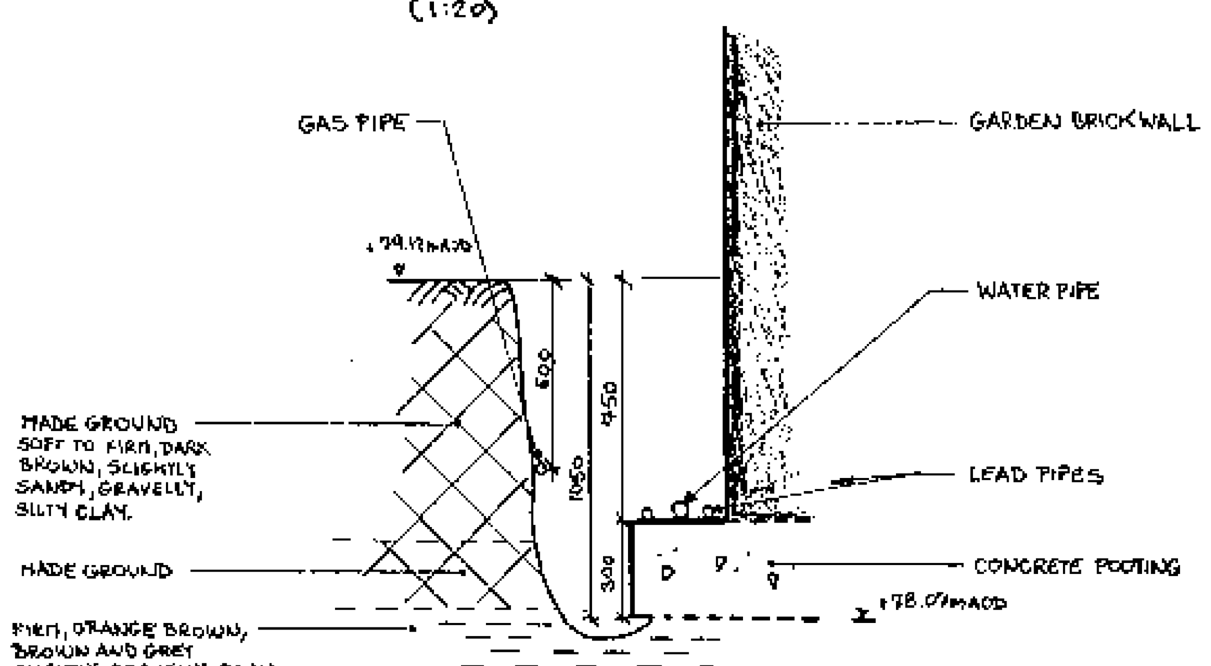

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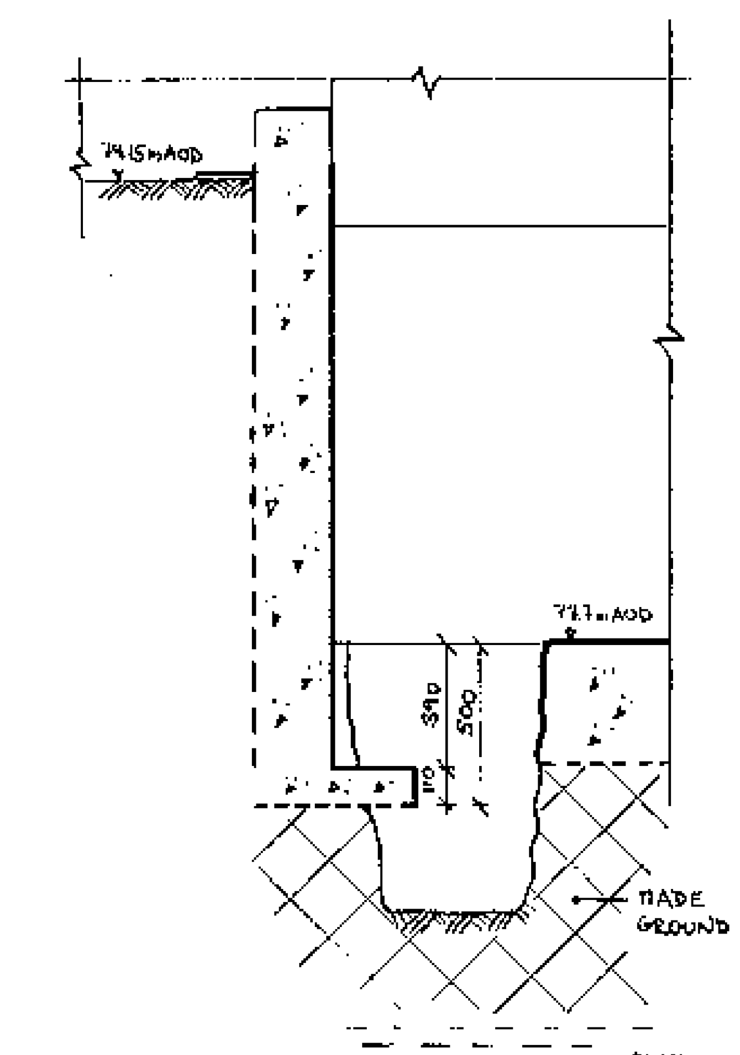

TRIAL PIT TP4 - SECTION E-E
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notes

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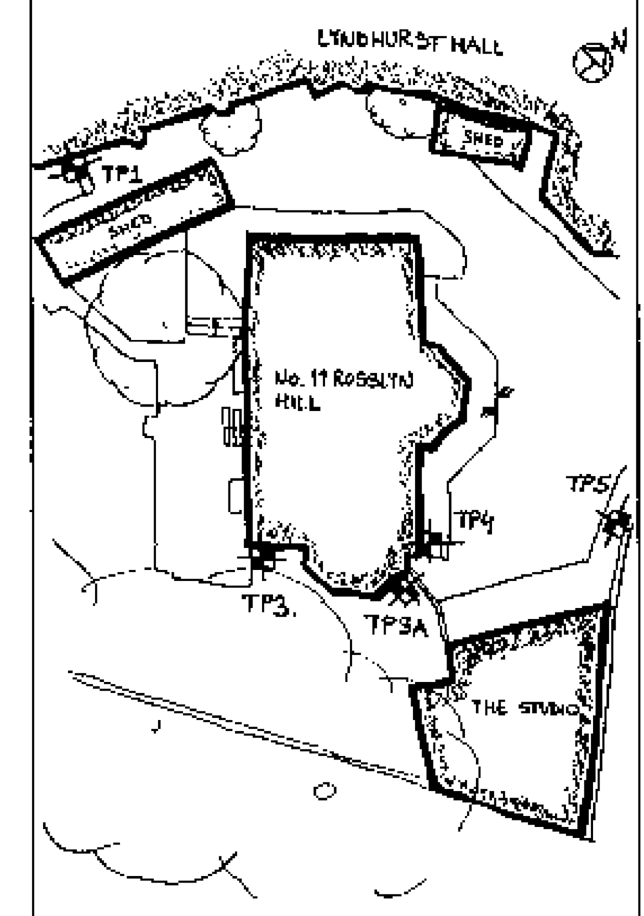
2. THIS DRAWING IS BASED ON FINDINGS FROM SITE INVESTIGATIONS BY ABA DURING JANUARY 2015.

FOR INFORMATION ONLY.



KEY PLAN
(N.T.S.)

-	29.01.15	ISSUED FOR INFORMATION	

job: 11 ROSSLYN HILL, NW3

title: SITE INVESTIGATIONS SUMMARY OF TRIAL PITS

drawn: RG
date: JAN'15
scale (original - A1): AS SHOWN (1:20)

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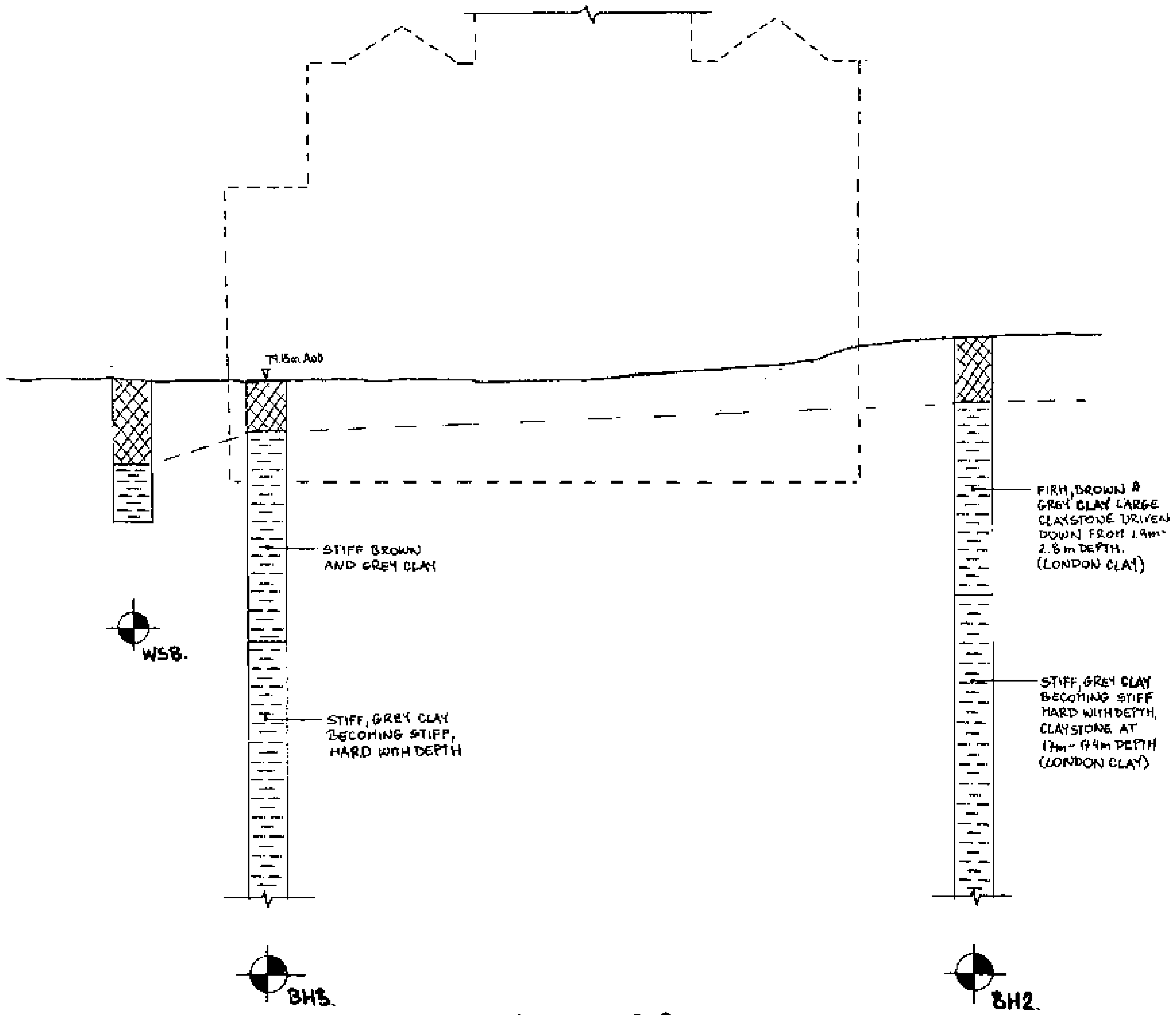
dwg. no. 1693/01/S02
rev. -



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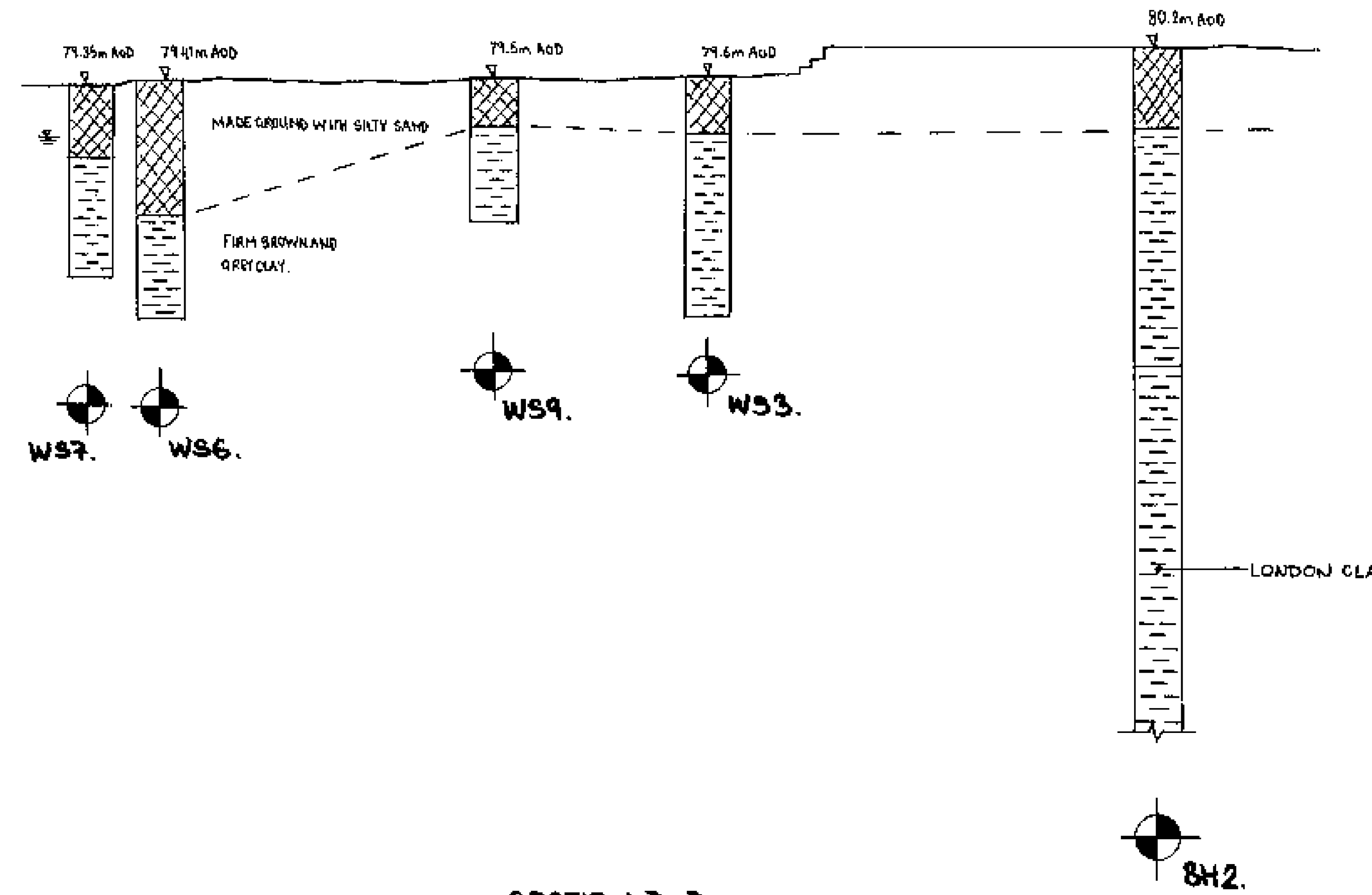

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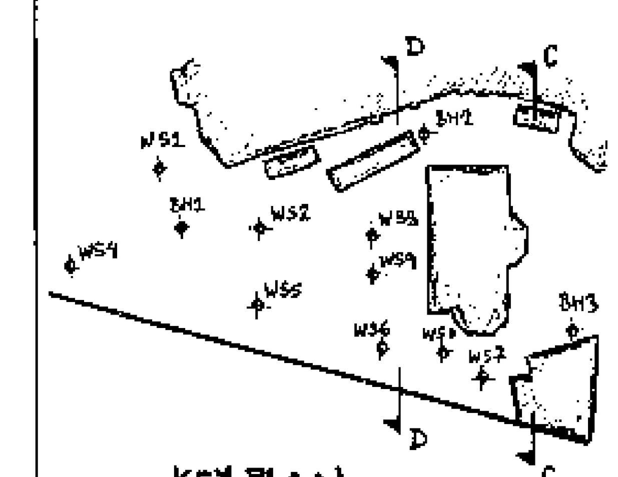

KEY PLAN
N.T.S.

	05.03.15	ISSUED FOR INFORMATION	RWa

job
11 ROSSLYN HILL, NW3

title
GEOLOGICAL SECTIONS OF SITE
SHEET 2 OF 2

drawn: RG | checked:
date: FEB'14 | scale (original - A1): 1:100

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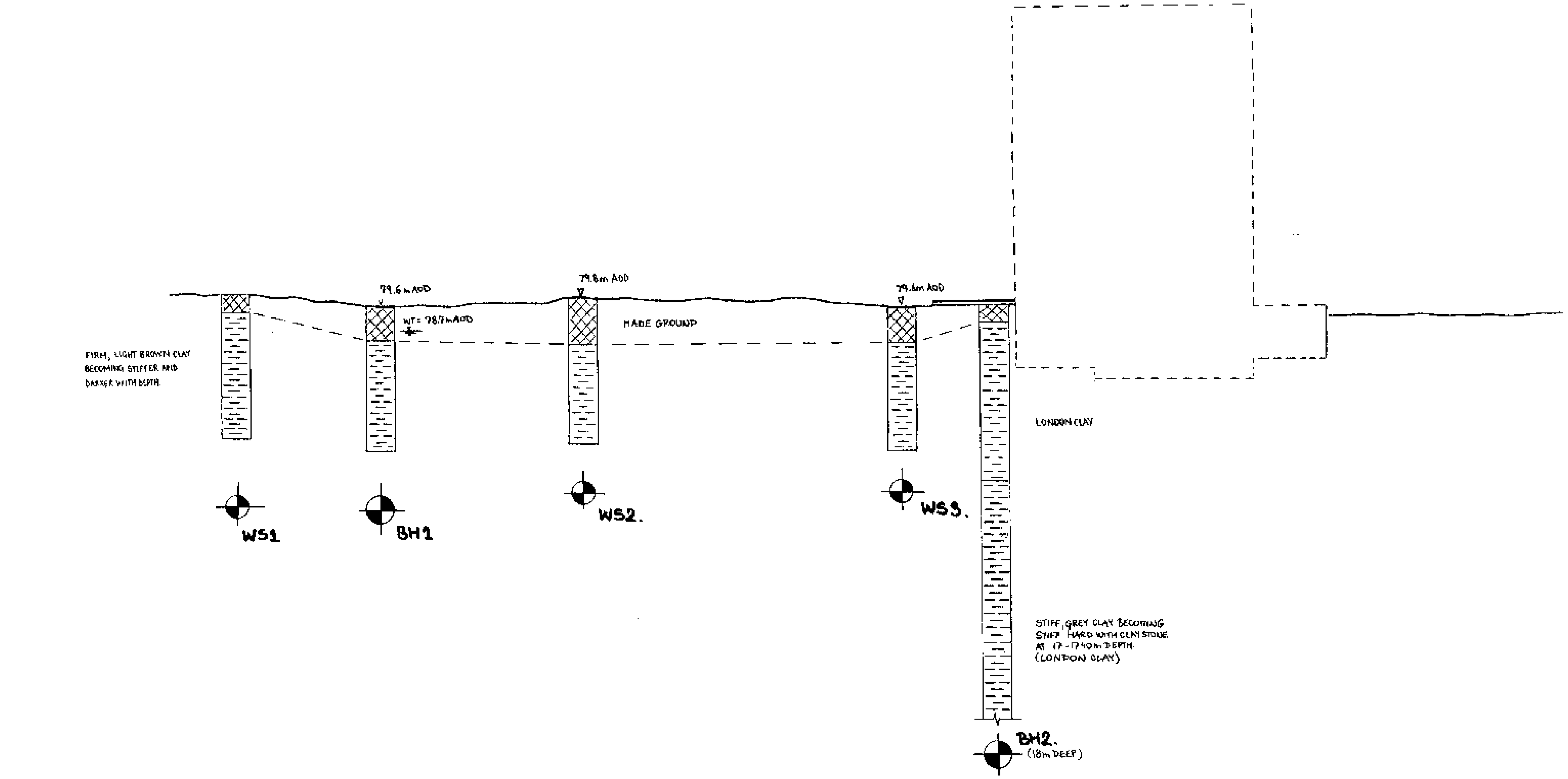
dwg. no: **1693/01/S04** | rev: -



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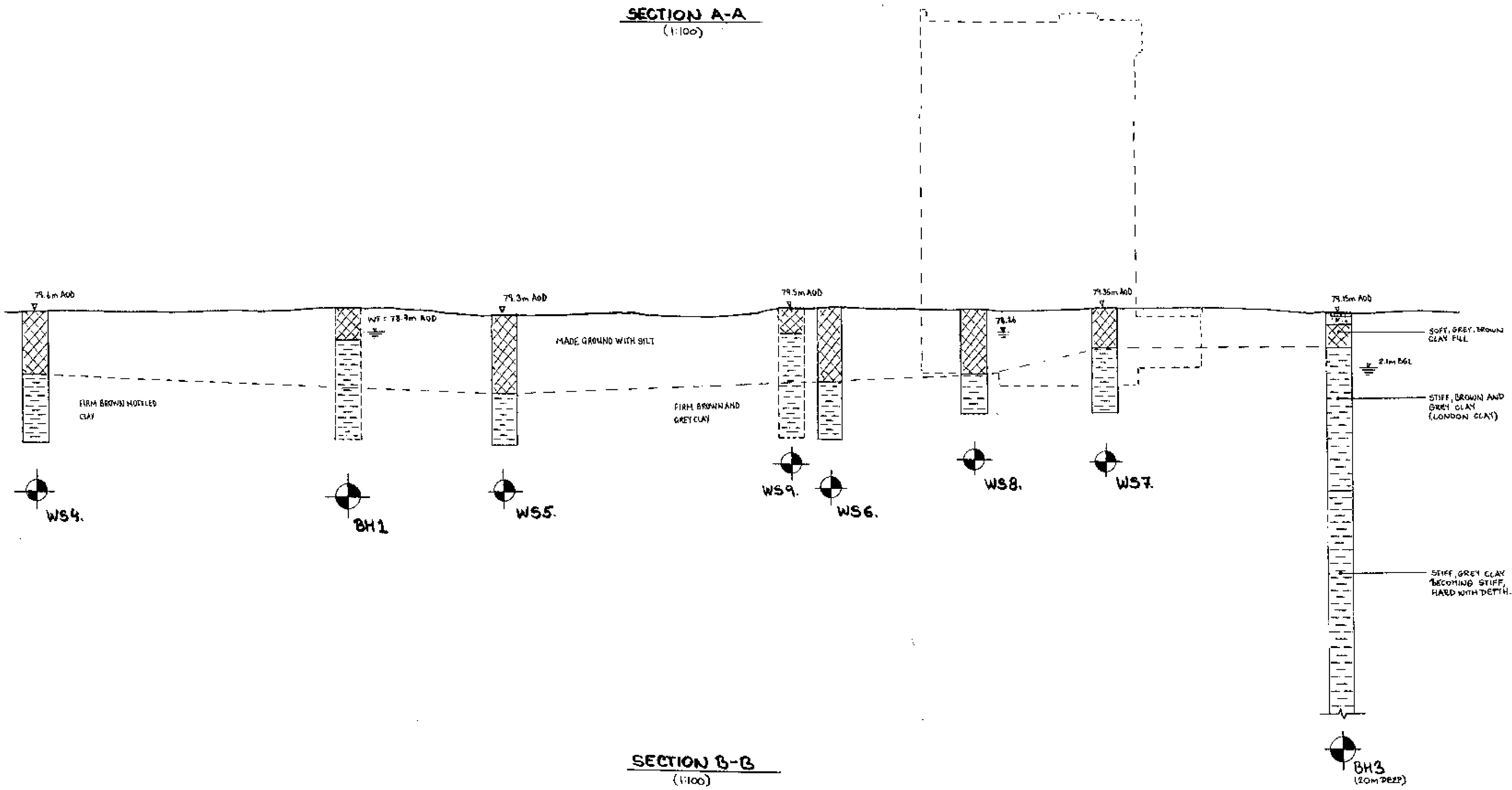

SECTION B-B
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notes

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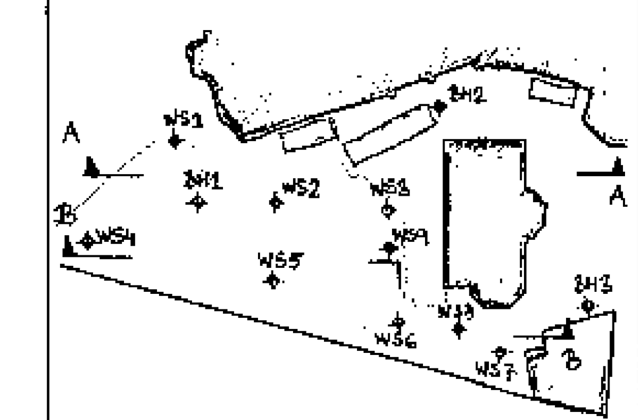

KEY PLAN
N.T.S.

	05.02.15	ISSUED FOR INFORMATION	RWa

job

11 ROSSLYN HILL, NW3

title

GEOLOGICAL SECTIONS OF SITE
SHEET 1 OF 2

drawn: RG
checked:
date: FEB'14
scale (original - A1): 1:100

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Appendix E Site Investigation Report 2015

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SITE INVESTIGATION REPORT

11 ROSSLYN HILL
HAMPSTEAD
LONDON NW3

Report Reference C13469

On behalf of:-

Andrew & Elizabeth Jeffreys
c/o Alan Baxter & Associates LLP
75 Cowcross Street
London
EC1M 6EL

March 2015

ANDREW AND ELIZABETH JEFFREYS

ALAN BAXTER ASSOCIATES

CONSULTING ENGINEERS

SITE INVESTIGATION REPORT
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Report Reference No. C13469 **March 2015**

INTRODUCTION

The client, Andrew and Elizabeth Jeffreys, proposes to amalgamate the main house with an adjacent studio dwelling to the rear of a No.11 Rosslyn Hill, Hampstead, London NW3. The proposed works will have a basement extending beyond the footprint of the converted studio area and connecting to an existing basement beneath the main house. This will contain a swimming pool with a sub-basement level extending partially beneath this to house a plant room. An extension with single level basement is also proposed to the north-west of the main house.

Ground Engineering Limited was commissioned by the client, under the direction of consulting engineers Alan Baxter Associates, to carry out a site investigation to determine the nature and geotechnical properties of the underlying soils, and provide information for the foundation design and construction of the basement. A desk study checking past uses and a contamination assessment were also included within the scope of this report.

LOCATION, TOPOGRAPHY AND GEOLOGY OF THE SITE

The site of No.11 is set back from the south-western side of the Rosslyn Hill roadway (A502), to the rear of Lyndhurst Hall and a United Reformed Church that face north onto Lyndhurst Road, London NW3. The site is approximately 400m south-west of Hampstead Heath railway station and is centred at National Grid Reference TQ 26998 85329. A site plan is presented in Appendix 1 and an aerial photograph indicating the site location is presented on page 1 of Appendix 3.

The irregularly shaped plot is approximately 60m long adjacent the rear garden boundaries of Nos.2 to 26 Belsize Lane from which the site extends north-westwards by approximately 30m to the south-east elevation of Lyndhurst Hall. Waterhouse Close is to the immediate west of the site and Rosslyn Hill is to the north-east. The main house of No.11, historically named Rosslyn Grove, is located in the northern part of the plot and comprises a Grade II listed detached three-storey dwelling with pediment attic level and single-storey basement. A curved front bay window was at the centre of the north-east façade and another was on the south-east gable end. A lightwell was to the front of the house, with its base at approximately 1.60m below the ground level of the adjacent front driveway. A second, similar, lightwell was to the rear of the house. A cellar was on the north-west side of the house, with vaulted roof, accessible via either the lower ground floor of the house or by external steps.

At the time of the investigation the site was accessed via a narrow gravel-surfaced driveway off the south-east side of Rosslyn Hill. A single-storey, flat roofed, brick-built dwelling, named 'The Studio', was located in the eastern corner of the site adjoining the rear garden boundary of No.2 Belsize Lane. Several timber sheds and a pathway were along the north-western edge of the site. The remaining peripheral and southern parts of the site comprised gardens.

Many mature trees were located within the site and adjoining plots. These were tentatively identified as Cypress, Horse Chestnut, Oak and London Plane.

The site is benched into a south-east facing hillside and the immediate surroundings slope down to the south-east. The site is generally level at approximately 79mOD to 80mOD.

The 1934, 1:10,560 scale geological map for the locality, London sheet LSE shows the western half of the site to be immediately underlain by the solid geology of the Claygate Beds over the London Clay. The Claygate Beds are absent beneath the lower ground in the eastern half of the site that is shown to be immediately underlain by the London Clay. A former river, the Fleet, is indicated flowing towards the south-east approximately 300m east of the site, along Fleet Road. Two southward flowing headwater streams of another former river, the Tyburn, are also marked rising approximately 300m south east and 350m west of the site. These historical watercourses are now culverted.

The 2006 geological map Sheet 256, at 1:50,000 scale, shows the site area to have a propensity for Head Deposits ('hillwash'), underlain by the solid geology of the London Clay. The Claygate Member, the upper unit of the London Clay Formation, is indicated beneath higher ground to the immediate west of the site.

Well records on the 1934 geological map indicate that the Unproductive stratum of the London Clay is about 90m thick beneath this part of London and that the underlying Principal Aquifer of the Chalk lies some 120m below ground level. Groundwater may be encountered 'perched' within the anticipated Head Deposits and Claygate Member that cover the London Clay.

Based on the topography of the site area the direction of near surface groundwater and surface water flow would locally be from north-west to south-east, downhill and towards the culverted River Fleet.

HISTORY OF THE SITE

Historical maps dating between 1745 and the present day have been reviewed as part of this desk study together with internet research. Selected map sheets are reproduced in Appendix 2 with relevant descriptions given below.

John Roque's Map of London was published in 1746 (not reproduced) and shows the site containing a large house (known as Wilde's House) set back from the south-western side of the southern part of Hampstead High Street (later named Rosslyn Hill) opposite the junction with Pond Street, on sloping ground to the south of Hampstead. According to internet research, this house was built within the Belsize Estate and was associated with brick making by 1557. A large elongate pond, possibly a flooded clay pit, is indicated close to the south-eastern site boundary, on the northern side of Belsize Lane. Similar maps of 1786 (Cary) and 1807 (Ordnance Survey) show the site apparently unchanged, as does J.J. Park's Map of the Topography of Hampstead of 1814. Although internet research indicates that Wilde's House was re-built soon after 1770 as Rosslyn Grove (the present day No.31 Rosslyn Hill), which was constructed of brick with a symmetric façade and pedimented attic.

John Tallis' map of 1851 (not reproduced) also shows the site unaltered. The former pond to the immediate south is not marked and was presumably infilled. Stanford's 'Library Map of London and its Suburbs' was published in 1862 (not reproduced) and shows the site as before with Rosslyn Grove and an associated driveway off the south-western side of Rosslyn Hill. Hampstead Station is marked approximately 400m north-west of the site, with Hampstead Junction Railway trending east-north-east to west-south-west entering a tunnel approximately 200m north-west of the site, running below Rosslyn Hill.

The 1866-1871, O.S. Town Plan for the area at 1:1056 scale (Figure A1), shows the house, Rosslyn Grove, within the north-eastern part of the site. The remaining site area comprises part of an associated large landscaped garden that extends beyond the site to the south and east. Similar neighbouring properties with large landscaped gardens include Rosslyn Lodge to the west, Belsize House to the south and Belsize Cottage on the opposite side of Belsize Lane to the south-east. The 1869-1874 Sheets Middlesex XI.SE & XV.NE (Figure B) at 1:10560 scale show the site and surroundings unaltered.

The 1893-1894 O.S. Town Plan for the area at 1:1056 scale (Figure C) and Second Edition 1:2500 scale London Sheet XXVII (Figure D), show the house unaltered in the north-eastern part of the site. The site boundaries are defined by: a hexagonal congregational chapel building with south-westward extending hall forming the north-west extent of the site; rear garden boundaries of detached and semi-detached houses facing Belsize Lane to the south-east; Rosslyn Hall to the west; and the garden boundaries of a detached house facing Rosslyn Hill to the east. Many semi-detached and detached houses were also built on former landscaped gardens in the wider surroundings. Hampstead General Hospital is marked off-plan to the east of the site, to the immediate east of St. Stephen's Church.

The 1915, 3rd Edition O.S. map (London Sheet I.16) at 1:2500 scale (Figure E) and 1920 O.S. map (London I.SE & V.NE) at 1:10,560 scale (Figure F) have the site and adjacent housing unchanged.

The London Bomb Damage Map (1939-1945) for the area (Figure G) shows the site to have survived unscathed. Four of the semi-detached houses to the south of the site along the northern side of Belsize Lane suffered minor blast damage. Reference to an online WW2 bomb census database indicates a high explosive bomb impact at these properties on the northern side of Belsize Lane, close to the south eastern site boundary. A 1940s aerial photograph (Figure H) shows the site unaltered, with the property set back from Rosslyn Hill and surrounded by large trees. The 1948-49 O.S. maps at 1:10,560 scale (TQ 28 SW & NW) also have the site (Figure I) and surrounding area as it was before WWII.

The 1954-1955, O.S. maps TQ 2685 & TQ 2785 at 1:2500 scale (Figure J) have Rosslyn Grove marked as No.11. Several blocks of flats including Belsize Court have been constructed 40m to the south of the site flanking Belsize Lane. The 1966 O.S. maps at 1:1250 scale, TQ2685SE & TQ2785SW (Figure K) show a building, marked The Studio, in the eastern corner of the site and a rectangular structure, known to be a timber shed, to the rear of the house. A row of five resident's garages were built immediately beyond the site, adjoining the north-east elevation of the studio, associated with five new dwellings that had replaced No. 9 Rosslyn Hill The former chapel to the immediate north-west is named Lyndhurst Road Congressional Church, together with its adjoining church hall. The 1972-1975, O.S. maps at 1:1250 scale, TQ2685SE & TQ2785SW (Figure L) show the site and surroundings unchanged.

The 1973-74, 1:10,000 scale maps TQ 28SW & TQ28NW (Figure M) have the site and immediate surrounding apparently unchanged from the 1960s. The 1985-1989, O.S. maps at 1:1250 scale, TQ2685SE & TQ2785SW (Figure N) show the site to remain unaltered. Waterhouse close was built to the west of the site, trending southwards from Lyndhurst Road to a newly constructed L-shaped block of flats. The western part of the former Rosslyn Lodge to the west of the site was demolished and the remaining structure was re-named the Olave Centre. The church to the immediate north of the site is named the United Reformed Church on this map extract.

The 1991 revisions of the 1:1250 scale maps TQ 2685SE and TQ2785SW (Figure O), have the site and surrounding area as before. The 2002 Raster Map at 1:10,000 scale (Figure P), shows the site and surrounding area unchanged from the 1990s, as does the December 2014 BT plan of 1:1250 scale (Figure Q). The 2013 aerial photograph presented on page 1 of Appendix 3 shows the site and neighbouring gardens to contain many large trees.

Summary

In summary, No. 11 was formerly named Rosslyn Grove and was built soon after 1770 on the site of an earlier house (Wilde's House) within the Belsize Estate. The latter was associated with brick making in 1557 and a pond, possibly a former clay pit, was located to the immediate south of the site and was apparently infilled before 1851. The site remained apparently unscathed during World War Two, although a high explosive bomb impact was recorded to the immediate south of the site, causing minor blast damage to several houses along the northern side of Belsize Lane. The Studio was built in the eastern corner of the site and a large rectangular shed was constructed to the rear of No.11 between 1955 and 1965, after which the site remained apparently unaltered. The surrounding area was largely developed during the latter part of the Nineteenth Century, and parts were progressively redeveloped from the 1950s as vacant plots were infilled as existing large houses and their gardens were covered with housing.

SUMMARY OF ENVIRONMENTAL DATA

Appendix 3 contains information derived from Environmental Databases for a radius of up to 2,000m from the site. The information covers datasets held by Groundsure with contributors including the local authority, the Environment Agency (EA), British Geological Survey, Ordnance Survey and the Coal Authority and the results, within a radius of 250m, are summarised below:

1. Environmental Permits, Incidents and Registers	**On-Site**	**0 - 250m**
Sites Holding Environmental Permits Authorisations	0	2
Records of COMAH and NIHHS Sites	0	0
Environment Agency Recorded Pollution Incidents	0	1
Sites Determined as Contaminated Land under Part IIA EPA 1990	0	0
2. Landfill and Other Waste Sites	**On-Site**	**0 - 250m**
Landfill Sites	0	0
Landfill and Other Waste Sites	0	0
3. Current Land Use	**On-Site**	**0 - 250m**
Current Industrial Sites Data	0	8
Records of Petrol and Fuel Sites	0	1
Underground High Pressure Oil and Gas Pipelines	0	0
4. Geology	**Description**	
Artificial Ground or Made Ground records	No	
Superficial Ground and Drift Geology records	None	
5. Hydrogeology and Hydrology	**On-Site**	**0 - 250m**
Productive strata within superficial geology	-	
Productive strata within solid geology	Yes	
Groundwater Abstraction Licences	0	0
Surface Water Abstraction Licences	0	0
Potable Water Abstraction Licences	0	0
Source Protection Zones	0	0
River Quality Data	No	No
Detailed River Network Entries	0	1
Surface Water Features -	No	No

6. Flooding	
Environment Agency indicative Zone 2 floodplains within 250m of site	No
Environment Agency indicative Zone 3 floodplains within 250m of site	No
Flood defences within 250m of site	No
Any areas benefitting from flood defences within 250m of site	No
Flood storage areas within 250m of site	No
Maximum BGS groundwater flooding susceptibility within 50m of site	Limited Potential
BGS confidence rating for groundwater susceptibility areas	Low

7. Designated Environmentally Sensitive Sites	On Site	0 - 250m
Environmentally sensitive sites	0	0

8. Natural Hazards (on site)

Hazard	Negligible	Very Low	Low	Moderate	High
Shrinking or Swelling Clay	-	-	-	On-site	-
Landslides	-	On-site	-	-	-
Soluble rocks	On-site	-	-	-	-
Compressible Ground	On-site	-	-	-	-
Collapsible Rocks	-	On-site	-	-	-
Running Sand	-	On-site	-	-	-

9. Mining	
Coal mining areas within 75m of site	No
Risk of subsidence relating to shallow mining within 150m of site	Negligible
Brine affected areas within 75m of study site	No

10. Radon

The Groundsure report indicates that the property is not in a Radon Affected Area, as less than 1% of properties are above the action level. No Radon Protective Measures are required for new residential properties or extensions.

Database Summary

There are no environmental permits on the site, and two within 250m of the site, relating to a fuel filling station located 192m south-east and a cement batching plant located 196m south-east of the site. There are no registered or historic landfills registered within 250m of the site. There is one Environment Agency recorded pollution incident recorded within 250m of the site, relating to metal wastes causing no impact to land, air or water. There are no current industrial uses recorded on-site, and eight within 250m of the site. The closest recorded use, positioned by address 9m north-west of the site and relates to a recording studio. The other uses comprise; three electricity sub-stations located 33m north-west, 138m east and 186m north-west of the site; two records for the same fuel filling station 191m and 192m south-east of the site; a car wash located 207m south-east at the filling station; and a Drill Hall located 228m north-east of the site.

The site is recorded as being underlain by the solid geology of the Claygate Member (the upper unit of the London Clay Formation) over the London Clay. The Claygate Member is designated by the EA as a 'Secondary (A) Aquifer' and London Clay is designated by the EA as an 'Unproductive' stratum. There are no groundwater abstraction licences within 250m of the site. There is one detailed river network entry relating to a large culvert draining southwards (the former River Fleet) noted to be approximately 184m east of the site. There are no surface water features within 250m of the site. The site does not lie within Zone 2 or Zone 3 flood plains and is not within a zone benefiting from flood defences. The site is also not within 250m of areas used for flood storage. The site is in an area that has a limited potential for groundwater flooding.

The site is not located within a designated environmentally sensitive area. According to the British Geological Survey there is a 'Moderate' hazard potential for Shrinking or Swelling Clay; a 'Very Low' hazard potential for Landslides, Running Sand and Collapsible Rocks and; a 'Null-Negligible' hazard potential for Soluble Rocks, Compressible Ground and Shallow Mining.

The site is not within an identified mining area, or brine affected area. No radon protection measures are required for new residential properties or extensions.

PRELIMINARY RISK ASSESSMENT

Potential sources of contamination present on or beneath the site would relate primarily to: the historical use of the site; the presence of contaminated soil; and the potential presence of hazardous or ground gas beneath the site.

In order to assess the risks associated with the presence of ground contamination the linkages between the sources and potential receptors to contamination need to be established and evaluated. This is in accordance with the Environmental Protection Act 1990, which provides a statutory definition of Contaminated Land. To fall within this definition it is necessary that, as a result of the condition of the land, substances may be present on or under the land such that:

- *Significant harm is being caused or there is a significant possibility of such harm being caused; or*
- *Pollution of controlled waters is being, or is likely to be, caused.*

There are three principal factors that are assessed whilst undertaking a qualitative risk assessment for any site. These are the presence of a contamination source, the existence of migration pathways and the presence of a sensitive target(s). It should be noted that it is necessary for each element of source, pathway and target to be present in order for exposure of a human or environmental receptor to occur.

UK Government guidance on the assessment of contaminated land, requires risk to human health and the environment to be reviewed using source – pathway – target relationships. If each of these elements is present, the linkage provides a potential risk to the identified targets.

Contaminants or ***potential pollutants*** identified as ***sources*** in relation to the identified previous uses are listed overleaf in Table 1.

Table 1: Identified Potential Contaminant Sources

Contaminant Source	*Comments*
Drainage	Effluent from leaking drains would provide a contaminant source.
Existing Buildings	May contain asbestos.
Soil Beneath Site	Contamination may be present within any made ground materials on the site.
Soil Gas	Potential soil gas generated from made ground or underlying geology
Ground Contamination Outside Site Boundary	Ground contamination migrating from adjoining sites. The adjacent historically infilled pond to the south would be a potential source of soil gas.

A *Pathway* is defined as one or more routes through which a receptor is being, or could be, exposed to, or affected by, a given contaminant.

Potential *Target or Receptors* fall within the categories of Human Health, Water Environment, Flora and Fauna, and Building Materials.

There are a number of possible pathways for the contaminants identified on the site to impact human and/or environmental receptors and these are summarised in Tables 2 and 3.

Table 2: Human Receptors and Pathways

Human Receptor-Mechanism	*Typical Exposure Pathway*
Human Inhalation	Breathing Dust and Fumes Breathing Gas emissions
Human Ingestion	Eating -contaminated soil, for example by small children -produce grown on contaminated soil Ingesting dust or soil on vegetables Drinking contaminated water
Human Contact	Direct skin contact with contamination Direct skin contact with contaminated liquids

Table 3: Water Receptors and Pathways

Receptor-Water Environment	*Typical Exposure Pathway*
Groundwater The site is recorded as being underlain by the Claygate Member a 'Secondary (A) Aquifer', over the London Clay that is an 'Unproductive' stratum.	Surface infiltration of atmospheric waters into the soils beneath the site could wash or dissolve potential contaminants and migrate to underlying groundwater. Contamination leads to restriction/prevention of use as a resource, for example, drinking water, and can have secondary impacts on other resources, which depend on it.
Surface Water There are no surface water features noted within 250m of the site The culverted River Fleet is located approximately 184m east of the site	Surface infiltration of atmospheric waters into the soils beneath the site could wash or dissolve potential contaminants and laterally migrate. Contamination leads to a restriction/prevention of use: -as drinking water resource -for amenity use Effects on aquatic life.

Preliminary Conceptual Model

Assessment of the potential linkage between ground contamination sources, human and environmental receptors have been assessed based on the desk study research documented in the preceding sections of this report.

A generalised preliminary conceptual model is presented below in Table 4.

Table 4: Preliminary Conceptual Model Relative to Proposed Development

Receptors	Pathway	Estimated Potential for Linkage with Contaminant Sources: Drainage	Existing Buildings	Soil Beneath Site	Soil Gas	Ground Contamination Outside Site Boundary
Human Health ground or building workers	Ingestion and Inhalation of contaminated Soil, Dust and Vapour	Likely	Likely (asbestos)	Low likelihood	Low likelihood	Unlikely
Human Health end users	Ingestion and Inhalation of contaminated Soil, Dust and Vapour	Unlikely	N/A	Low likelihood	Low likelihood	Unlikely
Water Environment	Migration through ground into surface water or surrounding groundwater	Low likelihood	Unlikely	Low likelihood	Low likelihood	Low likelihood
Flora	Vegetation on site growing on contaminated soil	Low likelihood	Unlikely	Low likelihood	Low likelihood	Unlikely
Building Materials	Contact with contaminated soil	Low likelihood	Unlikely	Low likelihood	Low likelihood	Low likelihood

Key to Table 4

Estimated Potential for Linkage with Contaminant Source	Definition
High likelihood	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution
Likely	There is a pollution linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term
Low likelihood	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such an event would take place, and is less likely in the shorter term
Unlikely	There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term
N/A	Not Applicable

SITE WORK

The site work conducted between 5th and 12th January 2015 comprised two cable percussion boreholes (BH2 & BH3), ten window sample boreholes (BH1 and WS1 to WS9) and five hand excavated trial pits (TP1 to TP5 and TP3A). Borehole BH1 was initially intended to be undertaken by a standard cable percussion rig but, due to limited access to the rear of the property, was completed using a smaller window sample rig. An initially intended trial pit, TP2 was cancelled on instruction from the Engineer. The positions are shown on the exploratory hole location plan in Appendix 1.

Public utility service drawings were sourced and consulted prior to determining the exploratory hole positions. These drawings are available from Ground Engineering Limited on request. A site survey was also provided by Alan Baxter Associates. Prior to excavation, a service scan was made at each position using a CAT (Cable Avoidance Tool) to check for the absence of detectable buried services that may otherwise have been damaged by the investigation.

A hydraulic breaker was used where required to penetrate near surface concrete layers within the exploratory holes, where present.

The exploratory hole records, presented following the plans, give the descriptions and depths of the various strata encountered, details of all samples taken, installation details and the groundwater conditions observed during and on completion of boring and excavation, and during subsequent monitoring of the installations. The ground levels on the exploratory hole records have been interpolated from the site survey provided by Alan Baxter Associates.

Cable Percussive Boreholes

Boreholes BH2 and BH3 were sunk using a standard cable percussive drilling rig on 5th and 6th January 2015. Prior to the start of boring, an inspection pit was dug to 1.20m below ground level at the borehole locations using hand tools to ensure the absence of buried services.

The boreholes were then advanced to 18m (BH2) and 20m (BH2) below ground level, using weighted shell and claycutter tools working initially within 150mm diameter steel casing. Chiselling tools were used to penetrate a concretionary limestone obstruction at 17.00m to 17.40m depth in BH2.

Representative small and bulk disturbed samples of soil were taken from the boring tools at regular intervals throughout the depth of the boreholes. Water samples were taken once sufficient water had entered the boreholes.

Undisturbed samples 100mm in diameter were taken within clay soils, the ends of the samples were capped to maintain them in as representative condition as possible during transit to the laboratory.

An indication of the shear strength of clay soils within recovered samples was made where possible using a hand shear vane (V) and the readings are presented on the respective exploratory hole records.

Standard penetration tests (SPT) were undertaken in order to give an indication of the in-situ density of the material. The tests were made by driving a solid cone attachment into the soil at the base of the borehole by means of an automatic trip hammer weighing 63.50kg falling freely through 760mm. The penetration resistance was determined as the number of blows 'N' required to drive the tool the final 300mm of a total penetration of 450mm into the soil ahead of the borehole. The SPT test is fully described in BS EN22476:3:2005 and the results of are presented on the borehole records.

On completion of boreholes BH2 and BH3, gas and groundwater monitoring standpipes were installed to a depth of 7.00m. The pipes were perforated to within 1.00m of ground level and the annulus backfilled with pea gravel. A bentonite seal was placed from ground surface to 1.00m depth and a gas tap fitted. Protective stopcock covers were concreted in place at ground level above the installations.

Window Sample Boreholes

The window sample boreholes BH1 and WS1 to WS9 were sunk to a maximum depth of 5.00m below ground level. A hand excavated inspection pit was undertaken at each hole location to 1.20m depth in order to confirm the absence of any buried services prior to boring.

Representative small disturbed samples of soil were taken at regular intervals throughout the depth of each inspection pit.

The borehole was formed by a small track mounted window sampling and super heavy dynamic probing rig. The window sampling equipment consisted of drive-in sample tubes of specially constructed and strengthened steel, lined with a plastic core-liner. The barrels were initially of 87mm internal diameter and were reduced in diameter with successive barrels with increasing depth. Upon extraction, a continuous 'undisturbed' profile of the soil was obtained within the plastic liners.

The liners were subsequently split and sub-sampled by a Geotechnical Engineer in the laboratory. An indication of the shear strength of clay soils within the recovered liners was made using a hand shear vane (V) at selected depths and the readings are presented on the respective exploratory hole records.

On completion, gas and groundwater monitoring standpipes were installed to depths of 5.00m in BH1 and 4.00m in WS8. The pipes were perforated to within 1.00m of ground level and the annulus backfilled with pea gravel. A bentonite seal was placed from ground surface to 1.00m depth and a gas tap fitted. Protective stopcock covers were concreted in place at ground level above the installations. The remaining holes were backfilled with arisings on completion.

Foundation Inspection Trial Pits

Five trial pits, TP1, TP3 TP3A, TP4 and TP5 were excavated using hand digging tools against existing structures in order to reveal the depth and profile of existing foundations. A pump was required to keep the trial pits dry and enable excavation to the required depths. The exposed strata were logged and sampled by a Geotechnical Engineer, in situ tests were conducted and samples collected for subsequent laboratory testing.

The exposed strata were logged and recorded by a Geotechnical Engineer. A profile of the existing foundation details and photographs are presented following the respective trial pit records.

Representative disturbed samples were taken at regular intervals throughout the depth of the pits.

An immediate assessment of the apparent shear strength of clay was made within the trial pits using a hand shear vane, the average of three readings for each test depth have been recorded and presented on the trial pit records in kilopascals (kPa).

On completion, the trial pits were backfilled with arisings and the surfaces reinstated.

Gas and Groundwater Monitoring Visits

As part of this investigation, five return visits to monitor the groundwater levels in the standpipes were required by the Engineer and were undertaken on 13th and 21st January, 3rd and 20th February and 2nd March 2015.

During the first visit that was undertaken on completion of the investigation, in addition to the groundwater levels requested by the Engineer, the concentrations of methane, carbon dioxide and oxygen gas levels in the standpipes were also measured using a GasData GFM 430 series gas monitor. Ambient pressures and flow rates were recorded together with groundwater observations. The results of the monitoring visits are presented to the rear of the exploratory records in Appendix 4.

LABORATORY WORK

The samples were inspected in the laboratory and assessments of the soil characteristics have been taken into account during preparation of the borehole and trial pit records. The soil descriptions have been made in accordance with BS5930:1999. The geotechnical test results, undertaken in accordance with BS1377:1990, are presented in Appendix 5 and the chemical test results are in Appendix 6.

The moisture contents of selected soil samples were determined. The moisture content results have been plotted versus depth on Figure 1.

The index properties of selected soil samples were determined as a guide to soil classification and behaviour. The liquid limit was determined by a cone penetrometer.

Test specimens were prepared at full diameter from selected undisturbed samples. Immediate undrained triaxial compression tests were performed under confining cell pressures equivalent to the overburden pressure. The moisture content and bulk density of each specimen was also determined. The apparent cohesion results have been plotted against depth in Figure 2.

An indication of the swelling and settlement characteristics of selected samples of clay was obtained from the consolidation apparatus or oedometer. Each test was performed on a specimen approximately 19mm thick, contained in a steel ring. Each sample was saturated and the swelling pressure balanced prior to applying a constant load with drainage allowed at both ends. When primary compression was complete, the load was increased and this repeated for three increments of load. The sample was then unloaded. The rate and total amount of consolidation were continually monitored using a computer controlled E.L.E. Datasystem 7 Unit. The results were plotted and analysed by the computer for each increment of load to obtain the coefficients of compressibility (m_v), and of consolidation (c_v), which govern the amount and rate of settlement respectively.

Selected samples of soil and water were analysed to determine the concentration of soluble sulphates. The pH values were also determined.

Chemical analysis of nine soil samples and a single water sample recovered from the exploratory holes was undertaken, by an independent laboratory, primarily for characterisation purposes. The samples were tested for a suite encompassing a wide range of potential contaminants outlined by the Environment Agency (EA) and National House Building Council (NHBC) document R&D 66: 2008 'Guidance for the Safe Development of Housing on Land Affected by Contamination'.

GROUND CONDITIONS

The ground conditions as found by the investigation have been plotted as a soil profile in Figure 3, Appendix 5. The ground conditions encountered comprised made ground to depths of between 0.60m and 3.20m that was underlain by the initially weathered solid geology of the London Clay. The deepest made ground was encountered along the south-eastern edge of the site and is related to either an historical pond that was infilled by 1851 or an infilled WW2 bomb crater. The presence of organic patches and a faint organic odour towards the base of this localised infill suggests the former. The deepest borehole was completed within the London Clay at 20.00m depth. The Claygate Member was not encountered beneath the site and would be expected to cap the London Clay on higher ground to the west of this site.

Made Ground

Made ground was encountered to depths of between 0.60m (WS3) and 3.20m (WS8). Trial pits TP3 and TP3A were located adjacent the south-east elevation of the main house within a gravel surfaced pathway. The gravel, comprising 'pea shingle' was proved to be 0.02m thick and based on concrete. In TP3 the concrete was cast on a 0.12m thick layer of brick paving and in TP3A the concrete was 0.29m thick and contained a stone paving slab layer at 0.07m to 0.13m depth. Trial pit TP4 was undertaken from the base of the lightwell to the front, north-east elevation of the main house, from approximately 1.60m below ground level and proved 0.35m of concrete. This was cast on a 0.15m thick layer of hardcore, comprising grey brown, silty sand and gravel with occasional cobbles of brick. The gravel fraction comprised brick, concrete, flint, plastic, polystyrene and ash.

The remaining exploratory holes were undertaken in soft landscaped areas where the surface 0.05m to 0.80m thick layer of made ground comprised topsoil fill of soft, friable, dark brown, slightly gravelly, sandy clay. The gravel fraction comprised brick, flint, quartz, quartzite, coal and ash. Below the hardstanding layers and surface topsoil fill, the made ground across the site was generally firm, locally soft, brown, orange brown and light brown mottled, slightly gravelly, sandy clay. The gravel fraction of this clay fill comprised brick, lime mortar, coal, flint, ash and locally (WS4) charcoal and bone fragments. Trial pit TP5 was completed in the made ground at 1.20m depth.

Most of the remaining exploratory holes proved the made ground to be between 0.60m and 2.30m thick, with the latter encountered in TP3 attributed to infill alongside the existing basement of the main house. In WS4, WS5, WS6 and WS8, the basal 0.20m to 0.65m of clay fill was soft, brown and dark grey mottled, slightly gravelly, silty clay with a faint organic odour, black organic patches and dead root fragments. The gravel fraction of this suspected pond infill comprised brick, lime mortar, flint and ash. The base of this pond infill was proved at depths between 2.85m and 3.20m in WS4, WS5, WS6 and WS8.

London Clay Formation

The solid geology of the London Clay was met below the 0.60m to 3.20m thick layer of made ground. This was initially weathered to firm, brown and grey mottled, silty clay with occasional orange brown silt partings and rare gravel size calcareous concretions. With depth the weathered London Clay became stiff, fissured, locally fissured to firm, brown clay with occasional grey stained fissure planes, orange brown silt partings and selenite crystals. Most of the exploratory holes were completed within this horizon at depths between 1.20m and 5.00m.

Below 6.70m in BH2 and 6.80m in BH3, the London Clay was stiff, fissured, brown grey clay with occasional grey silt partings. A cobble size concretionary limestone nodule was met at 17.00m depth in BH1. Boreholes BH2 and BH3 were completed in the London Clay at depths of 18.00m and 20.00m, respectively.

Live Roots

Live roots were observed in all of the exploratory holes to depths between 0.50m and 3.20m. The greatest depths of live roots were noted alongside the south-eastern tree lined boundary (WS8).

Groundwater

Seepages or strikes of water 'perched' near the base of the made ground were met at depths between 0.95m and 3.00m in WS2, WS9, WS5, WS6, TP1, TP2, TP3A and TP4. The remaining window sample holes and trial pits were recorded as dry in the short time they were left open prior to backfilling.

Groundwater was generally not encountered during drilling in BH1 to BH3, with the exception of a seepage associated with a concretionary limestone nodule at 17.00m depth in BH2. The use of 2.00m to 2.50m of casing, through the made ground and into the London Clay, would have prevented seepages from water 'perched' within the made ground above the London Clay. During the subsequent return monitoring visits during January, February and March 2015, groundwater levels in the borehole standpipes (BH1, BH2, BH3 and WS8) were recorded between depths of 0.50m and 2.95m below ground level.

Evidence of Contamination

The made ground encountered during this investigation was not noted to have olfactory or visual evidence of hydrocarbon contamination. The made ground was noted to contain fragments of brick, lime mortar, concrete, coal, ash and locally charcoal, bone, plastic and polystyrene. No asbestos containing materials were noted in the soils during this investigation.

Existing Foundation Details

Trial pit TP1 was undertaken against the north-western site boundary and the south west elevation of Lyndurst Hall. The foundations exposed comprised corbelled brickwork to 1.30m depth, resting on a 1.05m thick concrete footing, based within the London Clay at 2.35m depth with a projection of 0.34m.

Trial pits TP3 and TP3A were undertaken against the south-west bay window of No.11. Trial pit TP3, further south of TP3A, proved corbelled brickwork to 2.02mm depth, resting on a 0.17m thick concrete footing, based within the London Clay at 2.19m depth, with a projection of 0.16m. By contrast, TP3A on the opposite side of the bay window proved 2.03m of brickwork on a 0.87m thick concrete footing, based within the London Clay at 2.90m depth with a projection of 0.20m. A large diameter foul drain or brickwork sewer was met at 1.45m to 1.85m depth in TP3A that entered the building from the east. Trial pit TP4 was undertaken against the north-east elevation of No.11, in the front lightwell, approximately 1.60m below ground level. The exposed foundations of No.11 (Section B-B) comprised 0.39m of rendered brickwork, resting on a 0.51m thick concrete footing, based within the London Clay at depth of 0.90m below the lightwell floor level, with a projection of 0.52m. The foundations of the adjacent retaining wall to the lightwell (Section A-A) were also exposed in TP4 and comprised 0.39m of concrete, resting on a 0.21m thick concrete footing, based within the London Clay at depth of 0.60m below the lightwell floor level, with a projection of 0.22m.

Foundations of The Studio were exposed in TP5, which comprised 0.75m of brickwork, resting on a 0.34m thick concrete footing, based within made ground at 1.09m depth, with a projection of 0.28m.

COMMENTS ON THE GROUND CONDITIONS IN RELATION TO FOUNDATION DESIGN AND CONSTRUCTION

The investigation found a 0.60m and 3.20m thick layer of made ground that was underlain by the initially weathered solid geology of the London Clay. Foundations for the buildings to be retained and the new basements will need to be deepened through the locally thick made ground and within the range of influence of adjacent trees. A piled foundation scheme would therefore be considered more appropriate than strip or pad footings, particularly due to the presence of numerous mature trees within and adjacent the site. The new basements are proposed to have contiguous piled walls and locally, alongside the infilled pond, secant piled walls to act as temporary and permanent support to the basement excavations and minimise the scale of dewatering. The basements would be constructed using the top-down construction method, with the ground floor slabs built prior to basement excavation, also acting as temporary and permanent support to the basement walls.

Foundation Depths

The exploratory holes encountered made ground to depths between 0.60m and 3.20m, with the thickest made ground including infill to a presumed historical pond alongside the south-east site boundary. Large scale processes of natural sedimentation allow a certain degree of confidence to be placed in the absence of important variation of the engineering properties of natural soils across sites. By contrast, made ground, whose history is not completely known, must, despite any amount of investigation, inevitably present the possibility of conditions existing which could not be accepted when considering the material as a bearing stratum.

The underlying London Clay had modified plasticity indices of 51% and 53%, and so is of high volume change potential. A minimum foundation depth of 1.00m below existing or finished ground level, whichever is deepest, could be adopted within the naturally deposited clay on this site.

The presence of trees within and around the site will locally have increased the depth affected by seasonal changes in the moisture content of clay soils. Reference to the National House Building Council (NHBC) Standards Chapter 4.2 "Building near trees" (2014), indicates for example, a minimum footing depth of 2.50m when 10m from a mature Oak tree in high volume change potential soil. As much of the proposed building is less than 10m from mature Oak trees, the foundations should be engineer designed. In addition, the depth of clay desiccation may be increased due to the combined effects of numerous trees within and adjacent the site.

The moisture content-depth profiles, depicted in Figure 1 indicate moisture content deficits to depths of approximately 3.50m in BH1, WS1 & WS7, 2.50m in WS2 and WS9, and 2.00m in WS3. This is considered to provide evidence of desiccation to these depths within the London Clay.

Foundation excavations should be inspected for live roots, and where present in clay soils, deepened to at least 0.50m below the deepest visible root in the side of the footing trenches. Live roots were observed in all of the exploratory holes to depths between 0.50m and 3.20m. The greatest depths of live roots were noted alongside the south-eastern tree-lined boundary (WS8).

Foundations within the range of influence of removed and extant trees will have to be separated from the soil by a suitable void former. The required gap dimensions for footings in the high volume change potential clay soils are detailed in the previously cited NHBC document.

In summary, it is considered likely that minimum footing depths in the order of 1.30m (BH3) to 3.70m (WS8) below ground level, in natural ground, will be warranted for the new structures so that they are based on non-desiccated clay soils. For most of the exploratory hole locations, the depths of live roots observed would require footings over 2.50m depth. The depth of foundations required for individual footings will require separate assessment based on proximity to trees. The relative elevations of trees will need to be taken into account, particularly where present at lower elevations than adjacent footings.

The proposed single-storey basement excavation to say 3m depth is likely to remove all of the made ground from the proposed basement location (away from the pond infill) and most of the root affected clay, with foundations based within the underlying London Clay.

A piled foundation scheme may be preferred, with contiguous or secant piled walls acting as permanent support to the basement excavation. These could also form the walls of the proposed basement.

Mass Concrete Footings

At the minimum foundation depth of 1.30m and away from the influence of live roots, the naturally deposited clay would have a maximum safe bearing capacity of 145kN/m^2 beneath a 0.60m wide strip footing and 155kN/m^2 for a 1.20m wide square pad, both with a factor of safety of 3.0 applied against shear failure. Total settlement beneath such foundations cast within the weathered London Clay should be within tolerable limits for load bearing brickwork.

For the proposed basement foundations, the London Clay below 2.50m would have a maximum safe bearing capacity of 150kN/m^2 beneath a 0.60m wide strip footing and 170kN/m^2 for a 1.20m wide square pad, both with a factor of safety of 3.0 applied against shear failure. Total settlement beneath such foundations cast within the London Clay should be within tolerable limits for load bearing brickwork.

Alternatively a basement raft foundation could be considered for this structure. For example, the firm London Clay for a 10m wide square raft foundation at say 3.00m depth would have a maximum safe bearing capacity in the order of 110kN/m^2 with a factor of safety of 3.0 applied against shear failure.

Due to the presence of 'perched' water within the made ground above the base of the proposed basement excavation (anticipated to be in the order of 3m deep), dewatering from screened sumps may not be sufficient to keep such a deep excavation dry. Installation of secant piled walls, 'toed' into the practically impermeable London Clay, could act as a 'cut off' to groundwater, minimising the scale of dewatering required within the excavation. A secant piled foundation solution may be considered more appropriate than deepened mass concrete foundations or contiguous piles for the proposed basement excavation, with the piled wall forming the basement perimeter.

Piled Foundations

The London Clay should provide a suitable stratum into which piles can be installed for the proposed structure. The advice of a specialist piling contractor should be sought prior to design, with particular regard to obstructions such as concretionary limestone nodules as met in the London Clay at 17.00m in BH2. The use of driven piles may be ruled out on this site on the basis of the potential for vibrations caused by the piling to be potentially damaging to neighbouring properties and noise levels during installation in this predominantly residential area.

In order to avoid piles being subjected to the effect of future seasonal and tree root-induced moisture content and volume changes, predominantly heave, it may locally be necessary to either sleeve the piles to a minimum depth in excess of the maximum potential root depth, or ensure that the piles are reinforced sufficiently to withstand any uplift forces due to such changes. Similarly compressible material would need to be placed around pile caps and ground beams. These measures will be relevant to piles within the range of influence of the trees within and adjacent the site.

Where piles form retaining structures such as the proposed basement, it may be necessary to reinforce the piles due to the potential for failure under horizontal load. Such piles should also be extended to adequate depths to mobilise sufficient passive resistance to prevent rotation of the piles due to the horizontal load.

For the purposes of preliminary pile design, the pile bearing coefficients given, which are based on the following assumptions, may be used to assess working loads for a bored pile.

1) Ultimate shaft friction/adhesion within the made ground and root affected clay is ignored.

2) The ultimate load on a pile would be the sum of the side friction/adhesion acting on the pile shaft together with the end bearing load.

4) In clay the shaft adhesion and end bearing would be a function of the apparent shear strength values obtained from the triaxial compression tests. The laboratory triaxial shear strengths are plotted against depth in Figure 2.

5) A factor of safety of at least 2.0 would be used to assess pile working loads. If test loading of selected piles were not practical the factor of safety would be increased to at least 2.5.

Item	**Ultimate Pile Bearing Value kN/m²**
Shaft friction adhesion in made ground & desiccated clay	Nil
Average shaft adhesion in firm London Clay to 4.00m depth	30
Average shaft adhesion in stiff London Clay from 4.00m to 12.00m depth	40
Average shaft adhesion in stiff London Clay below 12.00m depth	50
End bearing in stiff London Clay 4.00m to 12.00m depth	720
End bearing in stiff London Clay below 12.00m depth	900

Based on these coefficients, a single 450mm diameter bored pile, installed to 18.00m depth at the location of BH3, would have estimated working load in the order of 420kN (F=2.5). This pile working load discounts any shaft adhesion to 3.00m depth, the assumed depth of the proposed single-storey basement excavation.

Different pile lengths, or diameters, from those detailed above would give different available working loads, which could be tailored to suit the working loads required. A piling specialist should undertake final design of piles. The piling specialist may choose to adopt alternative parameters to those outlined herein; however their suitability should be verified by an experienced geotechnical engineer and approved by Building Control. Whilst static pile load testing may enable the factor of safety to be reduced, this is unlikely to be practical or economical for this small site. Although not encountered by the investigation, the possibility of water strikes cannot be ruled out.

Basement Floor

The proposed basement may not extend into the area of the presumed historically infilled pond encountered in the south-eastern part of the site. In that case the floor of the single level basement would be cast within the London Clay and should be inspected on completion to ensure that the condition of the soil complies with that assumed in design. Should pockets of inferior material be present, they should be removed and replaced with well graded hardcore or lean mix concrete. The excavated surface should be protected from deterioration and a blinding layer of concrete used where foundations are not completed without delay.

The removal of say 3.00m of material to create the basement extension below the site will reduce the overburden pressure at the new basement floor level by an estimated $60kN/m^2$. The removal of 6.00m of material to create the sub-basement plant room below part of the basement swimming pool will reduce the overburden pressure the new plant room floor level by an estimated $120kN/m^2$. The amount of theoretical base heave would depend on the width and depth of the proposed basements, with the net heave/settlement dependant on the proposed building loads. For example, theoretical base heave, for the 12.00m long, 8.00m wide, 3.00m deep basement swimming pool is excavated could be in the order of 30mm, with an additional 10mm of base heave for the approximately 4m wide square plant room sub-basement excavation (assumed to be based 6.00m below ground level), beneath the swimming pool. Such movement would be expected to occur soon after excavations, unless confined by the loading imposed during construction of the basements floor shortly after excavation.

If the proposed foundation load is equal to the safe bearing capacity (110kNm^{-2}), settlement beneath an 8.00m wide, square, rigid basement raft foundation at 3.00m depth would be in the order of 70mm, with an additional 20mm settlement beneath the 4m wide square sub-basement plant room. The net settlement would therefore be in the order of 40mm for the basement swimming pool and 50mm for the sub-basement plant room, taking into account the theoretical base heave of 30mm for the swimming pool and 40mm for the plant room. The proposed structure is unlikely to have such a high imposed load and the net reduction in overburden pressure will need to be taken into account in the design of the basement, which will need to be adequately reinforced to withstand the anticipated settlement. This movement would occur differentially and would require additional reinforcement where different building loads are applied across the basement and between different basement levels.

The swelling stages of the oedometer tests undertaken on six selected undisturbed samples at depths between 1.90m and 5.00m gave pressures of 48kPa to 135kPa. These swelling pressures were recorded after each sample was fully saturated, which could occur during construction if the basement excavation is inundated. Water should therefore be rigorously excluded from the basement excavation. The latter may be more practical to achieve when adopting a secant piled wall foundation solution.

During the return monitoring visits groundwater levels in the borehole standpipes were recorded between depths of 0.50m and 2.95m below ground level. This water was 'perched' within the made ground above the relatively impervious London Clay. The absence of a significant head of groundwater, within the depth of the proposed basement excavations, will mean that flotation of the sub-structure would not be a problem on this site. As 'perched' water was met above the floor of the proposed basement, it would be necessary to waterproof the basement in order to prevent the ingress of groundwater into the completed structure. In addition, downward percolating surface water will need to be prevented from entering the basement.

Retaining Structures

The walls of the proposed basement will act as retaining walls and will need to be designed accordingly. For a permanent retaining wall analysis effective stress parameters would be appropriate, however, in the absence of effective stress testing on samples from this site, published parameters and in-situ test results could be used as a conservative approach. The design of retaining walls may be based on the parameters in Table 5 overleaf.

Soil Type	Bulk Density (Mg/m^3) γ_B	Angle of Shearing Resistance (degrees) ϕ'	Shear Strength (kPa) c_u	Effective Shear Strength (kPa) c'
Made Ground (Clay fill)	1.80	23	35	0
London Clay to 4.00m depth	2.00	23-26	60	0-2

Table 5

Excavations/ Groundwater

The excavation of the basement will require the construction of close support to its sides, the need to avoid undermining adjacent structures, and perhaps during wetter seasons the control of perched groundwater. Statutory safety precautions should not be neglected and excavations especially those where personnel are to enter, will need to be supported, or have battered sides where space permits. All excavations should be undertaken in accordance with CIRIA Report 97 '*Trenching Practice*'.

Excavations for the proposed basements are likely to encounter water 'perched' within the made ground, as met during the investigation with standing water levels recorded between 0.50m and 2.95m. The greatest head of this water, 'perched' above the London Clay, was encountered within the presumed pond infill in the southern part of the site (WS8). The use of secant piled walls, particularly in the area of the pond infill, would act as a shut off to this 'perched' water and dewatering from the screened sumps should in this case be sufficient to keep the basement excavations dry.

Care should also be taken to ensure that the walls of the new basement are adequately propped during excavation, by temporary support and permanently by the basement floor and roof, to prevent movement at the top of the retaining walls. Such lateral movement would otherwise be accompanied by settlement (vertical movement) of the ground behind the basement walls.

Provided that a stiff bracing system is used to prevent deflection of the proposed basement wall, resultant changes to the state of soil stress and structural movement of neighbouring structures should be negligible. Assuming that the neighbouring structures are of robust construction, the anticipated level of structural damage, if any, would fall within Category 1 ("very slight") to Category 2 ("slight") as described in Table 2.5 of the aforementioned CIRIA document.

Care should also be taken to ensure that the proposed retaining walls of the basement, in addition to the existing retaining walls and neighbouring basements, are not surcharged with plant and equipment or the stockpiling of materials and excavated soils outside the basement excavation.

Buried Concrete

Sulphate analysis on selected soil and water samples gave results in Design Sulphate Classes DS-1 to DS-4 of BRE Special Digest 1, Table C2 (2005), presented in Appendix 7. The mean of the highest 20% of the sulphate results to the nearest 100mg/l (3800mg/l) is taken as the characteristic value and gives a Design Sulphate Class of DS-4. The pH results were between 6.8 and 9.0, and so slightly acidic to alkaline.

London Clay is listed in this publication as being a stratum that may contain sulphides, such as pyrite, hence oxidation due to disturbance during the excavation of foundations and the basement may increase the total potential sulphate content. This clay should not be left exposed to the elements for any length of time, otherwise there would be a potential for oxidation of any pyrite within the London Clay and, in the long term, possible thaumasite formation. However, it should be noted that the use of piled foundations would minimise disturbance of the ground and consequently reduce the potential for the oxidation of any pyritic clay.

Using the characteristic Class DS-4 result and pH results, an Aggressive Chemical Environment for Concrete (ACEC) Class of AC-4 would be considered appropriate for buried concrete on this site, as detailed in the above cited BRE document.

Other Issues

The drainage and sewerage records for the site and adjacent dwellings will need to be referenced, if available, or perhaps surveyed to confirm that the site does not share a communal drainage system. The new development on this site is likely to only affect the drainage and sewerage of the site itself, rather than neighbouring properties.

The flow of surface water should not be changed by the relatively small scale redevelopment, with the area of the proposed basement mostly covered by the existing studio building.

The London Clay is typically practically impermeable and groundwater was encountered 'perched' within the overlying made ground, with groundwater levels recorded at depths between 0.50m and 2.95m below ground level in the standpipes. The interface between the London Clay and made ground was deeper towards the south-east and the groundwater beneath the site would be expected to flow towards the south-east, downhill and towards the culverted River Fleet.

The displacement of the presumed north-west to south-east flowing groundwater by its exclusion from beneath the proposed basements may theoretically result in an increase in local drainage path, which could result in marginally higher groundwater levels on the north-western side of the proposed basements. However when considering combined effects of adjacent structures. Lyndhurst Hall that is up hydraulic gradient and to the immediate north-west of the site was proved to have 2.35m deep foundations (TP1), which extended through the made ground and into the underlying practically impermeable London Clay. The pre-existing near surface/"perched" groundwater flow from uphill and up hydraulic gradient to the north-west would already be diverted around Lyndhurst Hall and would therefore not be anticipated to be affected by the proposed basement construction within the site.

COMMENTS ON THE CHEMICAL TEST RESULTS

The results of the laboratory chemical testing on near surface soil samples have been compared to CLEA Soil Screening Values (SSVs) and Category 4 Screening Levels (C4SLs), which have been used as screening tools for use in the assessment of land affected by contamination.

Atkins Limited has derived ATRISKsoil SSVs based on the default assumptions provided in SR3, which have been used in the development of the Soil Guideline Values (SGVs) published by the Environment Agency in 2009. Atkins SSVs have been derived in line with the Environment Agency 2009 guidance (SR2, SR3, SR4, SR7) using the CLEA v1.04 and CLEA v1.06 software. These are provided under licence to Ground Engineering Limited, and respective toxicology reports and technical details on the derivation of the SSVs can be provided on request.

Following revised statutory guidance to support Part 2A of the Environment Protection Act (April 2012), Final Category 4 Screening Levels have recently been published (for arsenic, benzene, benzo(a)pyrene, cadmium, chromium VI and lead) by the Department for Environment Food and Rural Affairs in their document SP1010: March 2014. With the exception of lead the C4SLs are higher than the SSVs.

The following standard land uses form the basis of the assessment in relation to soils:

- Residential use with home grown produce
- Residential use without home grown produce
- Commercial and industrial usage

The intended purpose of the SSVs are as "intervention values" in the regulatory framework for assessment of human health risks in relation to land use. These values are not binding standards, but are intended to inform judgements about the need for action to ensure that a new use of land does not pose any unacceptable risks to the health of the intended users.

Table 6 compares the test results for the made ground with the SSVs, and C4SLs for lead and hexavalent chromium, in relation to the specified uses. The numbers of test results, which exceed these values, are also provided.

Table 6: Comparison of Chemical Test Results with SSVs/C4SLs

Determinand	Number of Samples	Min Value (mg/kg)	Max Value (mg/kg)	Number of Samples Exceeding SSC for: Residential with home grown produce	Residential without home grown produce	Commercial/ Industrial	Measured 95th Percentile (mg/kg)	Assessment Method	Soil Screening Criteria SSC (1% SOM): Residential with home grown produce (mg/kg)	Residential without home grown produce (mg/kg)	Commercial/ Industrial (mg/kg)
Organic matter	9	0.97%	7.4%	-	-	-	-	-	-	-	-
Arsenic	9	13	23	0	0	0	19.86	SSV	32	35	640
Cadmium	9	<0.10	0.29	0	0	0	0.21	SSV	10	83	230
Trivalent* Chromium	9	27	52	0	0	0	41.20	SSV	12,800	15,500	21,300
Hexavalent Chromium	9	<0.50	<0.50	0	0	0	<0.50	C4SL[1]	21	21	49
Lead	9	38	640	6	4	0	393.14	C4SL[1]	200	310	2330
Mercury	9	0.13	2.5	0	0	0	1.40	SSV	6	7	66
Selenium	9	<0.20	<0.20	0	0	0	<0.20	SSV	350	595	13,000
Nickel	9	12	36	0	0	0	26.65	SSV	130	130	1800
Phenols	9	<0.30	<0.30	0	0	0	<0.30	SSV	162	262	686
Benzo[a]pyrene	9	<0.10	<0.10	0	0	0	<0.10	SSV	0.8	0.9	14
Copper	9	15	75	0	0	0	56.68	SSV	3970	8370	109,000
Zinc	9	41	140	0	0	0	102.14	SSV	16,900	46,400	917,000
Free Cyanide	9	<0.50	<0.50	0	0	0	<0.50	SSV	34	34	14

Notes:

*The concentration of Trivalent Chromium is assumed to be equivalent to the Total Chromium concentration. This is because most naturally occurring chromium is in the trivalent (chromic) state.

[1] Category 4 Screening Levels are based on 6% SOM.

Discussion of Results

The results of the laboratory analysis (Table 6) indicate that the made ground beneath the site contains elevated concentrations of lead, which exceeded residential soil screening criteria and fell below commercial/industrial screening criteria. None of the other contaminants tested for exceeded their respective screening criteria for a residential or commercial industrial land use.

Statistical analysis, based on the mean value test, indicates that the US95 value for lead exceeded the respective screening values for a residential with home grown produce end use and a residential without home grown produce end use. All of the other US95 values fall below the respective screening values for the specified end uses. The maximum value test for the lead data indicates that the highest values obtained are not statistical outliers, and so are representative of the sample population.

The results indicate that the made ground beneath the site would be unsuitable for retention at the surface in a residential setting due to the presence of lead within the made ground.

No visual or olfactory evidence of hydrocarbon contamination was detected in the exploratory holes.

No asbestos containing material (ACM) was encountered during sample preparation for the chemical laboratory tests and no visual evidence of ACM was encountered during the investigation.

Comparison of Water Analysis with Inorganic Drinking Water Standards

A sample of groundwater recovered from WS5 at 0.80m depth was analysed in the laboratory for a suite of common inorganic and organic potential contaminants primarily for characterisation purposes. The primary assessment tool employed for the generic screening of samples for the protection of 'Controlled Waters' consists of the Statutory Instrument 2000 No.3184 'The Water Supply (Water Quality) Regulations 2000' that amends the 1991 version. The fraction of test results that exceed these levels are summarised in Table 7.

Table 7: Comparison of Chemical Test Results with Water Supply Regulations

Determinant	Recorded Values BH2B 1.33m	The Water Supply (Water Quality) Regulations 1989-2000 Maximum Concentration/Value for Consumers Taps
Arsenic (Dissolved) µg/l	2.8	10 µg/l
Boron (Dissolved) µg/l	280	1000 µg/l
Cadmium (Dissolved) µg/l	<0.080	5.0 µg/l
Chromium (Dissolved) µg/l	5.3	50 µg/l
Copper (Dissolved) µg/l	<1.0	2000µg/l
Cyanide (Dissolved) mg/l	<0.050	0.05 mg/l
Lead (Dissolved) µg/l	<0.10	25 µg/l
Mercury (Dissolved) µg/l	<0.50	1.0 µg/l
Nickel (Dissolved) µg/l	10	20 µg/l
pH value	7.6	6.5 minimum 10.0 maximum
Total Phenols mg/l	<0.030	0.0005 mg/l
Selenium (Dissolved) µg/l	2.3	10 µg/l
Sulphate mg/l	750	250mg/l
Sulphide mg/l	<0.050	No limit
Zinc (Dissolved) µg/l	52	5000 µg/l
Total of 16 PAHs µg/l	<0.20	0.10 µg/l

With regard to the groundwater quality recorded, the concentration of sulphate in the 'perched' water sample obtained at 0.80m depth in WS2 exceeded the standard threshold. All of the other recorded concentrations of contaminants fell below the respective standard thresholds. This elevated sulphate result is considered to be representative of background concentrations.

SOIL GAS MONITORING RESULTS

A return visit to monitor gas levels in the BH1, BH2, BH3 and WS8 standpipes was undertaken in January 2015 to record the concentrations of landfill type gases (methane, carbon dioxide and oxygen). The results are presented to the rear of the exploratory hole records. The recorded concentrations of methane were less than 0.1%, whilst the carbon dioxide levels recorded were up to 0.4%. The recorded oxygen concentrations within the standpipe was close to atmospheric concentrations at 18.6% to 20.1%. The in-situ measurement confirmed gas emission rates between <0.1l/hr and 1.0l/hr.

Assuming a positive flow rate of 1.0l/hr, the results give a Gas Screening Value (GSV) of 0.004l/hr. This GSV falls within the modified Wilson and Card Characteristic Situation 1 or 'Green' classification of the NHBC traffic light system (for low rise housing), as defined by the Construction Industry Research and Information Association, CIRIA Report C665, 'Assessing risks posed by hazardous ground gasses to buildings'.

UPDATED CONCEPTUAL MODEL

Assessment of the potential linkage between ground contamination sources, human and environmental receptors have been assessed based on the desk study research and the intrusive ground investigation documented in the preceding sections of this report.

A generalised conceptual model relative to the existing site and proposed new school block use of the site is presented in Table 8 below.

Table 8: General Conceptual Model Relative to Existing Site and Future Development

Receptors	Pathway	Estimated Potential for Linkage with Contaminant Sources				
		Drainage	Buildings	Soil	Soil Gas	Off-Site Sources
Human Health - ground workers	Ingestion and Inhalation of contaminated Soil, Dust and Vapour	Moderate	High (asbestos)	Moderate	Low	Very Low
Human Health - users of completed development	Ingestion and Inhalation of contaminated Soil, Dust and Vapour	N/A	N/A	Very Low	Low	Very Low
Water Environment	Migration through ground into surface water or groundwater	Low	Very Low	Low	Very Low	Very Low
Flora	Vegetation on site growing on contaminated soil	Very Low	Very Low	Very Low	Very Low	Very Low
Building Materials	Contact with contaminated soil	Very Low	Very Low	Very Low	Very Low	Very Low

Key to Table 8 Risk	Definition
Very High	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, or, there is evidence that severe harm to a designated receptor is currently happening. The risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required.
High	Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) and remedial works may be necessary in the short term and likely over the long term.
Moderate	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild.
Low	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.
Very Low	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe.
N/A	Not Applicable because the proposed development will remove the source.

COMMENTS ON GROUND CONTAMINATION IN RELATION TO PROPOSED DEVELOPMENT

Anticipated exposure scenarios relating to the existing site and proposed redevelopment are discussed as follows.

This investigation may not have revealed the full extent of contamination on the site and appropriate professional advice should be sought if subsequent site work reveals materials that may appear to be contaminated.

Existing Building

The existing house to be extended and The Studio, to be converted, may contain asbestos-based insulation or roofing. It is recommended that an asbestos survey be conducted in order to determine the type and nature prior to construction. Suitable precautions, in line with current best practice, should be put in place to protect workers and end users from the effects of asbestos material.

Existing Drainage

Redundant foul or surface water drain runs, should be removed from beneath the site and precautions should ensure that any remaining effluent is directly disposed off-site. The integrity of existing drainage should be checked, and where they are to be retained, any damaged sections should be replaced prior to development. The latter measures should remove any future risk to human health and to the water environment.

Contaminated Soil

On the basis of the ground investigation, the site is underlain by between 0.60m and 3.20m of made ground with the thickest including presumed infill to an historical pond alongside the south-east site boundary. The made ground contained concentrations of lead which statistically exceeded residential soil screening criteria. The made ground would not therefore be suitable for retention or re-use at surface level within any soft landscaped or garden areas.

Soil Gas

There are no historic landfills within 250m of the site. The site is underlain by between 0.60m and 3.20m of made ground over the London Clay. The deepest area of made ground includes infill to a presumed historical pond alongside the south-east site boundary, where the infill was locally organic towards its base. On the basis of the work undertaken, the gas monitoring has determined that a Wilson and Card Characteristic Situation 1 or 'Green' classification of the NHBC traffic light system (for low rise housing) would apply. However due to the locally organic nature of the deep made ground, consideration should be given to increasing the Characteristic Situation to CS2 or Amber 1.

In any case, the basement structure will have to be adequately water-tight, with waterproofing also acting as an impermeable gas membrane. The incorporation of an impermeable gas membrane should not be problematic and would prevent the pathway between potential soil gas and end users, ensuring the risk of soil gas to end users remains low.

Human Health - Construction Workers

The risk of the identified ground contamination (lead) affecting the groundworkers during the construction phase of development, would be considered to be moderate.

Based on the chemical test results, no special precautions would be required during the development of the site by workers who may come into contact with the soil during groundworks, providing standard precautions are adopted which should generally include the procedures given by the Health and Safety Executive (The Blue Book) HS(G)66.

For the protection of workers during groundworks the following is recommended:

a) Limit repeated or prolonged skin contact with soils by wearing gloves with sleeves rolled down.

b) Washing facilities should be made available to groundworkers, so as to minimise the potential for inadvertent ingestion of soil.

c) If any soils are revealed which are different to those encountered by this ground investigation, the advice of a specialist should be sought in view of classifying the material and ascertaining its risk to groundworkers.

d) Suitable precautions, in line with current best practice, should be put in place to protect workers and neighbouring residents from the effects of asbestos material, during any demolition phase which may require the clearance of asbestos from buildings.

e) Generation of dust should be limited by damping-down.

f) Consideration should be given to gas monitoring within deep or confined spaces, particularly where made ground thickens, to ensure safety of personnel entering them, since carbon dioxide could accumulate within any excavations, service chambers or sub-structures.

Human Health - Users of Completed Development

The risk of the encountered ground contamination affecting the site users when present beneath buildings and permanent areas of hardstanding would be considered to be very low. This is because it would be highly unlikely that the general site users would normally be able to penetrate the building floors, basement walls and hardstanding, which would be necessary for them to uncover any contaminated soils beneath the site. However, there is considered a moderate risk to site users if the near surface fill were retained within private gardens or soft landscaped areas.

The presence of elevated lead within the made ground means that such soils should not be retained within gardens or soft landscaping in the proposed redevelopment. These soils will need to be removed from such areas and either disposed of off-site, covered with an adequate capping layer, or placed beneath areas of hardstanding, if geotechnically suitable.

Water Environment

There are no surface water features within 250m of the site, the former River Fleet has been culverted approximately 184m east of the site. The site is underlain by the solid geology London Clay that is indicated by the EA to be an 'Unproductive' stratum. The site is not within a Source Protection Zone.

Groundwater levels during the return monitoring visits were between 0.50m and 2.95m in the borehole standpipes. No significant sources of ground contamination were identified by the desk study research on site or in close proximity to the site. Significant soil or water contamination was not identified by the investigative works and there are no surface water features within 250m of the site. It is consequently considered unlikely that the proposed development would impact the quality of the water environment.

Effects on Building Materials and Buried Services

The sulphate requirements for buried concrete have been discussed in the previous section of this report.

The presence of lead within the made ground soils may require precautions to protect buried plastic water pipes and the local water supply company should be consulted.

Off-Site Disposal of Soil Arisings

The results of chemical analysis are provided following the exploratory hole records and can be used within the information necessary for basic characterisation of the soil destined for landfill. The Environment Agency publication Hazardous Waste, Technical Guidance WM2 outlines the methodology for classifying wastes and should be referenced for guidance. The test results (total metals, hydrocarbons and cyanide) should be compared to the relevant thresholds to determine whether they fall into the primary categories of non-hazardous or hazardous waste and will help indicate the likely European Waste Catalogue (EWC) code which is determined by the waste type.

Excavated material and excess spoil should always be classified prior to removal from site as required by 'Duty of Care' (Environmental Protection Act, 1990) legislation. This means that material has to be given a proper description and waste classification prior to removal. Basic characterisation is the responsibility of the waste producer, whilst compliance checking and on-site verification are generally the responsibility of the landfill operator. The landfill operator will need to liaise with the waste producer, as the approach relies on the information from basic characterisation.

It is expected that arisings of natural soils from the excavations across this site would fall into the inert category under the European Waste Catalogue description 'Soil and Stones', EWC code 17 05 04 with restrictions excluding topsoil and peat

CONCLUSIONS

The proposed residential development will include a single level basement with a swimming pool and a two-storey section for plant beneath the south-west corner. The proposed site layout will need to be provided by the Engineer in due course. This plan will need to clearly identify new areas of gardens and soft landscaping, if included in the development.

Remediation

Remediation of the soils beneath the site, in respect of the redevelopment, is only considered necessary in relation to the creation of new areas of gardens and soft landscaping, as any new hardstanding, and basement floors/walls, will prevent contact between any contaminated ground and the site end users.

In order to create new gardens on this site, as a minimum, it will be necessary to either remove a sufficient thickness of the surface layers and replace them with imported topsoil material or isolate the contaminated made ground with a sufficient thickness of cover. The removal of 0.60m of made ground and a cover thickness of the same magnitude would be considered prudent for soft landscaping.

The removal of the surface layers and their replacement will provide a cover layer that will prevent contact between any site end users and any underlying contaminant source. It would be considered prudent to place a geotextile membrane between the cover layer and the underlying ground in order to prevent mixing of these layers.

In the event that the garden is used to produce vegetables and fruit, an increased depth of removal and thickness of imported subsoil and topsoil of up to 1.00m would be required.

Remediation Plan

This remediation scheme should be used with the proposed development plan to derive a remediation plan, clearly labelled to show the different land uses (for example -

hardstanding, buildings, soft landscaping and private rear gardens), which should be submitted to satisfy planning conditions.

Topsoil

Imported topsoil should have appropriate certificates confirming its suitability prior to placement.

Validation

The implementation of this remediation scheme should be checked during construction and on completion, and appropriate records kept so that a Validation Report can be compiled and subsequently submitted to the local authority.

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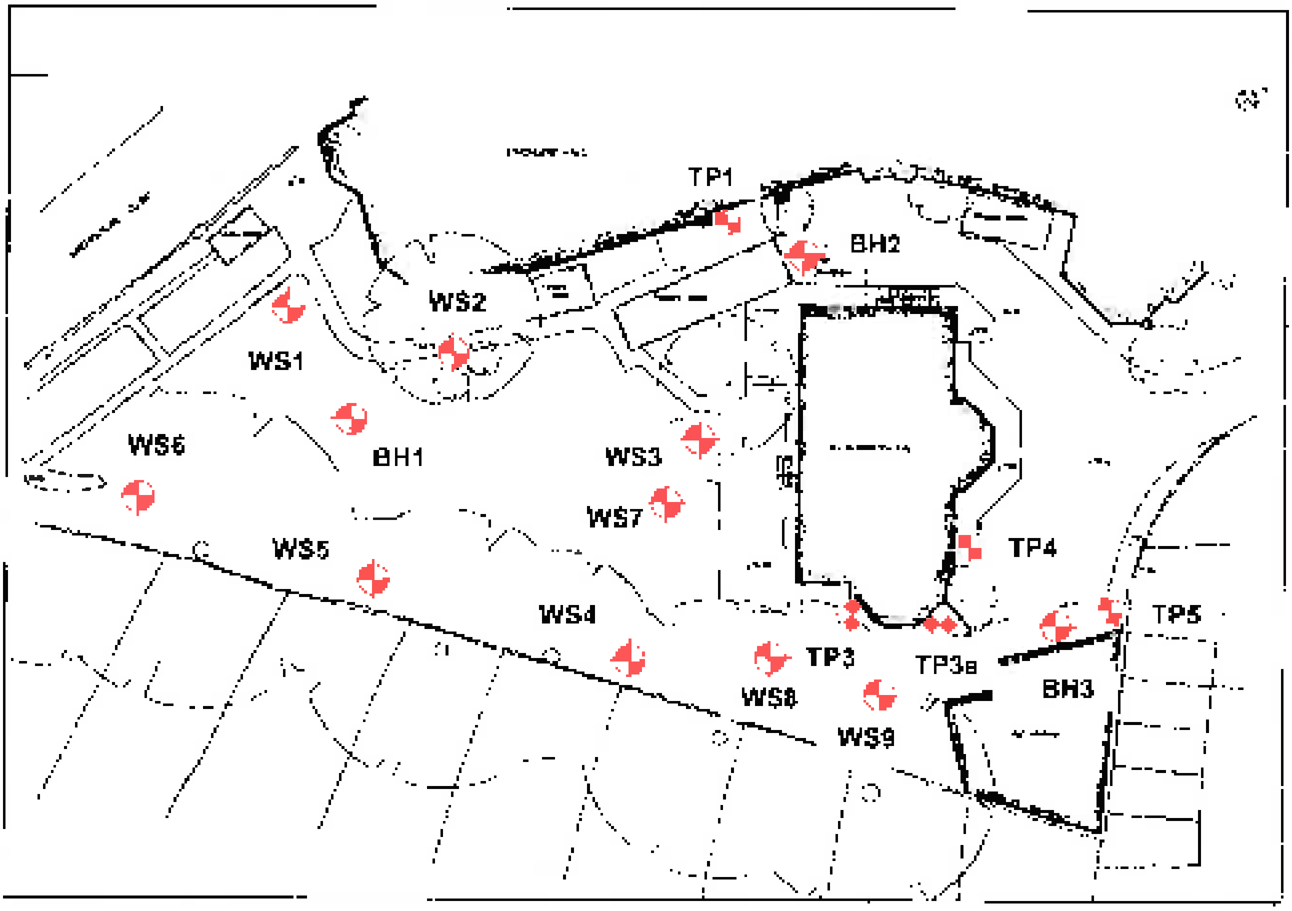
Appendix 1

Exploratory Hole Location Plan

Exploratory Hole Location Plan

Plan provided by Alan Baxter Associates



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Appendix 2

Historical Maps and Aerial Photographs

Site History

Figure A

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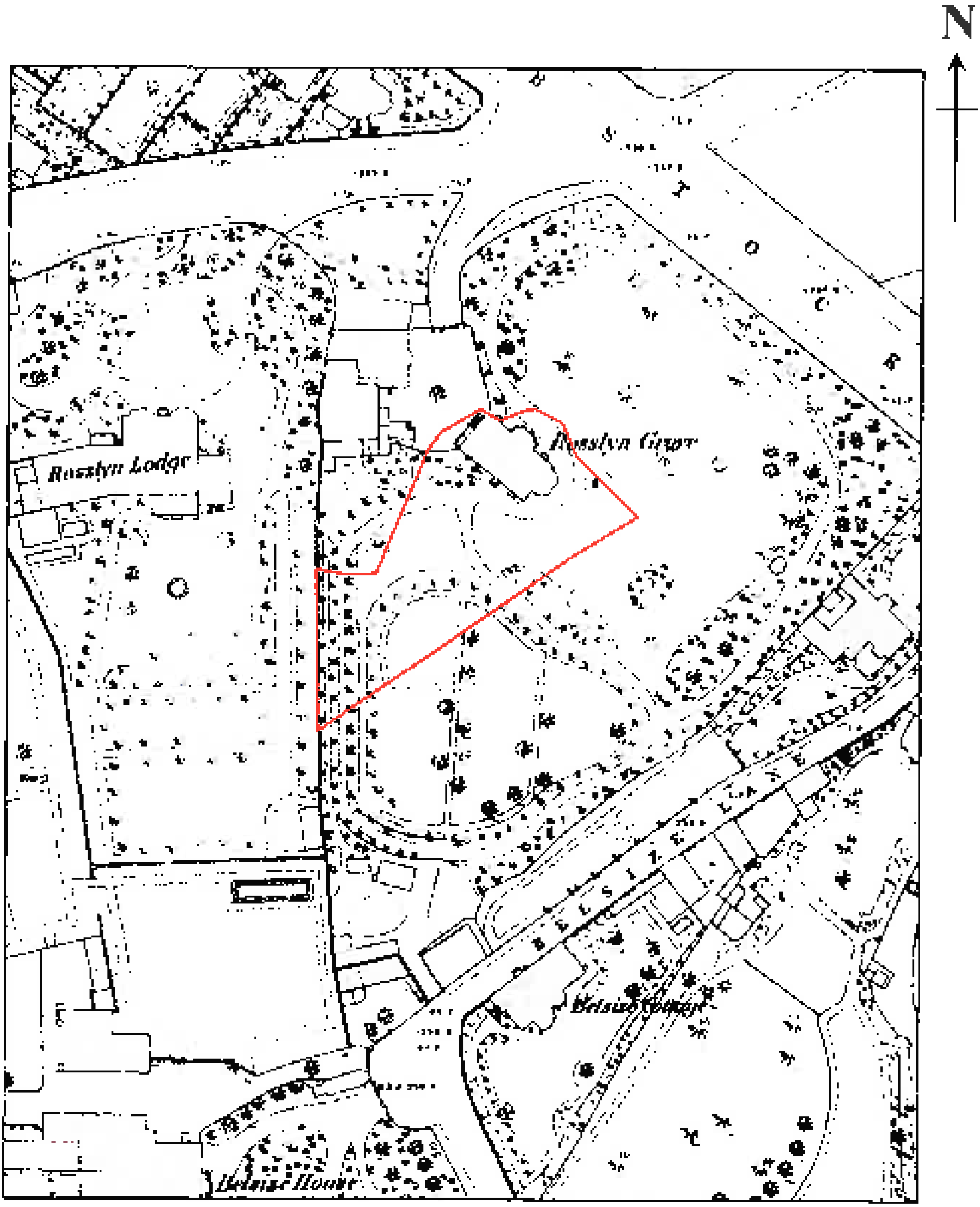

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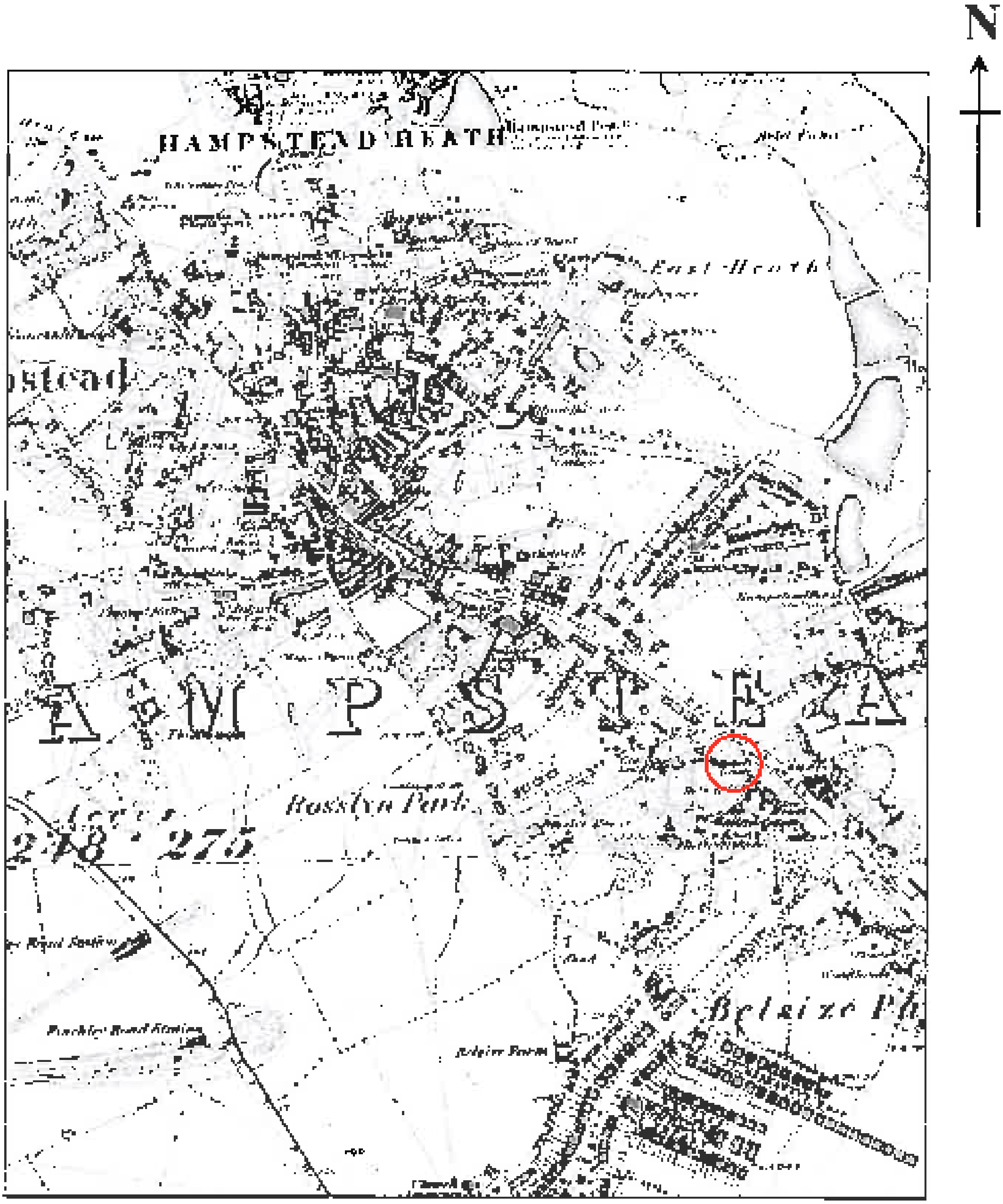
Site History

Figure B



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