6 Nutley Terrace
London NW3 5BX

Basement Impact Assessment

Job number:	211367
Revision:	P1
Status:	Information
Date:	January 2012

Document Control

issue no.	01	remarks	Information		
revision	P1	prepared by	Stephanie Bouhala (MEng) Sophie Treillard (MEng CEng MICE)	checked by	Gary Povey (BSc CEng MIStructE)
date	6th Jan 2012	signature	S. Bouhala S. Treillard	signature	

Contents

Appendices

Appendices cont. (included as a separate Report)

Executive Summary

To carry out this Basement Impact Assessment, guidance from Ove Arup's report "Camden geological, hydrogeological and hydrological study – Guidance for subterranean development" has been followed, in terms of Site Investigation (desk study, intrusive testing, monitoring and interpretive report) and in terms of the various Impact Assessments as well as reference to Camden's BIA.
Four different companies have worked together to compile the Basement Impact Assessment for 6 Nutley Terrace in order to cover the required qualifications as mentioned in the Camden Planning Guidance cgp4.

All reports have lead to the same conclusion: the deepening of the existing lower ground floor and the creation of a basement under the total footprint of the building will not have any adverse effect on the neighbouring properties, groundwater, surface water or slope stability.

Structural Engineering Notes

Introduction

This statement has been prepared by Stephanie Bouhala of Elliott Wood Partnership LLP, Consulting Structural and Civil Engineers, to accompany the planning application submitted by KSR Architects.

The purpose of the statement is to demonstrate a suggested method, form and sequence of construction for the design of the new basement and the construction of the new house that will not adversely affect any structures surrounding, road or ground.

The Contractor will, however, have to provide a detailed method statement including all temporary works taking in to account the permanent works design before the works can commence on site.

The Contractor is to accept full responsibility for the stability and structural integrity of the works during the Contract and provide temporary support as necessary. He shall also prevent overloading of any completed or partially completed elements.

The undertaking of such projects is specialist work and Elliott Wood Partnership will be involved in the selection of a competent Contractor who will need the relevant expertise and experience for this type of project. The Contractor will have to demonstrate his experience and competency to undertake the construction of this building.

This statement should be read in conjunction with Elliott Wood Partnership drawings 211367/S.001-S.002, S.50-S.52, KSR Architects' drawings, GEA Site Investigation Report dated October 2011, Chord Environmental Ltd's Groundwater Impact Assessment report dated November 2011 (Ref 1103/R1), GEA's Land Stability Impact Assessment report dated November 2011 (Ref J11158a) and Water Environment Surface Flow and Flood Impact Assessment report dated November 2011 (Ref WE11083).
This report follows the guidance given in the Camden Planning Guidance on Basements and Lightwells CPG4.
This assessment has been prepared in accordance with the guidance given in CPG4, DP23 and DP27.
The Basement Impact Assessment has been carried out by persons holding the required qualifications relevant to each stage.

Description of Existing Building and Site Conditions

The existing building at 6 Nutley Terrace is a detached two-storey house without a basement but with some storage space under the roof.

A site investigation has been carried out which indicates that the underlying ground appears to be a silty clay overlaid by a thin layer of made ground. The groundwater will be assumed at two third of the basement depth as recommended in the Site Investigation and standpipe monitoring will be continued to confirm this.

There are a number of mature trees both in the garden of No. 6 and in adjacent gardens and there are some root protection areas.

The Belsize Network Rail Tunnel runs under the road on Nutley Terrace, at around 23m below ground. This has been taken into account and final confirmation has been sought from Network Rail.

The proposals

The proposal includes the demolition of the existing house and the rebuilding of two detached houses, three-storey height with a single basement level at around 3.5-4m below existing ground.

A series of reinforced concrete piles forming a secant piled wall will be installed around the footprint of the two new basements enabling the basements to be excavated and constructed in a safe manner for both the Contractor and adjacent properties and gardens. This piled wall will also be used to prevent the ingress of ground water into the excavation during construction. It will need to be designed to safely support all the ground, water and surcharge loads applied to it in the temporary condition.

The new basements will comprise of a reinforced concrete box containing the basements' accommodation. The new ground floor slabs will provide the permanent props to the perimeter walls and ultimately the surrounding piled wall. These walls will act in the permanent condition as retaining walls resisting all the lateral loads from earth, water and surcharge loads from the adjacent ground.

The permanent vertical loads from the basement ground floor slabs will be supported on the walls of the basement and internal walls and columns. The foundation of the basements will be a reinforced concrete raft supported on a series of concrete piles. The piles will be designed to support the vertical loads from the new basements and also act to prevent hydrostatic and clay heave uplift.

The new structure to both houses will comprise a series of concrete floors supported on load bearing masonry walls. There will be a requirement to support some of the load bearing walls on steel beams.

Suitable monitoring arrangements should be agreed with the adjoining owners and specified to ensure that movements are maintained within acceptable limits and that early and immediate action can be taken to prevent any unexpected deflections or settlement.

Assumed Sequence of Construction

Sequence of works enabling excavation of the new basements

Below is an assumed sequence of works, this needs to be clarified by the Contractor prior to commencement of works:

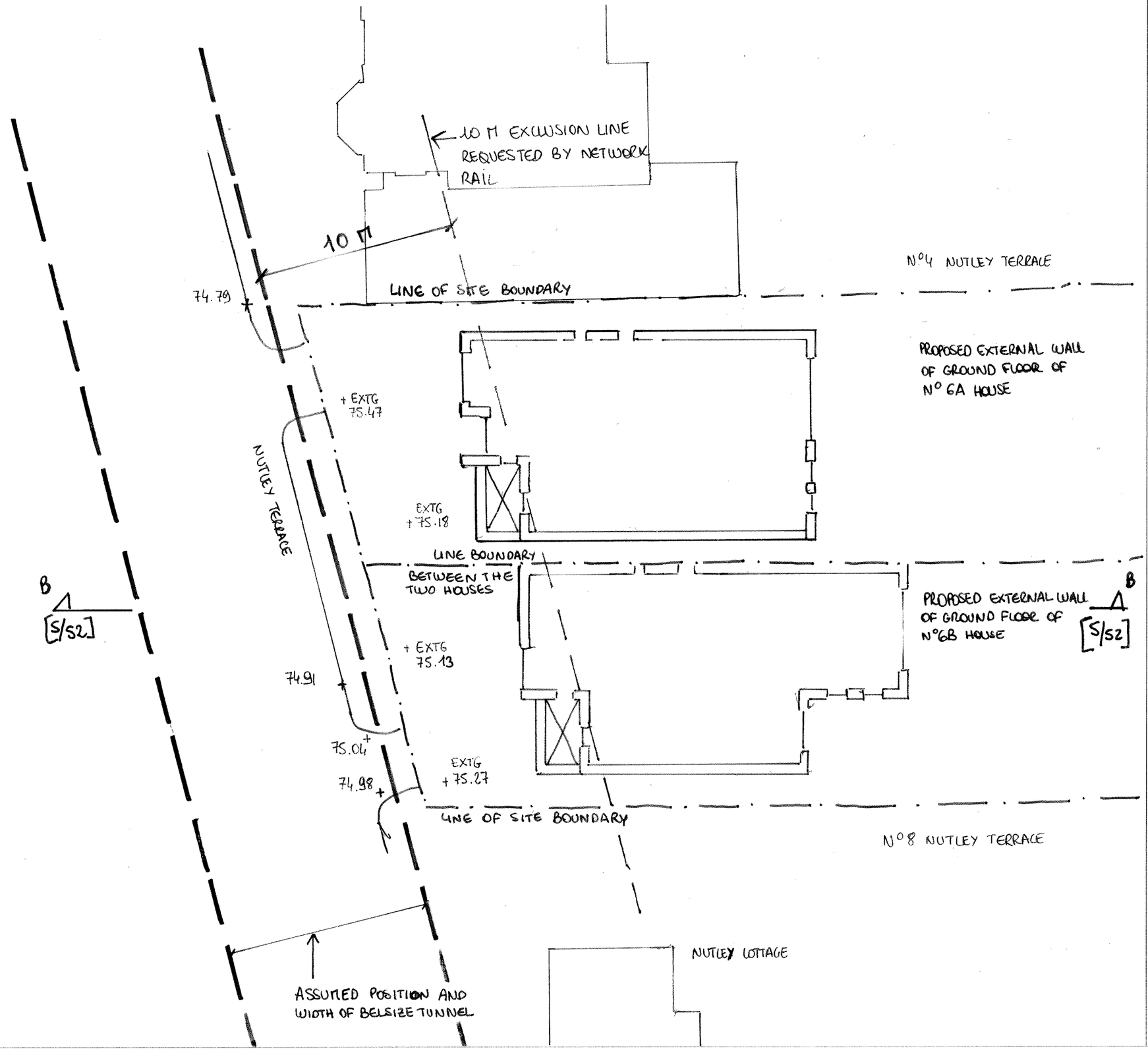
- Demolish the existing house.
- Install the secant piled wall around the footprint of both basements.
- Install temporary propping if required.
- Excavate to the lowest level.
- Cast the new reinforced concrete basement slab and allow it to gain sufficient strength.
- Cast the next level of floor slab and allow it to gain strength before removing the temporary propping.
- Complete the superstructure works once the basement is complete.

Summary and Conclusions

The above measures and sequence of works demonstrate the design and construction of the proposed works can be realised without significant effect on neighbouring properties, surrounding ground or roads.

Detailed method statements and calculations for the enabling and temporary works will need to be prepared by the Contractor for both approval and comment by all relevant parties including party wall surveyors and their engineers.

Structural Drawings



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revision	date	by	checked	approved
P1	06.01.12	SBO		
FOR PLANNING				

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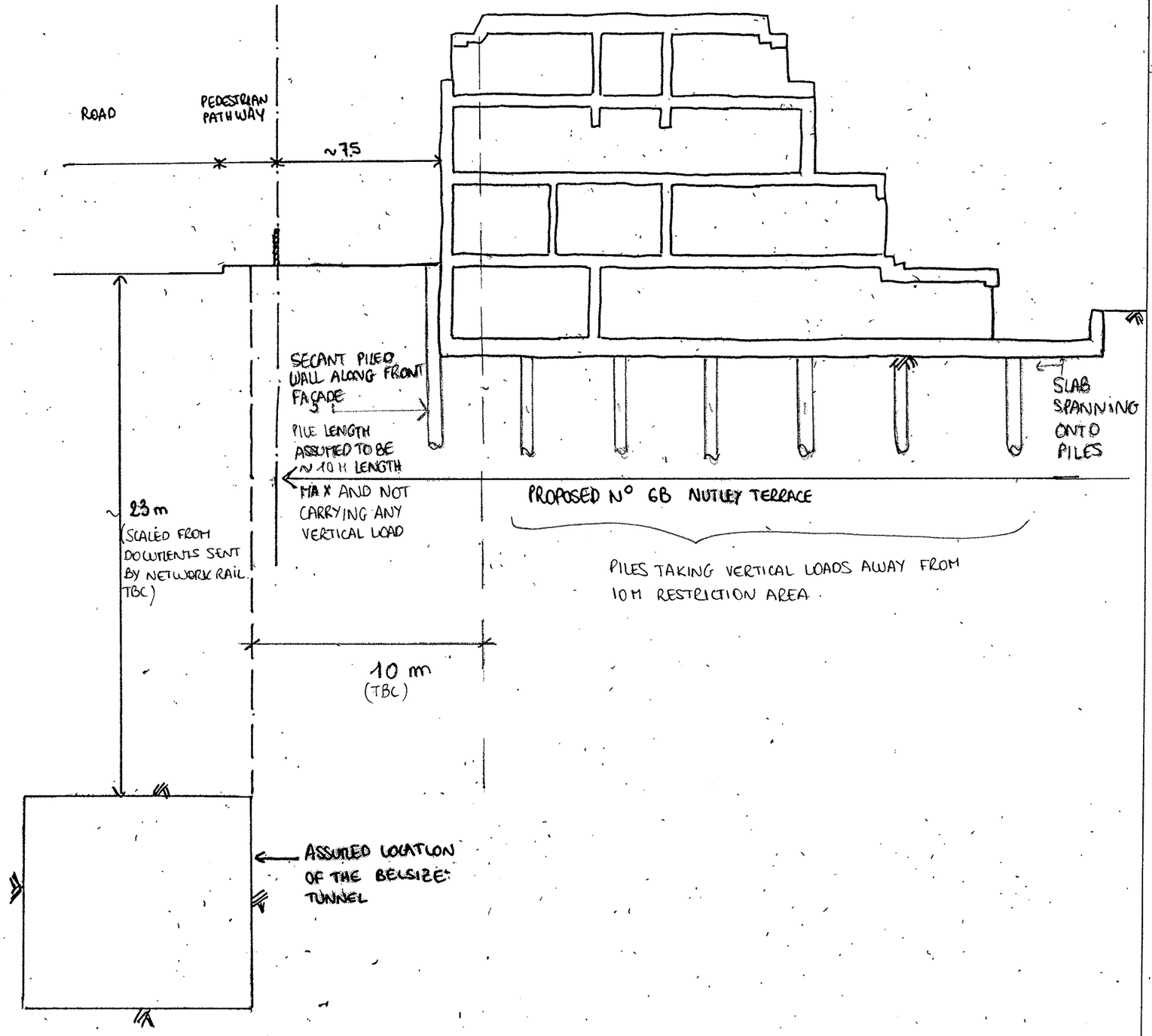
job title
6 NUTLEY TERRACE
LONDON NW3

drawing title
HOUSES' POSITION IN RELATION TO BELSIZE TUNNEL

scale(s)	date	drawn
1:200 @A3	10.11	SBO

drawing status
FOR INFORMATION

job no	drawing no	revision
21367	S-50	P1



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P2	06.01.12	SBO		
FOR PLANNING				
P1	20/10/11	SBO	GP	
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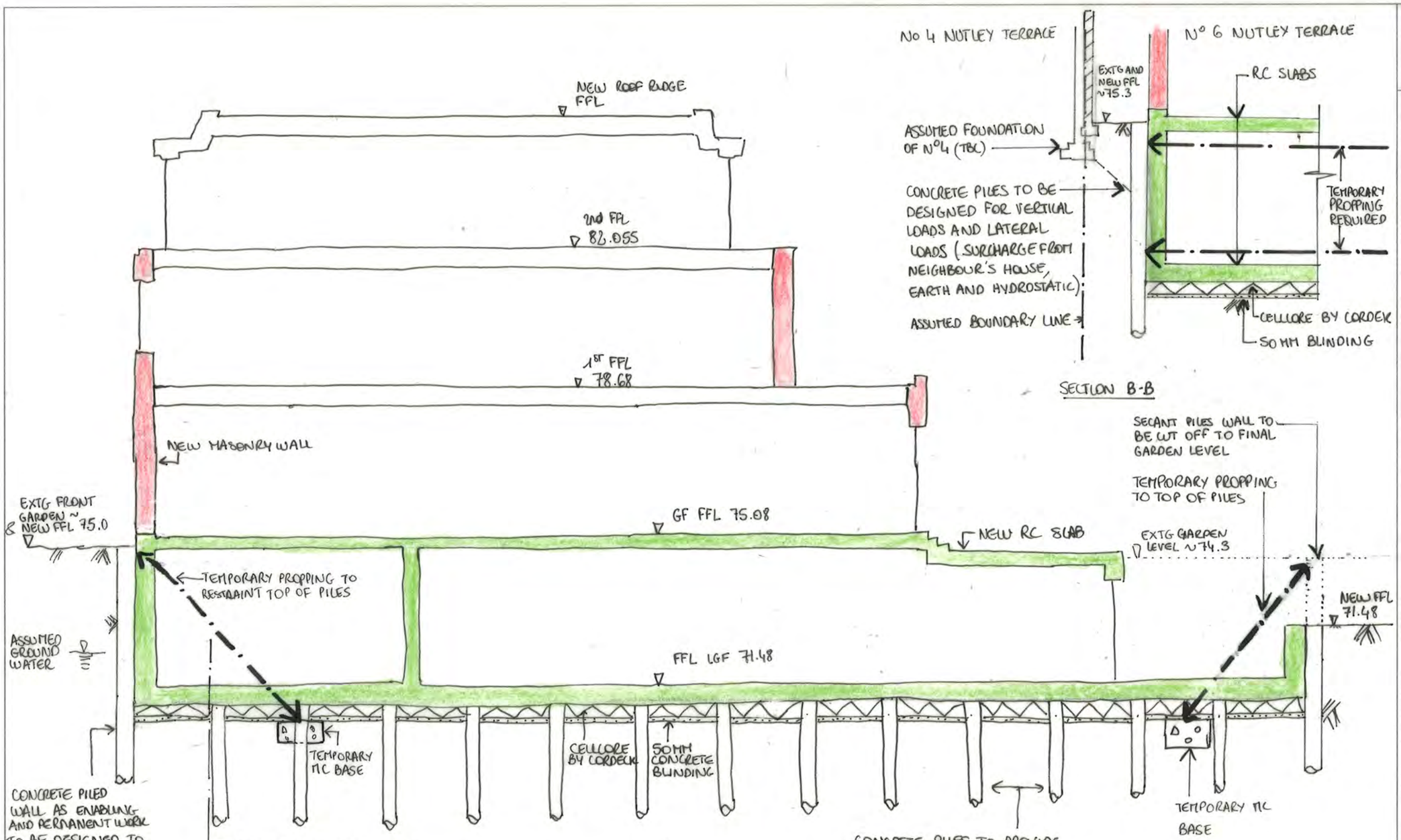
job title
6 NUTLEY TERRACE
LONDON NW3

drawing title
PROPOSED SECTION THROUGH SECTION OF TUNNEL

scale(s)	date	drawn
1:200 @A3	oct '11	SBO

drawing status
FOR INFORMATION

job no	drawing no	revision
211367	S-52	P2



N° 6B NUTLEY TERRACE

SECTION A-A

SECTION B-B

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

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. PILES AND ASSOCIATED ENABLING WORKS INCLUDING PROPPING TO PILES TO BE DESIGNED BY THE CONTRACTOR

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job title

6 NUTLEY TERRACE
LONDON NW3 5BX

drawing title

PROPOSED SECTIONS A-A & B-B

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FOR INFORMATION

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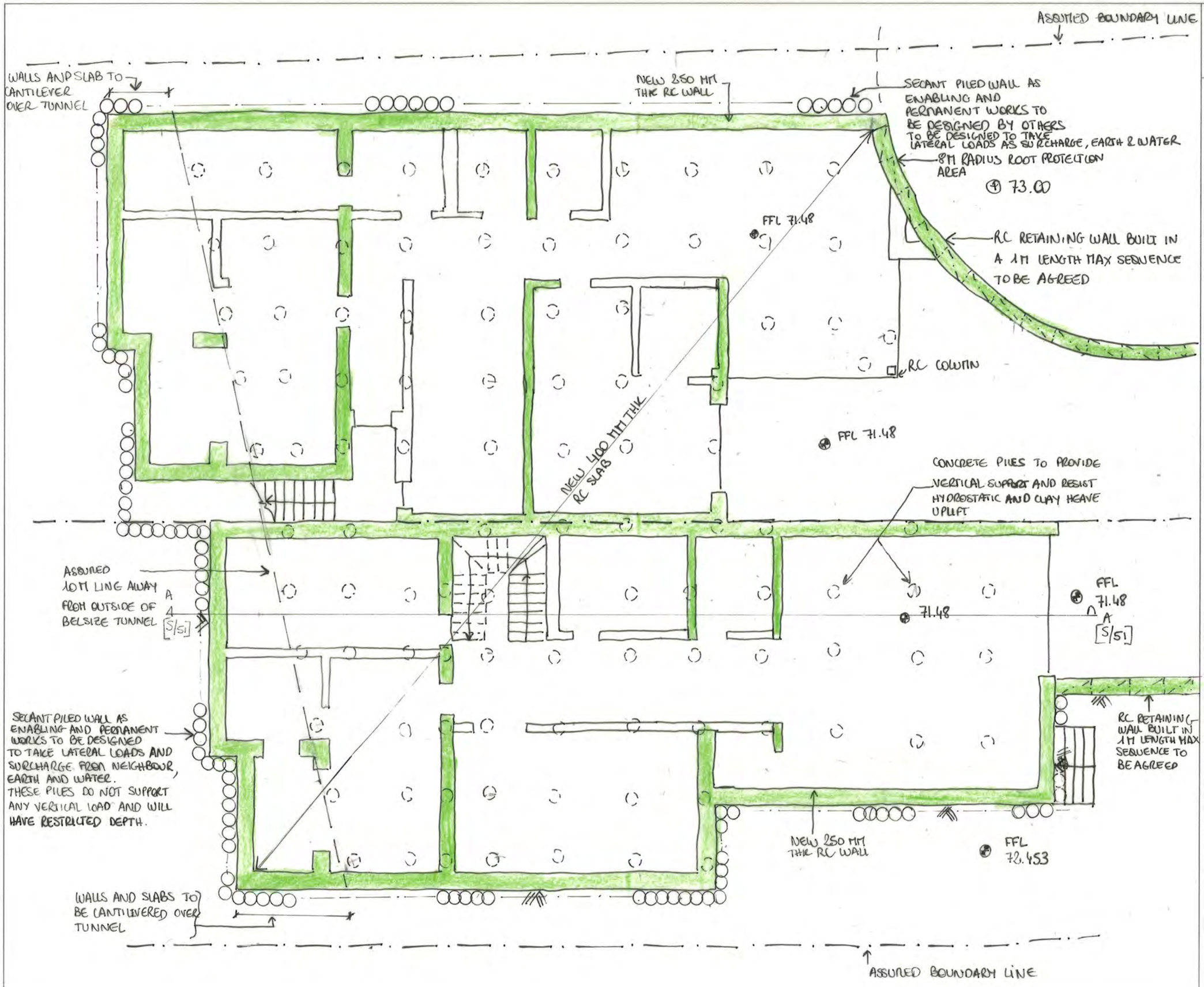

. PILES AND ASSOCIATED ENABLING WORKS INCLUDING PROPPING TO PILES TO BE DESIGNED BY THE CONTRACTOR.

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job title

6 NUTLEY TERRACE
LONDON NW3 5BX

drawing title

PROPOSED LOWER GROUND FLOOR PLAN

scale(s)	date	drawn
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drawing status

FOR INFORMATION

job no	drawing no	revision
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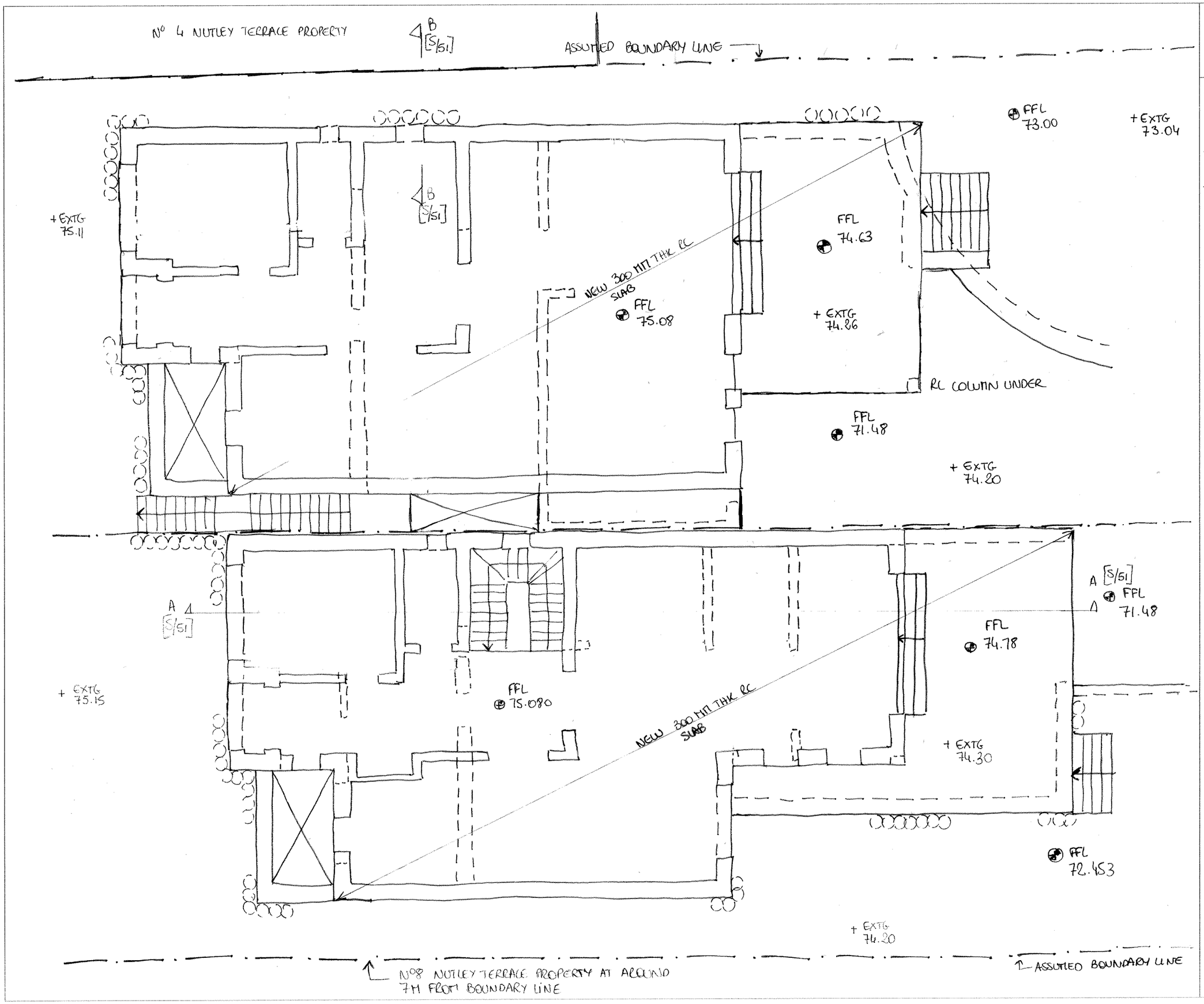

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- - - - ; LOAD BEARING STRUCTURE UNDER

. PILES AND ASSOCIATED ENABLING WORKS INCLUDING PROPPING TO PILES TO BE DESIGNED BY THE CONTRACTOR.

revision	date	by	checked	approved
P1 FOR PLANNING	06.01.12	SBO		

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job title

6 NUTLEY TERRACE
LONDON NW3 5BX

drawing title

PROPOSED GROUND FLOOR PLAN

scale(s)	date	drawn
1:100 @ A3	10.11	SBO

drawing status

FOR INFORMATION

job no	drawing no	revision
211367	S-002	P1

Civil Engineering Notes

Below ground drainage

Existing situation

Thames Water sewer records indicate that a 305mm diameter combined sewer runs in Nutley Terrace with a public manhole (MH 6903) in front of the property. The invert level of this manhole is 71.30 (Ordnance Newlyn Datum), its cover level is 75.62, according to the records.
These records also show that Belsize Tunnel runs underneath Nutley Terrace.

The topographical survey shows a few manhole covers around the existing house. The private drainage system seems to be combined too. It is likely that there is only one connection to the public sewer and that the existing house drains by gravity to the public sewer. A CCTV drainage survey of the existing private drainage system will be organized to confirm these assumptions.

Proposed strategy

The existing building will be completely demolished and two new houses will be built. These houses include a lower ground floor level.

It is proposed to reuse the existing combined connection to the public sewer if its condition allows it. It will be repaired in case it is damaged

The strategy is to drain by gravity the foul water generated at ground floor and above. It is likely that the foul water generated at lower ground floor will require pumping, however, this will confirmed when the results of the CCTV survey are received.

The amount of hardstanding area will increase between the proposed and existing situation. In order to comply with Thames Water requirements, the proposed site surface water runoff will have to be equal to, or less than that of the existing site runoff.

Any additional surface water runoff generated by the proposed development will have to be managed on site using SuDS techniques to restrict the new flow rates to the existing flow rates. The soil investigations report indicates that the soil is predominantly clay. Infiltration systems are therefore unsuitable for this site.
Other SuDS technique such as rainwater harvesting and green roofs will be considered as part of the design development.
Underground attenuation will also be provided to restrict the surface water discharge peak rate to the public sewer.

In order to comply with the Code for Sustainable Homes credit on surface water management, attenuation for a 6h long 1 in 100 year plus climate change storm return period will need to be provided for the additional hardstanding areas. The exact volume required will be determined during the next phase of the design.

Flood Risk

The site is located within Flood Zone 1 of the Environment Agency Flood Zone map. This zone is defined as having a low probability of fluvial and tidal flooding.
As the site is within Flood Zone 1 and under 1ha in area, no Flood Risk Assessment (FRA) is required.
A Surface Water Impact Assessment has been prepared as part of the Basement Impact Assessment..

Appendices

1.0 Network Rail Maps

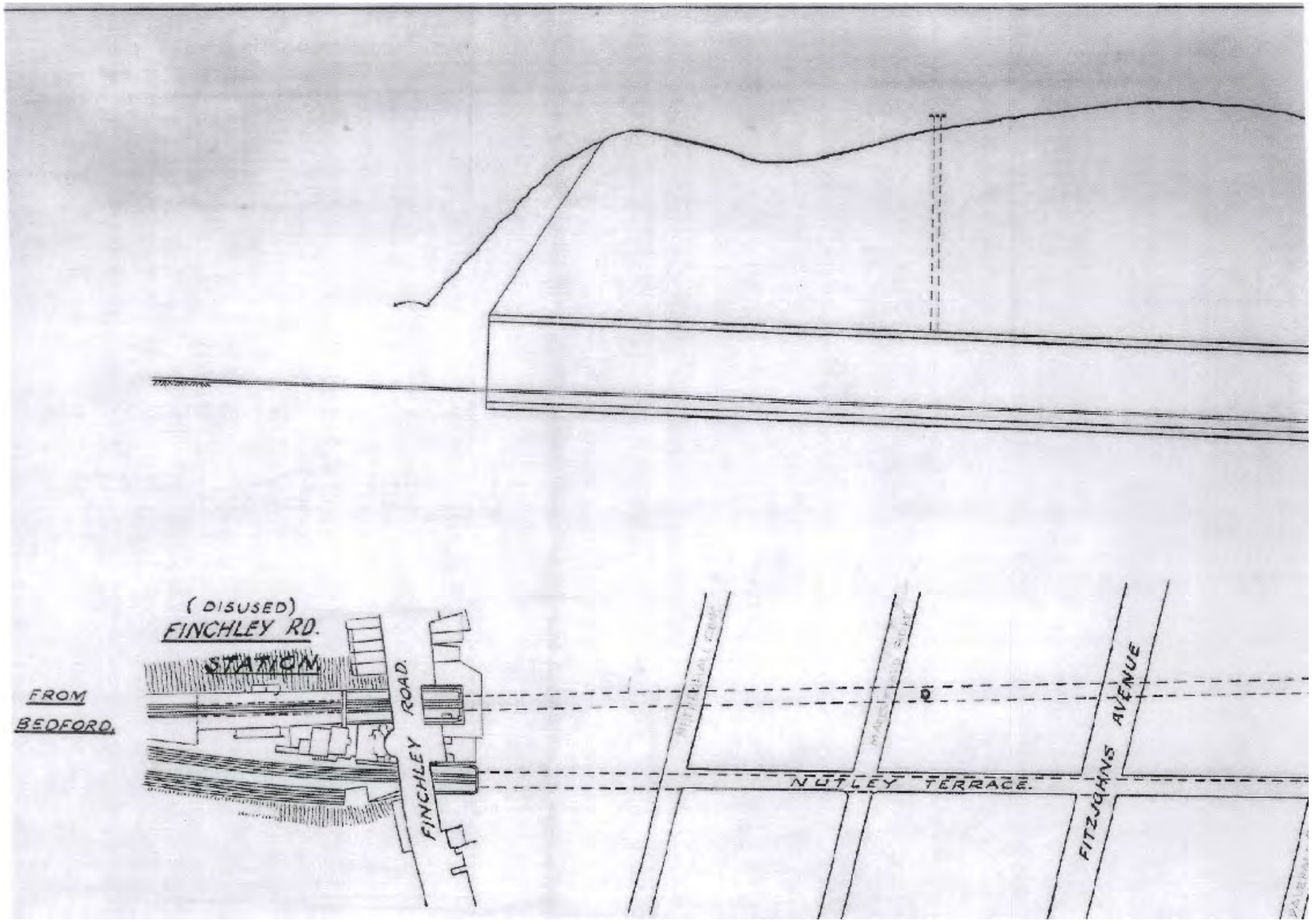
Centre of Map Window (E,N): 526825 , 185008

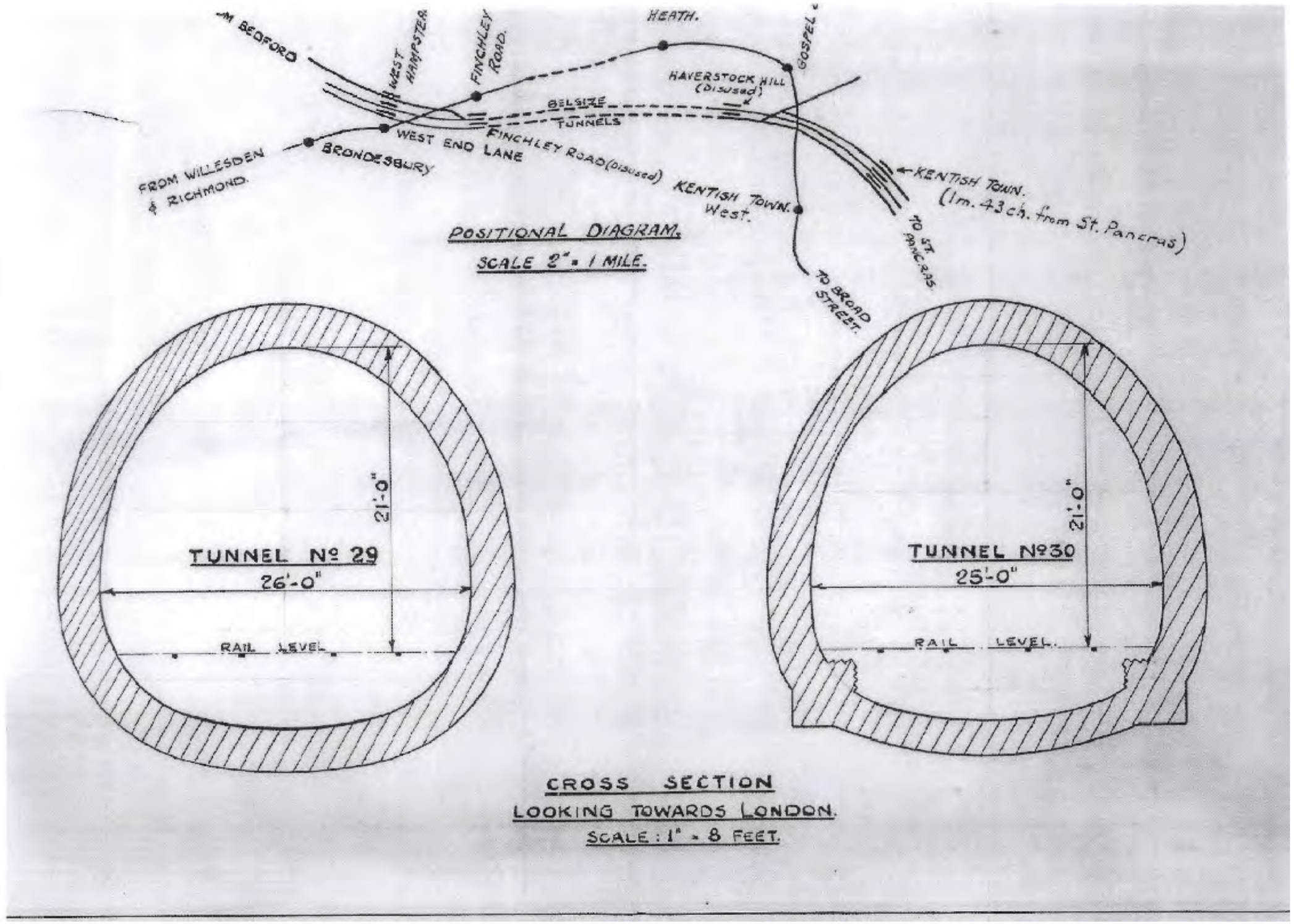
BELSIZE TUNNELS HAMPSTEAD

Plot Scale	1:500
Plot Date	11/8/2011

Network Rail

Output Created from the GI Portal - A4 Landscape


(DISUSED)
FINCHLEY RD.
STATION.
FROM
BEDFORD.
FINCHLEY ROAD.
NUTLEY TERRACE.
FITZJOHN'S AVENUE


HEATH.
GOSPEL
HAVERSTOCK HILL (Disused)
BELSIZE TUNNELS
WEST HAMPSTEAD
FINCHLEY ROAD.
FINCHLEY ROAD (disused)
WEST END LANE
BRONDESBURY
FROM WILLESDEN & RICHMOND.
KENTISH TOWN West.
KENTISH TOWN. (1m. 43ch. from St. Pancras)
TO ST. PANCRAS
TO BROAD STREET.
POSITIONAL DIAGRAM.
SCALE 2" = 1 MILE.
TUNNEL Nº 29
26'-0"
21'-0"
RAIL LEVEL
TUNNEL Nº30
25'-0"
21'-0"
RAIL LEVEL.
CROSS SECTION
LOOKING TOWARDS LONDON.
SCALE : 1" = 8 FEET.

2.0 Surface Water Assessment

surface water assessment

elliottwood

6 Nutley Terrace

Belsize Park

Camden

NW3 5BX

Surface Water Assessment

project no: WE11083

revision: P1

Document Control

issue no:	01	remarks:	Planning application for development at 6 Nutley Terrace				
revision:	P1	prepared by:	Laura Sleightholme	checked by:	Guy Laister	approved by:	Guy Laister
date:	November 2011	signature:		signature:		signature:	

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Drawing 3- Proposed Basement Layout

Executive Summary

The site located on Nutley Terrace is currently occupied by a detached residential dwelling with a large garden. Proposals include demolition of the existing dwelling, and erection of two townhouses on the site with associated landscaped gardens. This will include excavation of basements under both properties, to include additional living space and guest bedrooms.

The latest online Environment Agency flood zone maps indicate that the site is located in Flood Zone 1 (low risk) and the site is less than 1 hectare in area. In accordance with PPS25, a flood risk assessment is not required for the site. Local policy guidance on basement developments specifies that all new basement developments located in borough-defined areas at risk of surface water flooding need to be accompanied by a flood risk assessment. The site is not located in an area defined as being at risk of surface water flooding.

All sources of flooding have been assessed and are considered to pose a negligible risk to the site. While large areas in the north of the borough were affected by surface water and sewer flooding in 1975 and 2002, the site itself was unaffected in either event. The risk of surface water and sewer flooding are therefore considered to be low in this region of Camden.

An assessment of Surface Flow and Flooding has been carried out consistent with the requirements of the Camden Planning Guidance 4. The screening assessment identified a potential impact of development on surface water runoff rates and therefore an impact assessment was completed. A new surface water drainage system will be constructed as part of the development to capture runoff from the site and storage will be provided to attenuate the peak rate of runoff from the site to 5l/s for the 1 in 30 year event without flooding the surface.

The proposed basements to both properties are at a low risk of flooding from all sources, and the proposed basement is considered acceptable in the context of flood risk. Furthermore, surface water runoff from the site will not increase following development due to additional storage, and there will be no increase in flood risk elsewhere in the borough as a result of the development.

z:\projects\1083 nutley terrace\reports\1083 nutley terrace ex.doc | rev 01 | elliott wood partnership LLP consulting structural & civil engineers
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1.0 Introduction

General Information

1.1 The site is located in Belsize Park, London Borough of Camden and is currently occupied by a single, detached dwelling. The site is less than 1ha, and is characterised by the dwelling and a mixture of hard paved, decking and permeable garden areas.

1.2 The site is shown in Flood Zone 1 of the latest Environment Agency Flood Zone maps, and by definition the risk of flooding from fluvial and tidal sources is less than 0.1% in any year. The site is less than 1ha, and therefore a full flood risk assessment is not required by Planning Policy Statement 25[1].

1.3 The London Borough of Camden policy dictates that surface water and flood risk is considered in this case primarily due to basement construction. This Surface Water and Flooding impact assessment has been produced to assess the risks of flooding from other potential sources such as overland flow, groundwater, artificial water bodies and underground sewers. The impact of the proposed development on surface water infrastructure is considered, to form part of the Basement Impact Assessment.

Planning Policy

1.4 As part of the Local Development Framework (LDF), Camden adopted the Core Strategy and Development Policies in November 2010. Policy CS13 relates to flood risk and states:

"Water and surface water flooding "

We will make Camden a water efficient borough and minimise the potential for surface water flooding by:

- *protecting our existing drinking water and foul water infrastructure, including Barrow Hill Reservoir, Hampstead Heath Reservoir, Highgate Reservoir and Kidderpore Reservoir;*
- *making sure development incorporates efficient water and foul water infrastructure;*
- *requiring development to avoid harm to the water environment, water quality or drainage systems and prevents or mitigates local surface water and down-stream flooding, especially in areas up-hill from, and in, areas known to be at risk from surface water flooding such as South and West Hampstead, Gospel Oak and King's Cross (see Map 1).'*

1.5 The Development Policies also include a policy specific to basements as follows:

DP27 – Basements and Lightwells

"...The Council will only permit basement and other underground development that does not cause harm to the built and natural environment and local amenity and does not result in flooding or ground instability...."

1.6 The London Borough of Camden has strict policies with regards to basement development within the Borough, therefore they have provided guidelines for 'New basement developments and extensions to existing basement accommodation[2]'. Formal planning guidance has also been released[3] setting out specific criteria for assessing the impact of basement construction. As part of the Basement Impact Assessment (BIA), it is necessary to consider 'Surface flow and flooding'. A screening flowchart addresses individual sources of potential flooding, and where a risk of flooding is present, a scoping and impact assessment need to be undertaken as appropriate. This report covers this component of the BIA.

[1] Planning Policy Statement 25, March 2010

[2] London Borough of Camden, Shaping Camden – Guidelines – New Basement Development and Extensions to Existing Basement Accommodation, February 2009

[3] London Borough of Camden – Camden Planning Guidance (CPG4) Basements and Lightwells

1.7 In conjunction with ARUP, the London Borough of Camden produced a 'geological, hydrogeological and hydrological study for guidance on subterranean development[4]'.

Location

1.8 The site is situated on Nutley Terrace in Belsize Park, North London as shown in Figure 1.

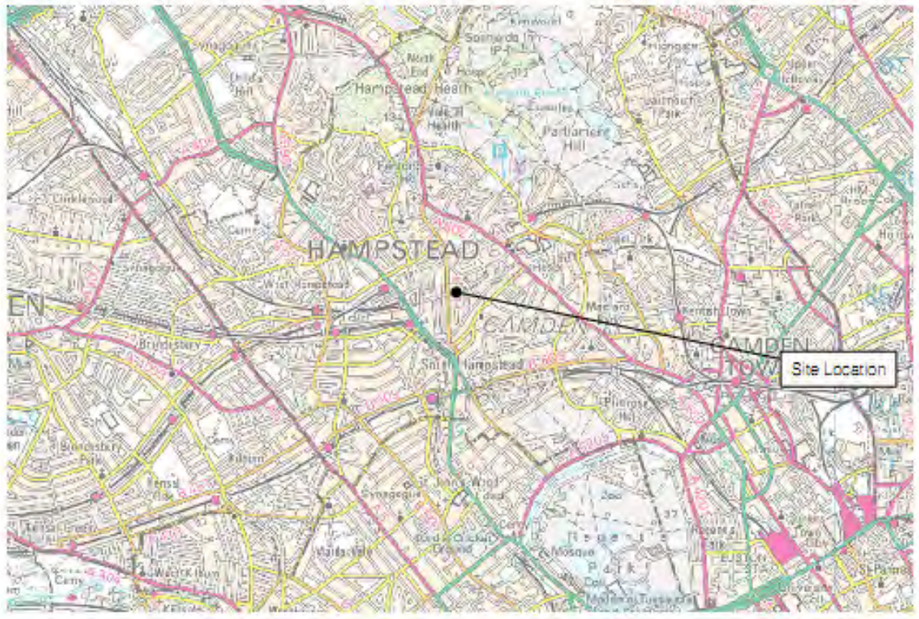

Figure 1- Site Location

Existing Development

1.9 The total roof area on site is 149m² (0.0149ha) which constitutes approximately 11% of the total site. The existing dwelling is a large family house with extensive garden.

1.10 A topographic survey of the site has been undertaken, and included as Drawing 1. The survey shows the site falling in a southerly direction away from the road, from a level of 75.0m at the front to 71.5m at the bottom of the garden. Ground levels are between 75.11m and 75.19m, and between 74.82m and 74.84m, at the front and rear of the dwelling respectively. The finished floor level is at 75.41m presently. The finished floor level of the house is therefore set above surrounding ground levels.

Proposed Development

1.11 Proposals include demolition of the existing dwelling, and erection of two townhouses on the site. This will include excavation of a basement under both properties, to include additional living space and guest bedrooms. The extent of the lower ground floor and basement is outside the building footprint of the

[4] ARUP Geological, Hydrogeological and Hydrological Study – Guidance for Subterranean Development, November 2010

existing dwelling and therefore the total roof area to be formally drained will increase substantially, to approximately 463m², based on current plans. The proposed site layout is included as Drawing 2, and the basement layout is shown in Drawing 3.

1.12 External areas will be landscaped and plans include a lower garden area, stepped down from the main garden and excavated to the basement level at the rear of both properties to allow doors opening onto an outside patio.

2.0 Potential Flooding on Site

Historic Information

2.1 No records have been found of the site flooding in the past from any of the sources identified in PPS25.

2.2 It is noted in the North London SFRA[3] that a large area in the north of Camden was affected by surface water flooding in August 2002, which was the result of heavy rainfall inundating the public sewer system. A similar region of Camden was affected by surface water/sewer flooding in 1975. In both instances the flooding that occurred is understood to have been the result of high intensity rainfall inundating the main sewer and causing manholes and gulleys to surcharge.

2.3 However, even during these high intensity events that have, on 2 occasions, affected large parts of Camden, there is no record of the site or Nutley Terrace being affected by surface water flooding.

2.4 Map 22 of the SFRA[3], and Figure 15 of the ARUP study[4] show the roads which were recorded as flooded in 1975 and 2002. Nutley Terrace is not highlighted on these maps.

Tidal and Fluvial Flooding

2.5 In October 2004, the Environment Agency released updated floodplain maps for the UK based on the 'JFLOW' project, a two-dimensional hydraulic modelling project.

2.6 The site is located in Flood Zone 1, approximately 5km north of the Thames at its nearest location. By the definition of Flood Zone 1, the risk of the site being affected by fluvial or tidal flooding is therefore less than 0.1% in any given year.

2.7 Although no area of London Borough of Camden is in Flood Zone 2 or Flood Zone 3, there are several watercourses in the borough, the majority of which have been culverted and are often referred to as 'Lost Rivers'.

2.8 Figure 11 of the ARUP study[4] shows the watercourses in Camden, including culverted sections. Tributaries of the Tyburn are shown to the west and east of Nutley Terrace. It is understood that these watercourses are culverted in the proximity of the site and therefore form part of the wider sewer system.

Flooding from Sewers

2.9 Surface water flooding is typically the result of high intensity rainfall that is unable to infiltrate into the ground or enter the drainage system, ultimately following overland flow paths. In an urban environment such as Camden, surface water runoff is disposed of almost entirely via formal drainage systems, and consequently sewer flooding and surface water flooding (overland flow) need to be considered in tandem in this instance.

2.10 It is reasonable to assume that adopted sewers have been designed to the 1 in 30 year return period (in accordance with Sewers for Adoption 6th Edition[5]), which is considerably lower than the 100 year standard considered for fluvial flooding. As such, sewer flooding is often more frequent but less severe than fluvial flooding.

2.11 Data collected from the 1975 and 2002 events were used to map areas of the borough that are more susceptible to surface water flooding. This information was subsequently used to inform Camden's supplementary guidance document on basement developments[2]. In this document, roads that were affected by either flood are known as "secondary areas", and roads affected by both floods are known as

[5] North London Strategic Flood Risk Assessment, (August 2008)

[5] WRc7 plc. (March 2006) Sewers for Adoption – A Design and Construction Guide for Developers, 6th Edition.

"primary areas". Any proposals for a basement development located in a primary or secondary area must include a flood risk assessment.

2.12 The site is not located in either a primary or a secondary area. The risk of sewer and surface water flooding is therefore considered to be low in this region of London Borough of Camden.

Flooding from Artificial and Lake Water Bodies

2.13 The Regent's Canal and Regent's Park Lake are the nearest artificial water bodies to the site (reference Figure 12 of the ARUP Study)[4]. However at both locations water is not retained above natural ground level and flooding as a result of infrastructure failure is therefore not possible.

2.14 Figure 14 of the ARUP study shows the Hampstead Heath Surface Water Catchments and Drainage, including the pond chains, in greater detail. The site is not located within the catchment of the pond chains on Hampstead Heath.

2.15 The risk of flooding from artificial water bodies is therefore considered extremely unlikely.

Flooding from Groundwater

2.16 The underlying geology of Camden and the majority of North London consists of London Clay, which typically has a very low infiltration rate. The North London SFRA[5] notes that this clay is over 100m deep in high lying parts of Camden. Consideration of the Environment Agency's groundwater maps confirms that the bedrock geology is not an aquifer.

2.17 The SFRA also noted that there have been very few recorded incidents of groundwater flooding in North London, none of which were located in Camden.

2.18 According to the Ground Investigation[7], groundwater not was encountered during the investigation. London Clay Formation was encountered below a thin layer of made ground (maximum depth 1.2m) to a depth of 20m below ground level (bgl). A weathered zone of soft to firm silty sandy clay extended to depths of between 4.75m and 5.50m bgl. This upper material is sandier than would be expected for the London clay and could partially represent material derived from the overlaying Claygate Member which is present upstream of the site.

2.19 Groundwater was subsequently recorded in standpipes at depths of 1.24m and 6.14m bgl indicating groundwater flow direction towards the south. The site investigation indicated that this is due to secondary permeability in the clay, causing small, discrete 'pockets' of water rather than significant flow through a continuous layer. The investigation confirmed that the location of the proposed basement in the clay means that it is not 'cutting-off' less permeable strata.

2.20 It was recommended that further monitoring is carried out to establish equilibrium levels of groundwater.

2.21 On the basis of groundwater observations to date, groundwater will be encountered within the depth of the proposed basement excavation. However these low volume pockets of water do not pose a significant risk in terms of flooding.

2.22 The risk of the site being affected by groundwater flooding is therefore considered to be low.

[7] Geotechnical & Environmental Associates Limited. October 2011.

3.0 Surface Flood and Flooding Impact Assessment

Stage 1: Screening

3.1 CPG4 includes a Surface flow and flooding screening flowchart for assessing the impact of potential sources of flooding, as well as the impact of the development on flood risk elsewhere.

3.2 The flow chart is set out with six questions, which are addressed with reference to the site and proposed development at 6 Nutley Terrace as follows:

- **Question 1**: Is the site within the catchment of the pond chains on Hampstead Heath?

  Reference: Figure 14 of the ARUP Study

  Answer: No

- **Question 2**: As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak runoff) be materially changed from the existing route?

  Reference: Surface water runoff mechanisms and connection type and location with receiving watercourse.

  Answer: No – surface and foul water from the dwelling will continue to drain to the combined sewer in Nutley Terrace using the existing connection.

- **Question 3**: Will the proposed basement development result in a change in the proportion of hard surfaced/paved external areas?

  Reference: Total roof area following development compared with the existing site.

  Answer: Yes

- **Question 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 watercourse.

  Reference: Proposed landscaping and drainage system to be implemented as part of the development compared with the existing site. SUDS are required to mitigate any increase in peak flow.

  Answer: Yes

- **Question 5**: Will the proposed basement result in changes to the quality or surface water being received by adjacent properties or downstream watercourses.

  Reference: Proposed landscaping and drainage system to be implemented as part of the development compared with the existing site. SUDS are required to mitigate any increase in peak flow.

  Answer: No

3.3 According to CPG4, it is necessary to carry forward to the scoping stage of the Basement Impact Assessment those matters of concern where the response is 'yes'. Therefore, it is necessary to consider Question 3 and 4 in more detail.

3.4 In addition:

- **Question 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

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example because the proposed basement is below the static water level of a nearby surface water feature?

Reference: Consider the risk of flooding from surface water and artificial water bodies

Answer: No – see chapter 2 for details. **A Flood Risk Assessment is therefore not required.**

Stage 2: Scoping

3.5 Increasing the roof area on site as result of development will increase the volume and peak flow rate of surface water generated. In order to ensure that development does not increase flood risk elsewhere, mitigation needs to be provided in the form of storage onsite to attenuate the peak rate of surface water runoff. Where possible it is also beneficial to prevent the additional volume of surface water discharging from the site, although this is not always feasible.

3.6 A new drainage system is proposed for the development, which will capture runoff from the two new houses. The development will increase the total roof area to be formally drained by 314m². The development will therefore increase surface water runoff rates, and storage is required to attenuate flows. Peak runoff rates from the existing site, and from the site following development have been calculated. A drainage strategy needs to be developed, taking into consideration the existing and proposed layouts, and storage needs to be provided in the system to ensure that the peak rate of runoff does not increase following development. SUDS should be prioritised where feasible.

Stage 3: Site Investigation and Study

3.7 Chapter 2 of this report contains information on the background of the project, the various organisations and studies which have been consulted for data, as well as the site investigations which have been undertaken. Surface water runoff is the only issue which requires further consideration past the screening stage. The scoping stage of the assessment identified the need for mitigation to minimise the impact of the development on surface water flows.

3.8 Thames Water asset plan shows a 305mm combined public sewer in Nutley Terrace. Combined sewer systems are common in this part of London.

3.9 It is proposed to reuse the existing private drainage connection to the public sewer and therefore the mechanism of drainage surface water from the site will remain unchanged following development.

3.10 The Ground Investigation found a thin layer of made ground and superficial deposits over London Clay proved to a depth of 20m. Infiltration techniques such as soakaways are therefore not feasibe on this site.

Stage 4: Impact Assessment

3.11 The site is underlain by London Clay and surface water runoff rates from permeable areas are expected to be relative high for comparative Greenfield rates. The existing site has a roof area of 149m². The development will increase the roof area by 314m² to 463m².

3.12 New, separate, private surface and foul water sewer systems will be constructed for the development, draining to the combined sewer in Nutley Terrace using the existing combined connection.

3.13 Surface water runoff will be captured from roof by rainwater downpipes. Surface water collecting at basement level from the lower garden patio will be collected with foul water from the basement and pumped into a manhole before leaving the site.

3.14 In accordance with Sewers for Adoption, the new surface water system will be designed for the 1 in 2 year rainfall event and storage will be provided to attenuate the peak rate of runoff to ensure that there is no flooding during the 1 in 30 year event.

3.15 This system has been modelled and shows that approximately 5m³ of storage is required to reduce proposed runoff to the estimated existing rate of 5.1l/s for the 1 in 30 year event. There is space to accommodate drainage storage under the driveway area at the front of each house, and this storage volume could be reduced by the introduction of green roof into the design. The proposed development will therefore not increase surface water runoff rates from the site.

3.16 Surface water runoff from the lower patio area at the rear of both properties should be collected to avoid ponding, and pumped from the basement.

3.17 It is recommended that the patio is designed to fall away from the building, with a drop of at least 150mm from the basement entry level to the lowest point, where flow should be collected by a strip drain or gulley. This will ensure that any surface water surcharging from the drainage system in an extreme rainfall event is prevented from entering the property at basement level. This is in accordance with CIRIA Guidelines[5]

[5] CIRIA C635 (2006) Designing for exceedance in urban drainage- good practice

4.0 Conclusions and Recommendations

4.1 The site is located on Nutley Terrace in the London Borough of Camden. At present the site is occupied by a detached residential dwelling. Proposals include demolition of the existing dwelling, and erection of two townhouses on the site. This will include excavation of basements under both properties, to include additional living space and guest bedrooms.

4.2 The latest online Environment Agency flood zone maps indicate that the site is located in Flood Zone 1 (low risk), and the site is less than 1 hectare in area. In accordance with PPS25, a flood risk assessment is not required for the site. Local policy guidance on basement developments specifies that all new basement developments located in borough-defined areas at risk of surface water flooding need to be accompanied by a flood risk assessment. The site is not located in an area defined as being at risk of surface water flooding.

4.3 All sources of flooding have been assessed and are considered to pose a negligible risk to the site. While large areas in the north of the borough were affected by surface water and sewer flooding in 1975 and 2002, the site itself was unaffected in either event. The risk of surface water and sewer flooding are therefore considered to be low in this region of Camden.

4.4 An assessment of Surface Flow and Flooding has been carried out consistent with the requirements of the Camden Planning Guidance 4. The screening assessment identified a potential impact of development on surface water runoff rates and therefore an impact assessment was completed. A new surface water drainage system will be constructed as part of the development to capture runoff from the site. Ground conditions prohibit soakaways, and the site will continue to drain to the existing 305mm diameter combined sewer in Nutley Terrace. Storage will be provided to attenuate the peak rate of runoff from the site to 5.1l/s for the 1 in 30 year event without flooding the surface.

4.5 It can be concluded that the proposed basement is at a low risk of flooding from all sources, and that the proposed basement is considered acceptable in the context of flood risk. Furthermore, surface water runoff from the site will not increase following development due to additional storage, and there will be no increase in flood risk elsewhere in the borough as a result of the development.

Appendix

Drawing 1- Topographic Survey

Anthony Brookes Surveys Ltd, Drawing Number 892/6312/1, July 2011
The drawing shows levels on the site, including carriageway level in Nutley Terrace, ground levels to the front, side and rear of the building, and finished floor levels of the existing dwelling.

Drawing 2- Proposed Site Layout

KSR architects, Drawing Number NUT-000 Rev C6, Sept 2011
The drawing shows the proposed layout at for the two new properties on the site.

Drawing 3- Proposed Basement Layout

KSR architects, Drawing Number NUT-001 Rev C6, Sept 2011
The drawing shows the proposed layout at basement level for both houses, including the finished floor levels.

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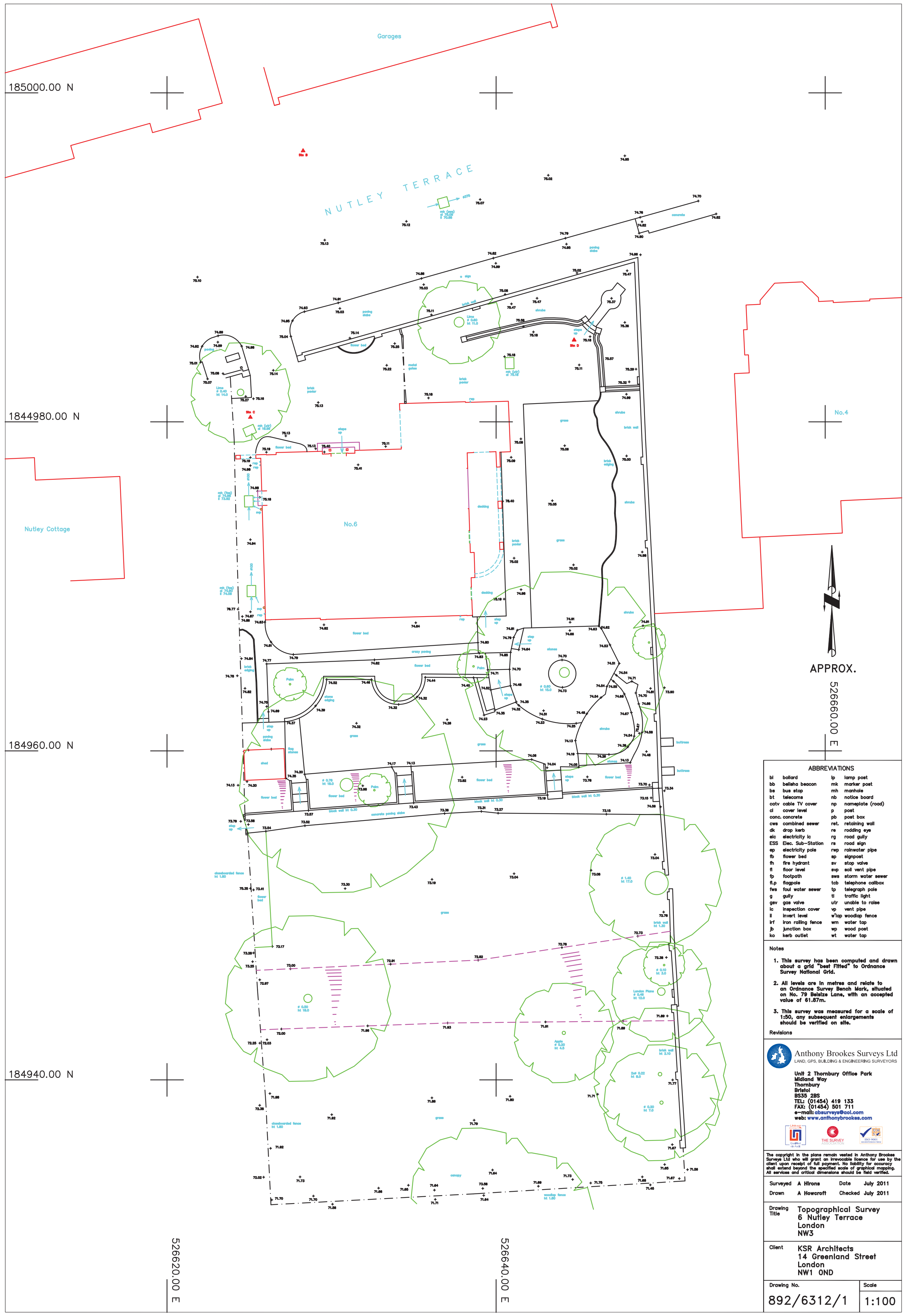
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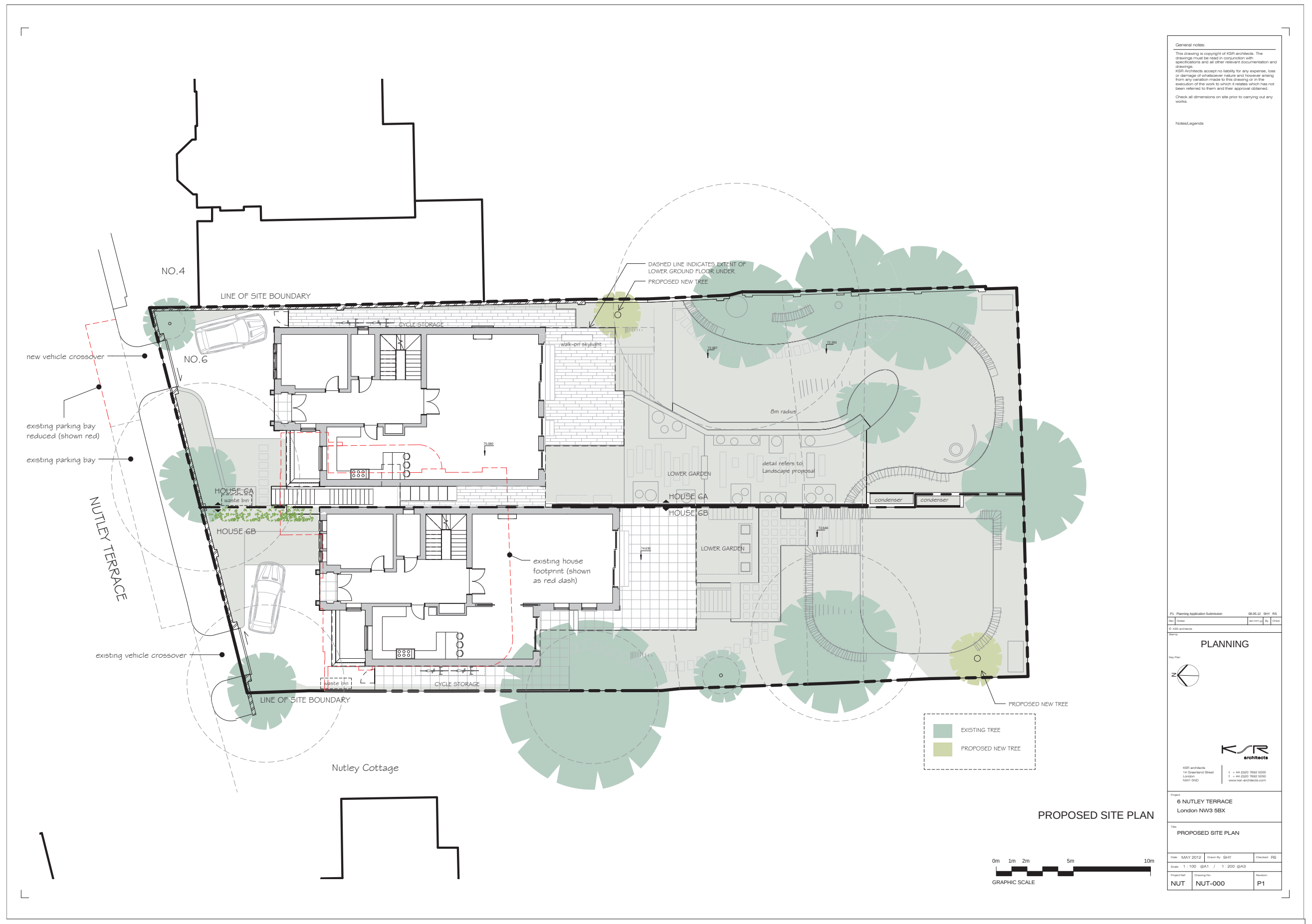
Garages
NUTLEY TERRACE
No.6
No.4
Nutley Cottage
APPROX.
ABBREVIATIONS
Anthony Brookes Surveys Ltd
Topographical Survey
6 Nutley Terrace
London
NW3
KSR Architects
14 Greenland Street
London
NW1 0ND
892/6312/1
1:100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NO.6
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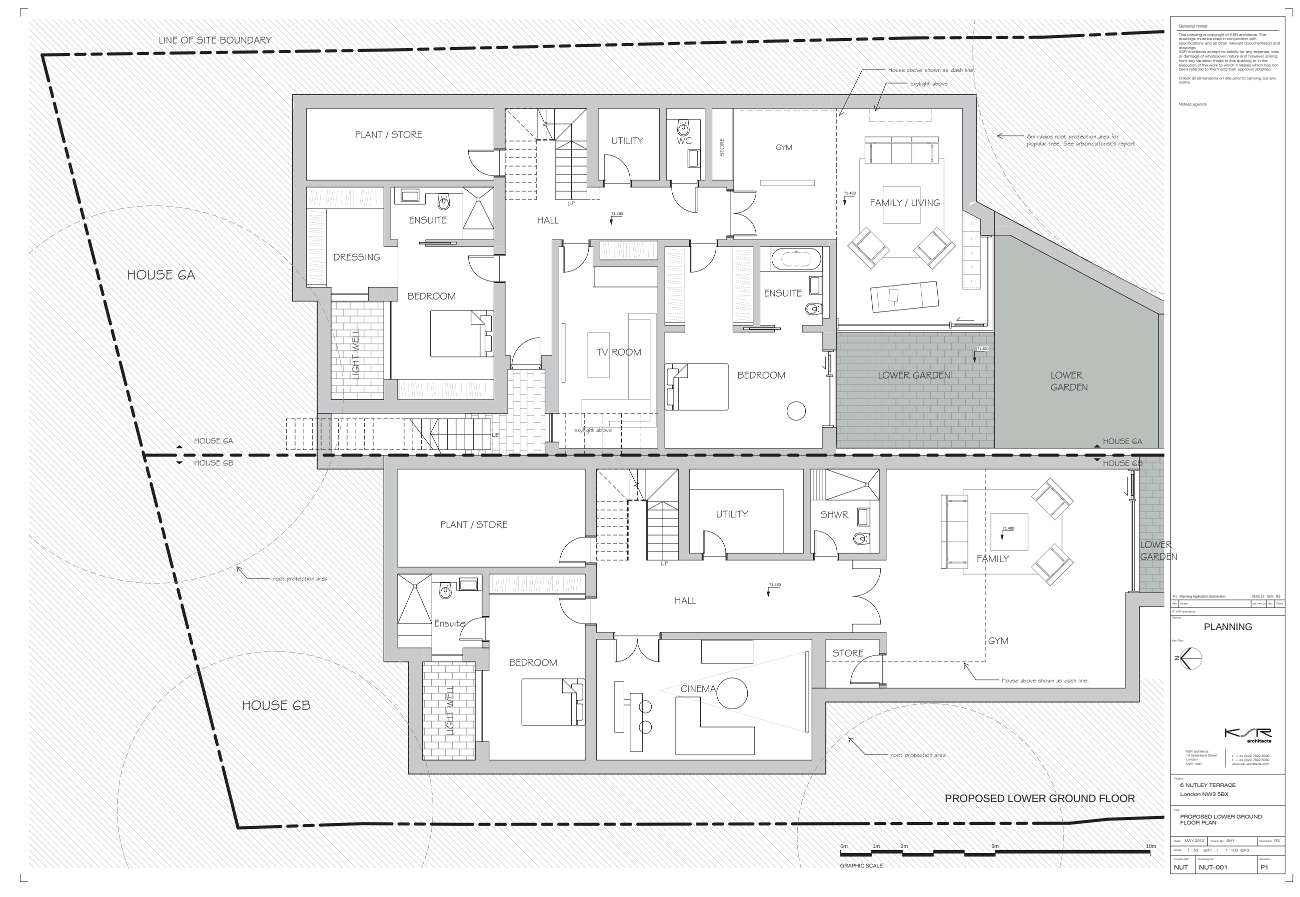
Nutley Cottage
PROPOSED SITE PLAN
PLANNING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ENSUITE
DRESSING
BEDROOM
HALL
UTILITY
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GYM
FAMILY / LIVING
TV ROOM
LOWER GARDEN
SHWR
FAMILY
CINEMA
STORE
PROPOSED LOWER GROUND FLOOR
PLANNING

3.0 Groundwater Impact Assessment

6 Nutley Terrace

Groundwater Impact Assessment

6 Nutley Terrace
London
NW3 5BX

Site NGR: TQ 2666 8499

Prepared for:
Mr & Mrs Shafi

Chord Environmental Ltd

Report no. 1103/R1
November 2011

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6 Nutley Terrace

Groundwater Impact Assessment

Site Address

6 Nutley Terrace

London

NW3 5BX

Site NGR: TQ 2666 8499

Document Control Sheet

Chord Environmental Ltd

Prepared by:	John Evans MSc FGS CGeol				
Report no:	1103/R1	**Issue no:**	3	**Date:**	8th November 2011

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6 Nutley Terrace
Groundwater Impact Assessment

Contents

6 Nutley Terrace
Groundwater Impact Assessment

1 Introduction

1.1 Background

Mr & Mrs Shafi are applying for Planning Consent to demolish the existing house and construct two new three-storey houses with single level basements. The basements will extend to a depth of 4.2 m and will, it is understood, cover the existing building footprint and extend partly into the existing rear garden.

Site investigation works have been undertaken by Geotechnical and Environmental Associates (GEA) Ltd. The work comprised a detailed Ground Investigation[1] and this assessment should be read in conjunction with GEA's site investigation report.

Chord Environmental has been commissioned by Elliott Wood Partnership on behalf of Mr and Mrs Shafi, to carry out a groundwater assessment for the proposed development at 6 Nutley Terrace, London, NW3 5BX, to meet the requirements of London Borough of Camden's "Guidance for Subterranean Development"[2].

1.2 Scope and Approach

This report reviews the proposed development at 6 Nutley Terrace within the context of the conceptual understanding of its site setting which has been informed through site investigation findings. The report will identify potential groundwater impacts the development may have. Appropriate mitigating measures can then be developed and adopted to avoid or minimise these affects where identified.

This report is limited to the groundwater flow component of the Basement Impact Assessment, as specified by the London Borough of Camden's "Guidance for Subterranean Development". The Author of this report is a qualified Hydrogeologist, Chartered Geologist and Fellow of the Geological Society of London, as required by the Guidance.

[1] Desk Study and Ground Investigation Report – 6 Nutley Terrace, London NW3. Geotechnical and Environmental Associates Ltd. October 2011.

[2] Camden Geological, Hydrogeological and Hydrological study - Guidance for Subterranean Development. Ove Arup & Partners Ltd., November 2010

2 Proposed Development

The Site occupied by 6 Nutley Terrace, South Hampstead, London (National Grid Reference TQ 2666 8500) is a residential property approximately rectangular in shape and 30m by 60m in area. The existing two-storey, detached L-shaped house is located on the northern part of the site. A brick paved parking area is present to the front of the house, adjacent to Nutley Terrace. A small grassed area with planted borders and two deciduous trees approximately 20 m high are present to the east of the house.

The proposal is to demolish the existing house at 6 Nutley Terrace and construct two new three-storey houses with single level basements. The basements will extend to a depth of 4.2 m and cover the existing building footprint and extend partly into the existing rear garden.

The basement excavation will be up to 4.0m below the existing ground level. The existing building footprint is proposed to be increased from c.175m^2 to c.390m^2 and existing hardstanding areas of 180m^2 proposed to be increased to 270m^2 with the development of terraced patio areas to the rear of the property. A majority of the existing hardstanding is brick pavior to the front of the property which is anticipated to facilitate some surface drainage.

3 Site Setting

The Site is located on the eastern end of Nutley Terrace in the South Hampstead area of London, NW3 5BX.

3.1 Topography

The Site lies at an elevation of approximately 75m above ordnance datum (OD) on ground which falls away to c.40m OD at the River Thames, c.2km to the south and rises to an elevation of 134m OD on Hampstead Heath, c.1.5km north of the site. Within the Site itself the ground slopes gently down towards the south in a series of terraces, from a level of 75.47 m OD at the northern boundary to 73.58 m OD at the southern boundary.

To the south of the house the rear garden comprises a terraced lawn with a number of mature trees on the eastern and western boundaries; species include ash, beech and poplar.

3.2 Hydrology and Drainage

The Site lies within the surface water catchment of the upper Tyburn stream, a tributary of the River Thames, and outside of the catchment of the Hampstead Heath chain of ponds. The Tyburn is entirely covered and culverted and forms part of the sewerage system, running beneath South Hampstead to where it discharges into the Thames at Pimlico. According to historic maps[3], the Tyburn flows c.50m to the east of the Site beneath the eastern edge of Fitzjohns Avenue.

There are no surface water features marked on Ordnance Survey mapping (1:25,000 scale) within 1km of the Site. The site is not located within a Flood Zone as defined by the Environment Agency and Nutley Terrace has not been identified as a street at risk of surface water flooding as a result of sewer surcharging within the London Borough of Camden.

3.3 Geology

According to the British Geological Survey (BGS) 1:50,000 scale sheet for the area (Sheet 256, North London. 2006) and the associated geological memoir, The Geology of London (BGS 2004), the Site lies on the Eocene London Clay. The Eocene silts and sands of the London Clay Formation Claygate Beds outcrop c.50m over the London Clay to the north of the Site which are in turn overlain by the sands of the Bagshot Formation on Hampstead Heath.

The Site lies within an area denoted by the BGS as likely to be covered by Quaternary Head deposits. This is disturbed material which has been mobilised from higher ground.

[3] The Lost Rivers of London: a study of their effects upon London and Londoners, and the effects of London and Londoners upon them. N. Barton. 1962.

The London Clay is underlain by the Cretaceous Chalk at a depth of over 100m beneath the Site.

Site specific geological data from the GEA site investigation (October 2011)[1], has established the presence of between 0.2m and 1.20m thickness of made ground beneath the Site locally. London Clay was then proved to a depth of 20m below ground level comprising c.5m of soft to firm weathered silty sandy clay becoming firm to stiff grey fissured clay with lenses of fine grey sand toward the base. This material was determined to be London Clay corresponding to the published geology for the area.

3.4 Hydrogeology

The Environment Agency classifies the London Clay as Unproductive Strata (formerly Non Aquifer), i.e. not capable of providing useable quantities of water; however this classification may not take into account local geological variations within the sandier upper London Clay Formation.

The Cretaceous Chalk is classified as a Primary (formerly Major) Aquifer however it is highly confined beneath over 100m of London Clay. The Site lies approximately 300m north of a Source Protection Zone as designated by the Environment Agency. This is for a licensed public water supply abstraction from the Chalk.

Groundwater within the London Clay beneath the Site is considered to be dominated by fissure flow through Unit D of the upper London Clay. Due to the very low permeability of the London Clay, any groundwater flow will be at very low rates. Without evidence to the contrary, groundwater flow beneath the Site is anticipated to follow topographic contours toward the south. The Tyburn stream is considered to rise from springs and seepages from the Bagshot Formation sands on Hampstead Heath and is perched on the London Clay.

Piezometers were installed to 6m in three exploratory holes (BH1 to BH3) during the site investigation in August 2011 and these were monitored and found to be dry. Further monitoring was undertaken and is summarised in Table 3-1 below.

Table 3-1 – Summary of Monitored Groundwater Levels

Borehole	2-4/08/11	16/08/11	13/10/11
BH1	Dry	1.24m bgl	2.45m bgl
BH2	Dry	6.14m bgl	5.46m bgl
BH3	Dry	Dry	5.28m bgl

Note: m bgl – metres below ground level

The groundwater monitoring results reflect the very low permeability of the London Clay strata with groundwater entering the boreholes very slowly after completion. Similar levels have been recorded within boreholes BH2 and BH3 and these are considered to represent true groundwater levels within the London Clay beneath the site with the shallower level within BH1 likely to be perched and not continuous. Winter groundwater levels are anticipated to rise above those recorded in October 2011.

4 Screening

The London Borough of Camden's "Guidance for subterranean development" states that any development proposal which includes a subterranean basement should be screened in order to determine whether there is a requirement for a BIA to be carried out.

4.1 Screening Assessment

Appendix E of the guidance document details six Basement Impact Assessment screening questions, each of which is stated and answered below:

- **Question 1a: Is the site located directly above an aquifer?**

  No. The Site is underlain by the London Clay which is designated as Unproductive Strata by the Environment Agency and cannot store and transmit usable amounts of water.

- **Question 1b: Will the proposed basement extend beneath the water table surface?**

  Based on the findings of the site investigation, the basement may extend beneath the winter water table surface (i.e. saturated London Clay). The proposed basement extends to a depth of approximately 4m below existing ground level. The monitoring standpipes installed during the site investigation indicated groundwater within the London Clay to be more than 5m below ground level during October 2011. In winter conditions, the groundwater level can be expected to rise. Refer to Section 3.4.

- **Question 2: Is the site within 100m of a watercourse, well (used/disused) or potential spring line?**

  According to historic maps[4], the Tyburn flows c.50m to the east of the Site beneath the eastern edge of Fiztjohns Avenue. The Tyburn is culverted and acts as a surface water sewer for the area. The London Clay does not support groundwater flows to the Tyburn and is effectively hydraulically isolated from it. The Site is not within a street which has been identified as being at risk of surface water flooding as a result of sewer surcharging within the London Borough of Camden. Refer to Section 3.2 and 3.4.

- **Question 3: Is the site within the catchment of the pond chains on Hampstead Heath?**

  No. The Site is outside the catchment of Hampstead Heath ponds. Refer to Section 3.

[4] The Lost Rivers of London: a study of their effects upon London and Londoners, and the effects of London and Londoners upon them. N. Barton. 1962.

- **Question 4: Will the proposed development result in a change in the proportion of hard surfaced / paved area?**

  Yes. The proposed building footprint would increase by c.215m^2 over the current building footprint of 175m^2, an increase of approximately 120%. The areas of hardstanding would increase by 90m^2 to 270m^2, an increase of 50%. The drainage from the Site will be directed to public sewer as the ground conditions would not be suitable for a soakaway.

- **Question 5: As part of the site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to ground (e.g. via soakaways and/or SUDS)?**

  No. The low permeability nature of the London Clay strata is unsuitable for receiving significant surface water discharge to ground.

- **Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to, or lower than, the mean water level in any local pond (not just the pond chains on Hampstead Heath) or spring line?**

- No. There are no ponds or spring lines present within 100m of the Site.

4.2 Screening Conclusions

The screening exercise has identified the following potential issue which should be assessed:

1. The basement structure may extend into saturated London Clay formation during winter conditions.
2. The Site lies within 100m of the culverted Tyburn stream.
3. An additional c.300m^2 of hard surfaced area will be created in the form of increased building footprint and hard standing areas.

5 Scoping and Site Investigation

Scoping is the activity of defining in further detail the matters to be investigated as part of the impact assessment. Potential impacts should be ascertained for each of the matters of concern identified during the screening process.

The investigation of the potential impacts is undertaken through a site investigation. In this instance, a desk study and site investigation has been undertaken to establish ground conditions for geotechnical assessment purposes. The investigation included the installation of three groundwater monitoring installations to depths of 6m. This assessment relies upon the findings of the desk study and site investigation.

5.1 Potential Impacts

The following potential impacts have been identified:

Potential Impact	Relevant Site Investigation conclusions
The basement structure may extend into saturated ground during winter conditions. The groundwater flow regime may be altered by the proposed basement. Changing is flow regime could potentially cause the groundwater level within the zone encompassed by the new flow route to increase or decrease locally. For existing nearby structures the degree of dampness or seepage may potentially increase as a result of changes in groundwater level.	The ground investigation has confirmed the presence of London Clay beneath the Site. It has also identified groundwater levels within the London Clay formation, and that the basement may extend beneath this water table during winter conditions. The London Clay is not considered to be an aquifer and will not store or transmit significant quantities of groundwater.
The site lies within 100m of the Tyburn stream. The development may have the potential to impact on the watercourse by reducing groundwater baseflow. The watercourse could impact on the basement by causing surface and groundwater flooding.	The site investigation did not establish the presence of alluvial deposits beneath the Site which indicated any hydraulic continuity with the Tyburn stream. The London Clay is not able to support groundwater base flows to watercourses.
An additional c.300m^2 of hard surfaced area will be created in the form of increased building footprint and hard standing areas. The sealing of the ground surface by pavements and buildings to rainfall will result in decreased recharge to the underlying ground. In areas underlain by an aquifer, this may impact upon groundwater flow or levels. In areas of non-aquifer or Unproductive Strata (i.e. the London Clay), this may mean changes in the degree of wetness which in turn may affect stability.	The ground investigation has confirmed the presence of London Clay beneath the Site, designated Non Productive Strata or a "non-aquifer". The lithological logs and site investigation findings indicate that soakaway drainage is not appropriate for the Site.

6 Groundwater Impact Assessment

The screening process identified three potential impacts. The results of the desk study and site investigation have been used below to address these concerns and assess the likelihood of a negative impact occurring. These are:

1. Altering of the groundwater flow regime as a result of the proposed basement development.

It has been established that the basements may extend into saturated London Clay during winter conditions. The potential impact of this is that the groundwater regime may be altered. However, it is apparent from the site investigation that the geological formation into which the basement will be constructed is not an aquifer as defined by the Guidance. The hydrogeological properties of the London Clay are such that groundwater is not present in significant quantities.

Additionally, based on the groundwater levels available, the basements are not likely to extend far (possibly 1m depending on winter water levels) into the saturated clay, which is in excess of 100m thick at this location. When considering the depth of the proposed basements and the relationship with the surrounding areas of private garden, it is considered very unlikely that the structure would cause damming of groundwater to occur.

It is therefore considered highly unlikely that the proposed development will result in significant changes to the groundwater regime beneath the Site.

2. The site is located within 100m of a watercourse.

A review of published data indicates that the Tyburn stream flows approximately 50m to the west of the Site. The Tyburn is culverted and acts as a surface water sewer. It flows over the London Clay and is not in significant hydraulic continuity with it. The Site is not within a street which has been identified as being at risk of surface water flooding as a result of sewer surcharging within the London Borough of Camden.

It is therefore considered highly unlikely that the proposed development will impact upon, or be impacted by, the culverted Tyburn stream.

3. Altering of the recharge rate or changes in the degree of wetness through the creation of additional hard surfaces.

As discussed above, the site investigation has demonstrated that the Site is located on a non-aquifer as defined within the Guidance[2]. Recharge to the London Clay is likely to be negligible. In addition, the properties of the London Clay negate the possibility of significant discharging of surface water drainage to ground.

Due to the nature of the soils beneath the site and the relatively small area of development, groundwater recharge (which is highly restricted due to the low permeability of the London Clay) is unlikely to be significantly affected by the proposed development. Drainage from the development will be directed to public sewer.

7 Review and Decision Making

A groundwater impact assessment of the proposed development has been undertaken. The assessment has been based on information and guidance published by the London Borough of Camden[2] and on site investigation information[3].

No potential adverse impacts have been identified and it is concluded that the proposed development is unlikely to result in significant changes to the groundwater regime beneath the Site.

4.0 Land stability Impact Assessment

Land Stability Impact Assessment Report

6 Nutley Terrace
London NW3

Client	Mr & Mrs Shafi
Engineer	Elliott Wood

J11158a

November 2011

GEA Geotechnical & Environmental Associates

Document Control

Project title	6 Nutley Terrace, London, NW3 5BX	Project ref	J11158a
Report prepared by	Martin Cooper BEng CEng MICE FGS		
Report checked and approved for issue by	Steve Branch DSc MSc CGeol FGS FRGS MIEnvSc		

Issue No	Status	Date	Approved for Issue
1	Final	21 November 2011	

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

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CONTENTS

1.0 INTRODUCTION

Geotechnical and Environmental Associates (GEA) Limited has been commissioned by Elliott Wood, on behalf of Mr and Mrs Shafi, to carry out a Land Stability Impact Asssessment of this site at 6 Nutley Terrace, London NW3 5BX, in accordance with guidelines from London Borough of Camden ("the Council") in support of a planning application.

A Desk Study and Ground Investigation has previously been completed by GEA (report ref J11158m dated 11 October 2011) and has been referred to as necessary.

1.1 Proposed Development

The current proposals are to demolish the existing house and construct two new three-storey houses with single level basements. The basements will extend to a depth of about 4.2 m and will, it is understood, cover the existing building footprint and extend partly into the existing rear garden.

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

1.2 Scope and Purpose of Work

The work carried out comprises a Land Stability Assessment (also referred to as Slope Stability Assessment) which forms part of the Basement Impact Assessment (BIA) procedure specified in the London Borough of Camden Planning Guidance CPG4[1] and their Guidance for Subterranean Development[2] prepared by Arup.

The aim of the work is to provide information on land stability and in particular to assess whether the development will affect the stability of neighbouring properties and whether any identified impacts can be appropriately mitigated by the design of the development.

1.3 Qualifications

This assessment has been carried out by Martin Cooper, a BEng in Civil Engineering, a chartered engineer (CEng), member of the Institution of Civil Engineers (MICE), and Fellow of the Geological Society (FGS) who has over 20 years specialist experience in ground engineering. The assessment has been made in conjunction with Steve Branch, a BSc in Engineering Geology and Geotechnics, MSc in Geotechnical Engineering, a chartered geologist (CGeol) and Fellow of the Geological Society (FGS) with 25 years experience in geotechnical engineering and engineering geology. Both assessors meet the Geotechnical Specialist criteria of the Site Investigation Steering Group and satisfy the qualification requirements of the Council guidance.

1.4 Limitations

The conclusions and recommendations made in this report are limited to those that can be made on the basis of the research carried out. The results of the research should be viewed in the context of the work that has been carried out and no liability can be accepted for matters outside

1 London Borough of Camden Planning Guidance CPG4 *Basements and lightwells*
2 Ove Arup & Partners (2010). *Camden geological, hydrogeological and hydrological study: Guidance for Subterranean Development*. For London Borough of Camden November 2010

the stated scope of the research. Any comments made on the basis of information obtained from third parties are given in good faith on the assumption that the information is accurate. No independent validation of third party information has been made by GEA.

2.0 THE SITE

2.1 Site Description

The site is located approximately 400 m to the north-east of Finchley Road London Underground station. It fronts onto Nutley Terrace to the north and is bounded by private gardens to the south, east and west. The site is also located immediately to the south of Network Rail's Belsize Tunnel which carries the Midland Mainline service; the tunnel crown is understood from Network Rail to be at a depth of about 22 m below ground level.

The site may be additionally located by National Grid Reference 526659, 184995, as shown on the adjacent map.

The site is roughly rectangular in shape, measuring approximately 30 m by 60 m and at the time of the recent GEA investigation was occupied by an existing two-storey L-shaped house, located on the northern part of the site. A brick paved parking area was present to the front of the house, adjacent to Nutley Terrace. A small grassed area with planted borders and two deciduous trees approximately 20 m high were present to the east of the house.

To the south of the house the rear garden comprises a terraced lawn with a number of mature trees on the eastern and western boundaries; species include ash, beech and poplar. The site slopes gently down towards the south in a series of terraces, from a level of 75.47 m OD at the northern boundary to 73.58 m OD at the southern boundary.

The adjacent photograph illustrates the stepped lawn.

2.2 Topography

As noted above, the site lies at an approximate elevation of 75.5 m OD at the front (north), falling to about 73.5 m OD at the rear (south) and the general area slopes gently to the south and east at an angle in the order of 3° to 4°. The site itself falls on average at an angle of less than 3°, although it has been regraded to create a number of level terraces.

3.0 GROUND CONDITIONS

3.1 Soil Conditions

The Geological Survey map of the area (BGS sheet 256: North London) indicates that the site should be underlain by London Clay, with the Claygate Member overlying the London Clay approximately 50 m to the north of the site, as shown on the geological map extract below.

The GEA investigation, carried out in August 2008, comprised three cable percussion boreholes advanced to a depth of 20.0 m, by means of a dismantlable drilling rig, together with five window sample boreholes, advanced to depths of between 2.80 m and 6.00 m, in order to provide additional coverage of the site.

Beneath a surface covering of paving or topsoil, the previous investigation encountered made ground overlying the London Clay formation to the full depth of the investigation of 20 m. The made ground comprised orange-brown silty sandy clay with fine gravel, brick, charcoal fragments and rootlets and was encountered to depths of between 0.20 m (73.10 m OD) and 1.2 m (73.71 m OD). A weathered zone of soft or firm orange-brown mottled brown and grey silty sandy clay extended to depths of between 4.75 m (69.57 m OD) and 5.50 m (69.68 m OD). This upper weathered material is sandier than would be expected for London Clay and could partly represent soliflucted material derived in part from the overlying Claygate Member which is present upslope of the site. Firm dark brownish grey silty fissured clay extended to depths of between 14.0 m (60.32 m OD) and 14.3 m (60.88 m OD) whereupon stiff grey fissured silty clay with lenses of fine grey sand was encountered to the full depth of the investigation of 20.0 m (55.18 m OD).

Classification tests on the clay soils indicated that they are generally of high shrinkage potential, as is typical for the London Clay.

3.2 Groundwater Conditions

The bedrock aquifer of the site is classified by the Environment Agency (EA) as "Unproductive Strata", which are rock or drift deposits with low permeability that have negligible significance for water supply or river base flow. The Claygate Member to the north of the site is classed as a Secondary A Aquifer by the EA, which is defined as permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.

There are no Environment Agency designated Source Protection Zones (SPZs) on the site, but there is a SPZ II, within 1 km of the site.

Historically the Tyburn River[3] rose approximately 150 m to the northwest of the site. It is shown on a map dated 1871 rising from a pond near to what is annotated as Shepherd's Well, although is no longer shown on maps dated after 1874, after the construction of Fitzjohns Avenue. The stream flowed in a southerly direction, passing the site at a distance of approximately 75 m, where it merged with another tributary just north of Regent's Park and flowed into a large lake that is still present today. From there the river then flowed through central London and into the Thames, although due to the fact that the Tyburn was only a small stream, the exact course of the lower part of the river is not clear.

Given the location of the source of the Tyburn, it is likely that it was formed by a spring issuing from within the Claygate Beds close to the boundary with the London Clay, which is located approximately 50 m to the south of the source. The direction of groundwater flow within the London Clay beneath the site is likely to be controlled by the local topography and is therefore likely to be in a southerly direction, in the direction that the former river flowed.

Any groundwater flow within the London Clay will be at a very slow rate, due to its negligible permeability; the permeability will be predominantly secondary, through fissures in the clay. Published data for the permeability of the London Clay indicates the horizontal permeability to generally range between 1×10^{-11} m/s and 1×10^{-9} m/s, with a lower vertical permeability.

The site is not located within a Flood Zone as defined by the Environment Agency. In addition, Nutley Terrace has not been identified as a street at risk of surface water flooding as a result of sewer surcharging within the London Borough of Camden. The nearest existing surface water features are the "Hampstead Ponds", which are located approximately 1.2 k m to the northeast of the site.

Groundwater was not encountered during drilling of any of the previous boreholes. Standpipe piezometers were installed in each of the cable percussion boreholes, to a depth of 6.00 m (69.18 m OD) in each of Borehole Nos 1 and 3, and to 6.20 m (68.12 m OD) in Borehole No 2. They were monitored on a single occasion on 19th August 2011, approximately two weeks after completion of the site work. Groundwater was measured at depths of 1.24 m (73.94 m OD) and 6.14 m (68.18 m OD) in Borehole No 1 and 2 respectively, whereas Borehole No 3 was noted to be dry with the standpipe extending to 6 m (68.32 m OD). Whilst the relative levels are as would be expected, in that they indicate groundwater flow to the south, the wide variation in groundwater level between Borehole No 1 at the northern boundary and Borehole No 2, in the centre of the site, indicate that the water levels had not reached equilibrium at the time of the monitoring and further monitoring should be carried out.

3 Nicholas Barton (2000) *London's Lost Rivers*. Historical Publications Ltd.

4.0 SCREENING

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

4.1 Screening Assessment

A number of screening tools are included in the Arup document and for the purposes of this report reference has been made to Appendix E which includes 14 questions within a screening flowchart. Responses to the questions are tabulated below.

Question	Response for 16 Daleham Gardens
1. Does the existing site include slopes, natural or manmade, greater than 7°?	No
2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7°?	No
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	No
4. Is the site within a wider hillside setting in which the general slope is greater than 7°?	No
5. Is the London Clay the shallowest strata at the site?	No
6. Will any trees be felled as part of the proposed development and / or are any works proposed within any tree protection zones where trees are to be retained?	*Yes – some trees are proposed to be felled. No - no works are proposed within the root protection zones of the trees to be retained.*
7. Is there a history of seasonal shrink-swell subsidence in the local area and / or evidence of such effects at the site?	*Yes – the Hampstead area is prone to these effects as a result of the presence of shrinkable London Clay and abundant mature trees*
8. Is the site within 100 m of a watercourse or potential spring line?	Yes – see comments above with regard to the location of the former River Tyburn with respect to the site.
9. Is the site within an area of previously worked ground?	No
10. Is the site within an aquifer?	No
11. Is the site within 50 m of Hampstead Heath ponds?	No
12. Is the site within 5 m of a highway or pedestrian right of way?	*Yes - the site fronts onto a public road*
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	*Yes? – the development will increase foundation depths in the centre of the site to in excess of 4.2 m deep but the depths of foundations of adjacent properties are not known.*
14. Is the site over (or within the exclusion zone of) any tunnels, eg railway lines?	Yes – the site is within about 2 m laterally of Network Rail tunnels, which are at a depth of about 22 m below ground level.

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

Q6 Some trees will be felled but no works are proposed within tree root protection zones.
Q7 The site is in an area of seasonal shrink-swell.
Q8 The site is within 100 m of a potential spring line.
Q12 The site is within 5 m of a public highway.
Q13 The development will increase the foundation depths relative to the neighbouring properties to a relatively significant extent.
Q14 The development is probably within the exclusion zone of a railway line.

5.0 SCOPING AND SITE INVESTIGATION

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

The investigation of the potential impacts is carried out through a suitable site investigation and this has been carried out by GEA in August 2011. It is considered that the scope of the investigation complies with the guidance issued by the Council and is therefore a suitable basis on which to assess the potential impacts.

5.1 Potential Impacts

The following potential impacts have been identified.

Potential Impact	Site Investigation Conclusions
Felling of trees	None – this is a determination that needs to be made outside of the BIA, subject to relevant Tree Preservation Orders etc
Seasonal shrink-swell can result in foundation movements and in particular if a new basement is dug to below the depth likely to be affected by tree roots this could lead to damaging differential movement between the subject site and adjoining properties	The investigation has indicated that the site has a cover of made ground and naturally reworked clay, but that shrinkable London Clay is present within a depth that can be affected by tree roots. The subject property is however not structurally linked to adjacent properties.
Site within 100 m of a watercourse or potential spring line – risk of slope movements resulting from changes in groundwater regime	The findings of the investigation indicate that the site is wholly within London Clay and not particularly steep.
Location of public highway – excavation of basement could lead to damage	The investigation has not indicated any specific problems, such as weak or unstable ground, voids, high water table, that would make working within 5 m of public infrastructure particularly problematic at this site.
Founding depths relative to neighbours – excavation may lead to structural damage to neighbouring properties if there is a significant differential depth between adjacent properties.	As above; in addition, the proposed basement is deepest in the centre of the building, whereas closer to neighbours the new foundations will be less deep and outside the zone where excavation may give rise to instability of neighbouring structures.
Site over (or within the exclusion zone of) any tunnels, eg railway lines – excavation of a basement may result in damage to the tunnel	Although the site is close to the tunnel, the current proposals are for the basement to be set back from the front of the site and thus further from the tunnel.

6.0 LAND / SLOPE STABILITY IMPACT ASSESSMENT

The screening identified four potential impacts. Of these, it is considered that the question of tree felling is not a material impact, other than possible effects on the clay, which is dealt with as a consideration of shrink-swell. The results of the site investigation have therefore been used below to review the remaining potential impacts, to assess the likelihood of them occurring and the scope for reasonable engineering mitigation.

Seasonal Shrink-Swell

The proposed development involves deepening the foundations to below what would be expected as a depth of influence of tree roots on the basis of the trees present on the site. Consideration will need to be given to the effects of clay swelling following the removal of some of the trees, but similarly the foundations are to be placed at depths that should not be affected. Subject to inspection of foundation excavations in the normal way to ensure that there is not significant unexpectedly deep root growth, it is not considered that the occurrence of shrink-swell issues in the local area has any bearing on the proposed development.

Site within 100 m of a watercourse or potential spring line

The site appears to be no closer than 75 m from the historic course of the River Tyburn and the basement excavation will therefore not have any effect.

Location of public highway

The basement excavation is at least 6 m from the highway, such that the basement excavation should not affect the highway. In addition, the proposed development will include retaining walls that will be designed to maintain the stability of the surrounding ground, thus protecting the adjacent road and associated infrastructure beyond. There is nothing unusual or exceptional in the proposed development or the findings of the investigation that give rise to any concerns with regard to stability over and above any development of this nature.

Founding depths relative to neighbours

The depths of adjacent foundations are not known, but they do not immediately abut the new basement excavation. The basement excavation can be readily managed using standard engineering solutions to ensure that the stability of the adjacent foundations is maintained. These solutions could include preventing excavation within a zone that would lead to instability, or constructing retaining walls using methods designed to minimise movements. The investigation has not highlighted any issues that give rise to concerns regarding the effectiveness of these normal engineering solutions at this particular site.

The development is within the exclusion zone of a railway line

As the basement excavations, and new foundations, are more than 5 m laterally from railway tunnels, they may not be within the exclusion zone, although the closest site boundary may be within the zone. The tunnels are in excess of 20 m deep and the proposed development is therefore not likely to have any effect on the tunnels. There is however likely to be a requirement to liaise with Network Rail in this respect.

7.0 CONCLUSIONS

A Land Stability Assessment, also referred to as a Slope Stability Assessment, has been carried out following the information and guidance published by the London Borough of Camden. Information from a Site Investigation has been used to assess potential impacts identified by the screening process.

It is concluded that the proposed development is unlikely to result in any specific land or slope stability issues.

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