Addendum to Basement Impact Assessment

in connection with proposed development at

No. 39 Fitzjohn's Avenue
Camden
London
NW3 5JY

for

Godfrey London

LBH4498bia Ver 1.3

April 2019

LBH WEMBLEY

ENGINEERING

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1.0	17th Dec 2018			
1.1	19th Dec 2018			
1.2	20th Dec 2018			
1.3	12th April 2019			

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Non-Technical Summary

It is proposed to re-build a large Victorian property at No. 39 Fitzjohn's Avenue, which will include the construction of a basement beneath the full extent of the building that will also extend into the rear garden.

A Basement Impact Assessment was prepared in May 2018 by RWA London in support of a full planning application (2018/2415/P) to the London Borough of Camden.

Following an audit of the submission by Campbell Reith Hill (CRH), dated August 2018, the BIA was revised in November 2018.

This addendum has been prepared to address the remaining issues that have been raised.

Hydrological Impacts

Although the building footprint will increase, the development will lead to a net reduction in the impermeable area as a result of the removal of an existing tarmac tennis court.

Hydrogeological Impacts

The site is underlain by essentially impermeable London Clay and hence there is no shallow groundwater table and no scope for any adverse hydrogeological impacts to be caused by the proposed basement construction.

Stability Impacts

Ground movement assessments have been undertaken to demonstrate the acceptability of the proposed construction methodology upon the neighbouring structures, resulting in a prediction of maximum Burland Category 1 (Very Slight) damage.

Two Network Rail tunnels run at depth beneath the area of the site. A detailed asset impact assessment is being undertaken separately for Network Rail. However, initial assessment suggests that there will not be any adverse impact upon these tunnels.

The depth of the new basement will obviate concerns regarding both potential seasonal shrink/swell movements, and the potential effects of the planned removal of some trees in the rear garden.

Conclusion

The assessment concludes that no adverse residual or cumulative stability, hydrological or hydrogeological impacts are expected to either neighbouring structures or the wider environment as a result of this development.

Contents

Foreword-Guidance Notes

GENERAL

This report has been prepared for a specific client and to meet a specific brief. The preparation of this report may have been affected by limitations of scope, resources or time scale required by the client. Should any part of this report be relied on by a third party, that party does so wholly at its own risk and LBH Wembley Engineering disclaims any liability to such parties.

The observations and conclusions described in this report are based solely upon the agreed scope of work. LBH Wembley Engineering has not performed any observations, investigations, studies or testing not specifically set out in the agreed scope of work and cannot accept any liability for the existence of any condition, the discovery of which would require performance of services beyond the agreed scope of work.

VALIDITY

Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances shall be at the client's sole and own risk. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should therefore not be relied upon in the future and any such reliance on the report in the future shall again be at the client's own and sole risk.

THIRD PARTY INFORMATION

The report may present an opinion based upon information received from third parties. However, no liability can be accepted for any inaccuracies or omissions in that information.

1. Introduction

1.1 Background

A Basement Impact Assessment (Rev E) was prepared in May 2018 by RWA London in support of a full planning application (2018/2415/P) to the London Borough of Camden.

Following an audit of the initial BIA submission by Campbell Reith Hill (CRH) in August 2018, this document has been prepared to address the issues raised, in conjunction with a revised document (Rev F) by RWA London.

The following comments were set out in the audit report.

1.2 CRH Audit Checklist

Item	Yes/ No	CRH Comment	LBH Response
Are BIA Author(s) credentials satisfactory?	No	Persons undertaking the BIA report to hold relevant qualifications. Confirmation of author(s) qualifications to be confirmed as set out in CPG Basements.	Both the original BIA and this addendum have been reviewed in accordance with CPG Basements by Seamus Lefroy-Brooks, who holds the required qualifications.
Is data required by Cl.233 of the GSD presented?	No	Outline construction programme to be provided. Limited information has been provided on mitigation measures being considered.	Cl.233 of the Arup report advises on the information that may be needed to complete the BIA screening and does not refer to the construction programme or mitigation measures. However, the construction is referred to in section 5 of this document. Mitigation measures are discussed in section 7.
Does the description of the proposed development include all aspects of temporary and permanent works which might impact upon geology, hydrogeology and hydrology?	No		The proposed construction methodology is described in section 5 of this document.
Are suitable plan/maps included?	No	Relative maps and extracts to support screening questions have not been provided.	Map extracts from the Camden Geological, Hydrogeological and Hydrological Study are included in this document (section 10).
Do the plans/maps show the whole of the relevant area of study and do they show it in sufficient detail?	No		Additional plans/maps are contained within the updated RWA BIA document

Land Stability Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	No	Site investigations should be provided to justify answers. Question 4 omitted. Assessment referenced in JAL report should be provided.	A response to Question 4 is included in this document (Section 3.1.3). JAL Ground Investigation report (Nov 2017) has now been provided.
Hydrogeology Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	No	Proposed development will increase the impermeable area by 140%, SUDS should be provided. Anticipated groundwater should be confirmed by site investigation. Assessment referenced in JAL report should be provided.	An Outline SuDS Strategy is presented as a separate report (LBH4498suds). JAL Ground Investigation report (Nov 2017) has now been provided.
Hydrology Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	No	Question 3 omitted. SUDS to be provided. Assessment referenced in JAL report should be provided.	A response to Question 3 included in this document (Section 3.1.1). An Outline SuDS Strategy is presented as a separate report (LBH4498suds). JAL Ground Investigation report (Nov 2017) has now been provided.
Is a conceptual model presented?	No	A conceptual model indicating the proposed changes to the site in the context of the ground / groundwater conditions and adjacent structures, noting potential risks/impacts and proposed mitigation should be presented.	A description of the proposed changes to the site in the context of the ground / groundwater conditions and adjacent structures is contained in section 6.1 of this document. An assessment of the potential risks/impacts and the proposed mitigation is presented in section 7.
Land Stability Scoping Provided? Is scoping consistent with screening outcome?	No	Site investigation to be provided	JAL Ground Investigation report (Nov 2017) has now been provided.
Hydrogeology Scoping Provided? Is scoping consistent with screening outcome?	No	Ground investigation and SuDs to be provided	An Outline SuDS Strategy is presented as a separate report (LBH4498suds). JAL Ground Investigation report (Nov 2017) has now been provided.
Hydrology Scoping Provided? Is scoping consistent with screening outcome?	No	SuDs to be provided Response to be provided for all screening questions	An Outline SuDS Strategy is presented as a separate report (LBH4498suds). Responses to additional screening questions answered with a "yes" are provided in this document (Section 3.2.1).

Is factual ground investigation data provided?	No	Reference is made to Site Investigation in JAL report P1153J1199 however this report has not been provided.	JAL Ground Investigation report (Nov 2017) has now been provided.
Is monitoring data presented?	Yes	Reference is groundwater monitoring, SI results should be provided to justify assumptions	Groundwater monitoring results are included in JAL Ground Investigation Report (Nov 2017).
Is the ground investigation informed by a desk study?	Yes	A desk study carried out by Jonas Associates Limited has been referenced but not provide for review.	JAL Ground Investigation report (Nov 2017) has now been provided.
Has a site walkover been undertaken?	Yes		
Is the presence/absence of adjacent or nearby basements confirmed?	No	The report assumes that neighbouring properties do not have basements. This should be investigated further and included in BIA.	The neighbouring property at the northern wing extension to No. 39 does not have a basement, as shown on the existing lower ground floor plan in section 11. The other buildings in the vicinity of the site are considered to be located at sufficient distances, such that they will not be unduly affected by the proposed basement development.
Is a geotechnical interpretation presented?	No	This should be rectified and GMA provided	A discussion of the geotechnical issues is contained in section 4 of this document and a GMA is included Section 6.
Does the geotechnical interpretation include information on retaining wall design?	No	This should be rectified and preliminary retaining wall calculations provided with reasonable assumption provided for soil parameters.	Retaining wall calculations are contained in the appendix of the revised BIA (Ref F).
Are reports on other investigations required by screening and scoping presented?	No	SuDs not provided. Ground Movement Assessment Report not provided. Evidence of consultation with Network Rail regarding infrastructure below the site not provided. Further details to be provided on the temporary works proposals and the construction methodology.	An Outline SuDS Strategy is presented as a separate report (LBH4498suds). A GMA is included in this document (Section 6). Evidence of consultation with Network rail is contained in section 4 of the updated RWA document. Details of the temporary works proposals are described in section 5 of this document and drawings are included in Appendices 2 and 3 of the updated RWA document

Are the baseline conditions described, based on the GSD?	No	GMA and Site Investigations to be provided	A GMA is included in this document (Section 6). JAL Ground Investigation report (Nov 2017) has now been provided.
Do the base line conditions consider adjacent or nearby basements?	No		Adjacent or nearby basements are considered in Section 6.1 of the GMA.
Is an Impact Assessment provided?	Yes	However JAL report referenced should be provided. Sufficient information has not been provided to demonstrate stability. GMA required.	JAL Ground Investigation report (Nov 2017) has now been provided. A GMA is included in this document (Section 6).
Are estimates of ground movement and structural impact presented?	No	GMA should be provided with estimated heave movements from excavation and vertical and horizontal movements from excavation and underpinning. Impact on the surrounding highway, pathway and Belsize tunnel should be considered and applicable protection agreement sought.	A GMA is included in this document (Section 6). Estimated heave movements from excavation and vertical and horizontal movements from excavation and underpinning are discussed in sections 6.3-6.5 of this document. Impact on the surrounding highway, pathway and Belsize tunnel are discussed in sections 6.6.2 and 6.6.3 of this document. Contact has been made with Network Rail.
Is the Impact Assessment appropriate to the matters identified by screen and scoping?	No	GMA and SuDs to be should be provided	A GMA is included in this document (Section 6). An Outline SuDS Strategy is presented as a separate report (LBH4498suds).
Has the need for mitigation been considered and are appropriate mitigation methods incorporated in the scheme?	No	Indicative underpinning sequence and temporary works proposals have been provided however these should be reviewed following completion of GMA	Underpinning sequence and temporary works proposals are described in section 5 of this document and have been reviewed in section 7 following the GMA.
Has the need for monitoring during construction been considered?	Yes	Need for monitoring has been noted however this should be reviewed following completion of GMA. A movement monitoring proposal including trigger levels should be provided.	The monitoring scheme is described in section 8 of this document.
Have the residual (after mitigation) impacts been clearly identified?	No	This should be provided as part of the GMA.	A GMA is included in this document (Section 6).
Has the scheme demonstrated that the structural stability of the	No	This should be rectified and proposals supported by calculations in GMA. GMA	The GMA describes all relevant neighbouring structures and properties. (Section 6).

building and neighbouring properties and infrastructure will be maintained?		should reference all neighbouring properties and infrastructure within	
Has the scheme avoided adversely affecting drainage and run-off or causing other damage to the water environment?	No	Area of hardstanding to be increased by 140%. SuDs assessment to be provided	An Outline SuDS Strategy is presented as a separate report (LBH4498suds).
Has the scheme avoided cumulative impacts upon structural stability or the water environment in the local area?	No	SuDs assessment to be provided.	An Outline SuDS Strategy is presented as a separate report (LBH4498suds).
Does report state that damage to surrounding buildings will be no worse than Burland Category 1?	Yes	However the values noted should be support by reference to a GMA. Impact on infrastructure assets and applicable protection agreements to be referenced.	A GMA is included in this document (Section 6).
Are non-technical summaries provided?	No		A non-technical summary is provided at the front of this document.

2. Description of the Proposed Development

It is proposed to re-build a large Victorian property at No. 39 Fitzjohn's Avenue, which will include the construction of a basement beneath the full footprint of the existing building and will also extend into the rear garden. The front and side facades to the existing building will be retained and restored.

The new basement will open out to the rear onto a basement level patio that will link to the remaining rear garden area by means of some stepped planting.

As part of the proposed development, the existing western wing and the link corridor to the northern wing will be removed. The northern wing will be retained as a separate building and extended rearwards under a separate planning permission.

In order to create a net reduction in the impermeable area of the site, it is now proposed to remove the existing tarmac tennis court; hence the retention of the tennis court, as indicated on proposed development drawings and within the revised RWA BIA, should be disregarded.

3. Screening & Scoping Questions missed in original assessment.

3.1 Screening

3.1.1 Surface Flow and Flooding

Question	Response	Justification
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	**Yes**	The basement will extend into the rear garden. However, the net impermeable area will actually reduce as a result of removal of a tarmac tennis court.

3.1.2 Groundwater Flow

Question	Response	Justification
2. Is the site within 100m of a watercourse, well (used/disused) or potential spring line?	**Yes**	A tributary of the River Tyburn is located approximately 75m to the east of the site, as shown on the Camden 1920 Geological Map (CGHHS Fig 2). A map extract is provided in section 10.

3.1.3 Slope Stability

Question	Response	Justification
4. Is the site within a wider hillside setting in which the general slope is greater than 7°? (approximately 1 in 8)	**No**	The general slope of the wider hillside is less than 7°.
8. Is the site within 100m of a watercourse, well (used/disused) or potential spring line?	**Yes**	A tributary of the River Tyburn is located approximately 75m to the east of the site, as shown on the Camden 1920 Geological Map (CGHHS Fig 2). A map extract is provided in section 10.
14. Is the site over (or within the exclusion zone of) tunnels, e.g. railway lines?	**Yes**	Belsize Tunnel 2 (Slow) and Belsize Tunnel 1 (Fast) run beneath the northern half of the site and south of site beneath Nutley Terrace respectively.

3.2 Scoping

3.2.1 Surface Flow and Flooding

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

The guidance advises that a change in the in proportion of hard surfaced or paved areas of a property will affect the way in which rainfall and surface water are transmitted away from a property. This includes changes to the surface water received by the underlying aquifers, adjacent properties and nearby watercourses. Changes could result in decreased flow, which may affect ecosystems or reduce amenity, or increased flow which may additionally increase the risk of flooding.

3.2.2 Groundwater Flow

- The site is within 100m of a watercourse, well (used/disused) or potential spring line

The guidance advises that the flow from a spring, well or watercourse may increase or decrease if the groundwater flow regime which supports that water feature is affected by a proposed basement. If the flow is diverted, it may result in the groundwater flow finding another location to issue from with new springs forming or old springs being reactivated. A secondary impact is on the quality of the water issuing or abstracted from the spring or water well respectively.

3.2.3 Land Stability

- The site is within 100m of a watercourse, well (used/disused) or potential spring line

The guidance advises that seasonal spring lines and changes to groundwater regimes within slopes can affect slope stability.

- The site is over (or within the exclusion zone of) tunnels, e.g. railway lines

The guidance advises that excavation for a basement may result in damage to the tunnel

4. Geotechnical Issues

4.1 Basement Construction

The basement excavation will extend down into the London Clay Formation.

In the absence of any substantial groundwater inflows into the basement excavation, the basement perimeter walls will be formed by conventional underpinning and the construction of L-shaped reinforced cast in-situ concrete segments excavated and cast around the site in a 'hit and miss' sequence of 1m wide sections.

The depth of underpinning the existing Victorian façade will be around 3.5m, although this will increase to around 6m where the façade adjoins the deeper part of the proposed basement. Two stages of underpinning during the works will therefore be utilised.

During the works, temporary propping will be installed to ensure that lateral ground movements are minimised.

An upper row of props will be installed across the site between the newly underpinned walls prior to the main basement excavation, within reinforced concrete thrust blocks set at proposed basement level.

In the permanent situation the reinforced concrete underpins connected to the reinforced concrete floor slab will combine to form a rigid concrete box to support the vertical structural loading of the overlying building. Both the basement raft slab and the ground floor slab will act as props.

5. Outline Construction Methodology

The following outline methodology and sequence of works should be varied by the basement contractor or the structural engineer only by agreement with the basement design engineer and should be incorporated into the engineer's construction design and the contractor's method statements.

5.1 Construction Sequence

1. Underpin the existing foundations to the façade and install temporary propping.
2. Demolish the existing building, retaining the façade.
3. Construction of the remaining basement perimeter walls
4. Where the proposed basement extends into the rear garden, a battered open excavation will be undertaken prior to the new basement perimeter walls being formed by excavation of a series of pins to approx. 6m depth, using "hit and miss" excavation methods. Support will be provided using inclined temporary props set from reinforced concrete thrust blocks at basement level.
5. Main basement bulk excavation down to the basement slab formation level.
6. Installation of below-slab drainage for foul and ground water, sumps and pumps.
7. Slab reinforcement placed and basement slab cast.
8. Ground floor slab cast
9. Temporary propping removed.
10. Basement liner walls, membranes, cavity drainage, insulation and screeds to be installed.
11. Superstructure construction

5.2 Underpinning

Underpinning sections will be excavated in short widths not exceeding 1000mm.

The sequence of the underpinning will be in an extended 1, 3, 5, 2, 4 & 6 type numbering sequence, such that any given underpin will be completed, dry packed, and a minimum period of 48 hours lapsed before and adjacent excavation is commenced to form another underpin.

In the event that the existing foundations to the wall are found to be unstable, sacrificial steel jacks will be installed underneath the existing foundation to prop the bottom few courses of bricks. These steel jacks will be left in place and will be incorporated into the concrete.

Each pin excavation will be undertaken only under the direct supervision of a suitably experienced and competent person. In the event that the vertical soil face to an underpin is judged to be potentially unstable, face support and lateral propping will be provided as required, using perforated plywood shutter sheeting supported by temporary walings and adjustable steel trench "acrow" props.

6. Ground Movement Assessment

An assessment of the expected ground movements is undertaken below, followed by an analysis of the potential damage to the neighbouring structures. This section supersedes section 11 (assessment of adverse effects) of the revised RWA BIA and Sections 8.2, 8.3.3 and 8.3.6 of that report should also be disregarded.

6.1 Structures Assessed for Ground Movement

Northern Wing Extension to No. 39 Fitzjohn's Avenue

The northern wing to No. 39 Fitzjohn's Avenue is a 1950s three storey extension that lies approximately 1m from the proposed basement. The ground floor level is situated at approximately +77m OD; hence, for the purposes of this assessment, the existing foundations to the northern wing are assumed to extend to 1m depth (+76m OD), in order to represent a worst case scenario.

It is also proposed to construct a three storey extension to the rear of the northern wing.

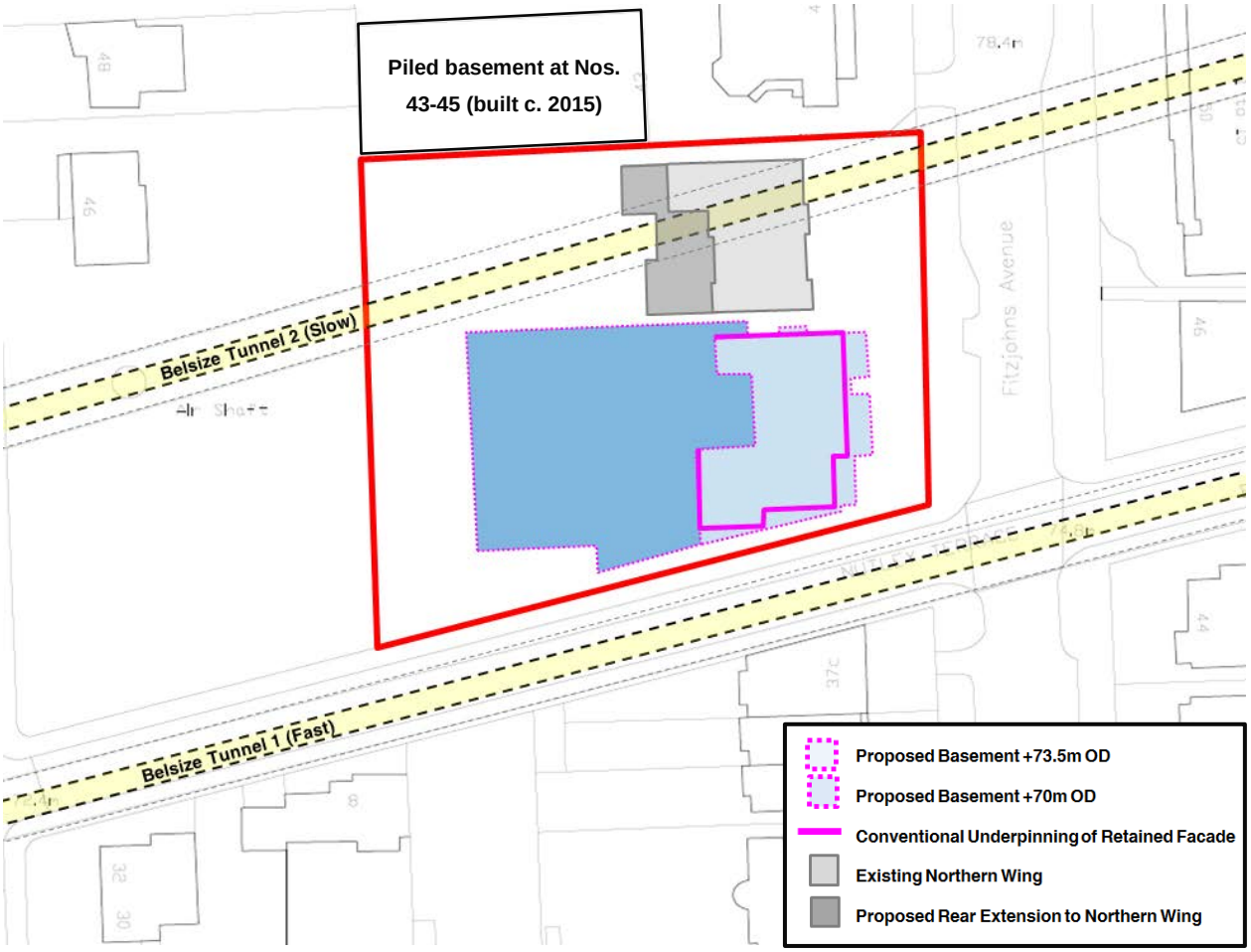
Belsize Tunnels

An enquiry made to Network Rail has revealed that there are two tunnels in the vicinity of the proposed basement.

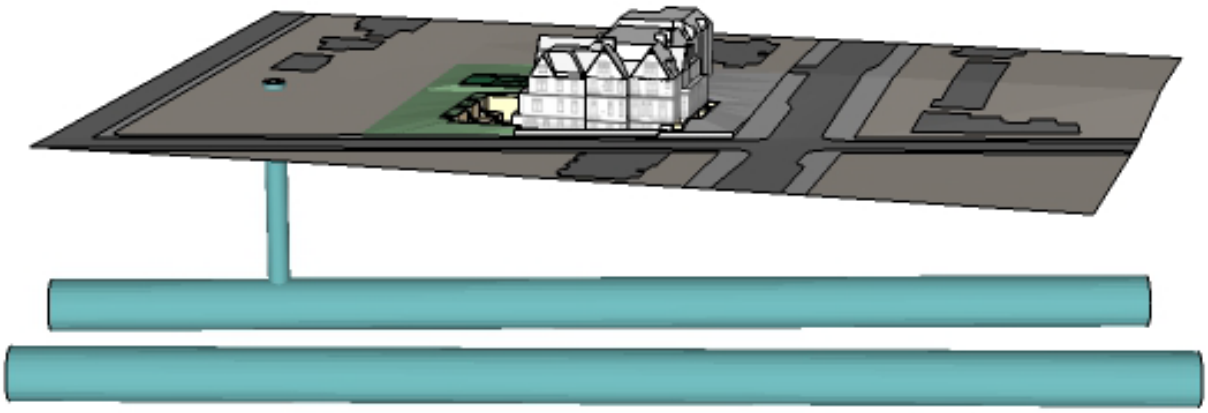
Belsize Tunnel 1 (Fast) lies approximately 8m to the southeast of the proposed basement and runs beneath Nutley Terrace in a southwest-northeast direction.

Belsize Tunnel 2 (Slow) lies approximately 10m to the northwest of the proposed basement and runs beneath the tennis court and northern wing extension in a southwest-northeast direction.

The Basement Impact Assessment by RWA London indicates the crown level to these tunnels to be set at approximately +53.5m OD, which corresponds to 16.5m below the deepest part of the proposed basement. The BIA also infers that the diameters of the tunnels are approximately 7.5m.



Plan showing structures assessed for ground movement



6.2 Modelled Ground Conditions

The ground investigation found the London Clay Formation to be present at shallow depth and no groundwater table is present beneath the site.

Excavation of the basement will result in unloading of the clay leading to theoretical heave movement of the underlying soil in both the short and long term.

Therefore, an analysis of the vertical movements has been carried out for a modelled situation, based on a soil model devised from the results of the ground investigation, together with published information on the London Clay Formation.

For design purposes a conservative undrained strength profile has been adopted, assuming an average Cu of 50kN/m^2 at the surface of the London Clay Formation, increase by 8kN/m^2 per m depth.

The Undrained Modulus of Elasticity (Eu) has been based upon an empirical relationship of Eu = 750 x undrained cohesion (Cu), and the Drained Modulus of Elasticity (E') has been based upon an empirical relationship of 350 x Cu.

Stratum:	**Undrained Elastic Modulus Eu (kN/m^2)**	**Drained Elastic Modulus E' (kN/m^2)**
London Clay Formation	37,500kN/m^2 at surface increasing linearly to 337,500kN/m^2 at 50m depth	17,500 kN/m^2 at surface increasing linearly to 225,000kN/m^2 at 50m depth

Poisson's Ratios of 0.5 and 0.1 have been used for short term (undrained) and long term (drained) conditions respectively.

The analysis uses classic modified Boussinesq elastic theory, assuming uniform loading/unloading applied to a semi-infinite elastic half-space, using the above parameters for stratified homogeneity and with the introduction of an assumed rigid boundary at approximately 50m depth.

6.3 Short Term Vertical Movements

There are two components of short term movement that will interact to affect the neighbouring structures.

These components are firstly progressive sagging movements of the underpinned walls due to imperfections in the underpinning process itself and then secondly elastic heave of the ground as a direct response to the unloading caused by excavation of the new basement.

The basement excavation will extend to approximately 3.5m beneath the front part of the proposed building, increasing up to approximately 7m where the basement deepens beneath the rear part of the proposed building.

The excavation will also decrease to approximately 1m beneath the existing lower ground floor beneath the southern part of the main building.

The potential effect of the excavation may be considered by a net unloading of up to -140kN/m2 due to soil removal.

6.3.1 Short Term Movement due to Underpinning

It is not possible to rigorously model the extent of party wall settlement arising from underpinning and experience indicates that amount of any movements are very much dependent on workmanship.

However, it is suggested that given dry conditions and good workmanship, the amount of vertical movement of the existing perimeter walls can reasonably be expected to be a maximum of 5mm per stage of underpinning.

The depth of underpinning the existing Victorian façade will be around 3.5m; although this will increase to around 6m where the façade adjoins the deeper part of the proposed basement. Two stages of underpinning will therefore be utilised.

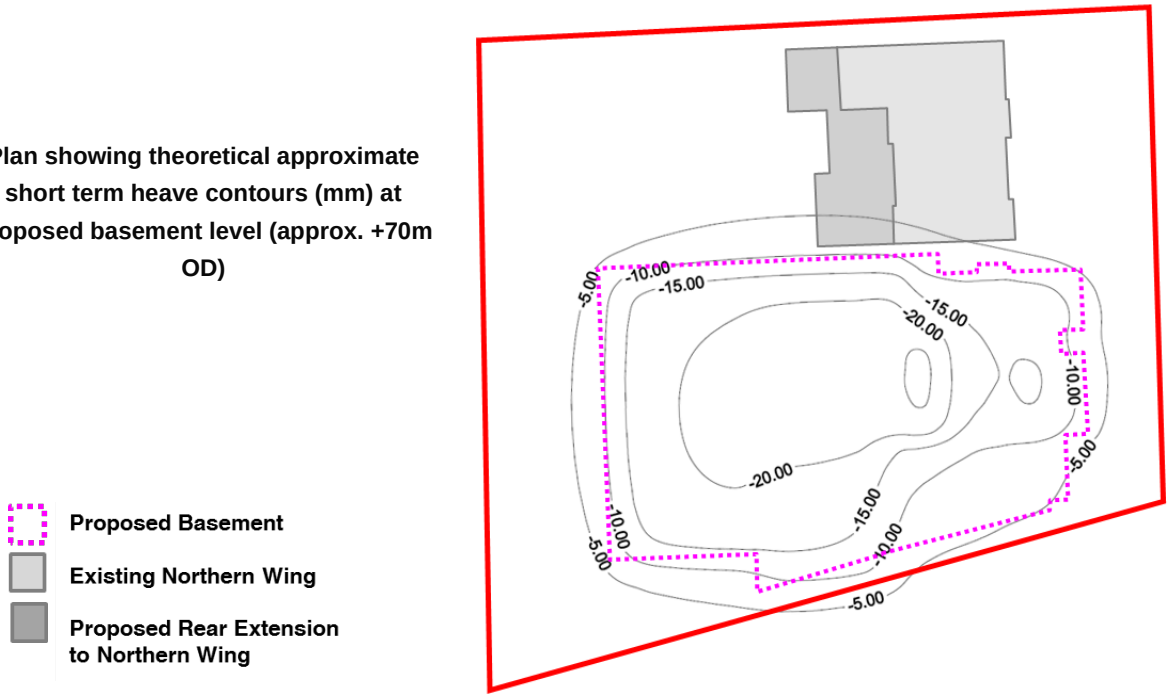
As a result, up to approximately 10mm of settlement can be expected at the underpinned perimeter walls.

On the simplistic assumption of a 45° of support to the perimeter wall extending away in a direction perpendicular to wall, the scale of this vertical movement associated with the underpinning process itself is assumed to extend to a distance of 6m behind the wall.

6.3.2 Short Term Movements due to Excavation Heave

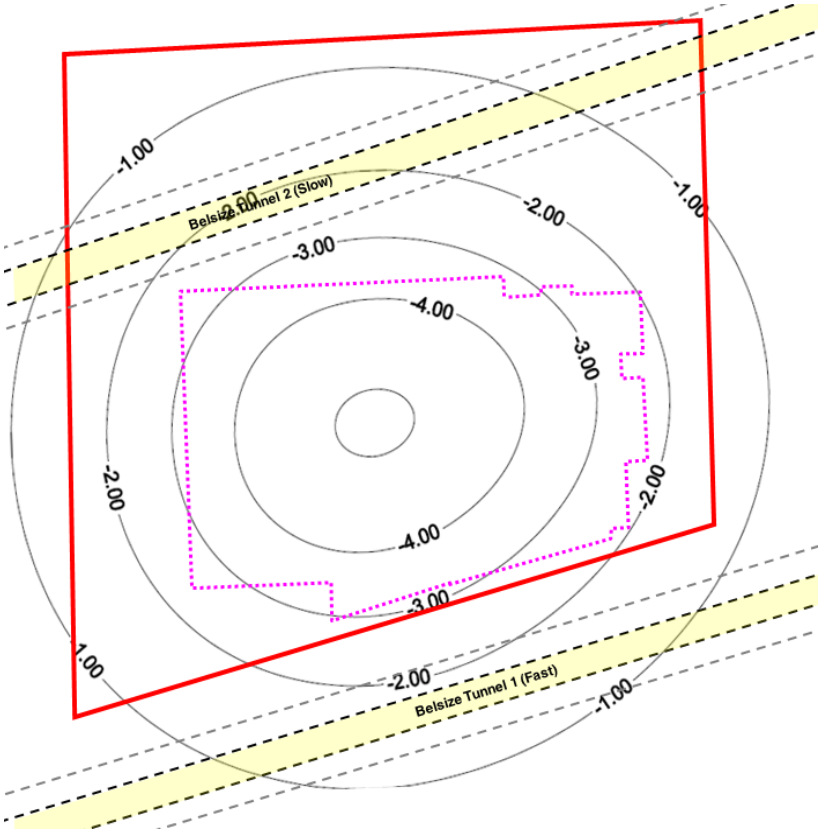
Approximately 25mm of short term heave is predicted to occur at the centre of the basement excavation, reducing to less than 10mm beneath the perimeter wall to the northern wing.

Plan showing theoretical approximate short term heave contours (mm) at proposed basement level (approx. +70m OD)



The potential effect of the basement excavation may also result in approximately 3mm of short term heave at the crown level of both Network Rail Belsize Tunnels.

Plan showing theoretical approximate short term heave contours (mm) at crown level of both Belsize Tunnels (approx. +53.5m OD)



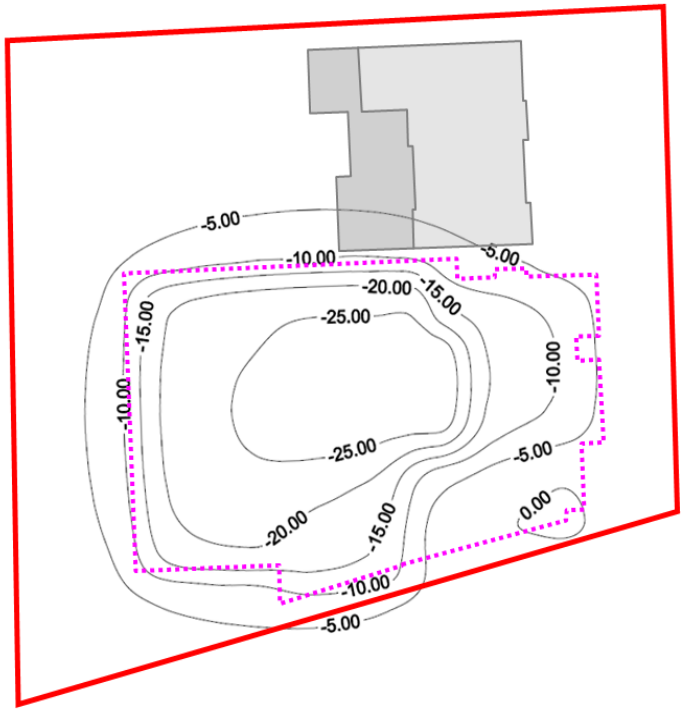
6.4 Post Construction Vertical Movements

There will be a mismatch between the weight of soil that is removed and the weight of the new structure. In this situation, a component of long term heave that could proceed for decades is inevitable.

However, the new structural loading will work to counteract some of the heave movement; hence an initial estimate of the new structural loading has been undertaken. The potential effect of the proposed construction has been considered by applying a uniformly distributed structural load of approximately 35kN/m^2 on the proposed basement raft slab.

The analysis, as presented on the plan shown below, suggest that the scale of this additional long term heave will potentially amount to approximately 30mm beneath the centre of the proposed basement, reducing to approximately 10mm beneath the perimeter wall to the northern wing.

Plan showing theoretical approximate long term heave contours (mm) at proposed basement level (approx. +70m OD)



The analysis also suggests that the potential cumulative effect of the basement excavation and subsequent new construction will result in negligible heave movement at the crown level of both Network Rail Belsize Tunnels.

6.5 Horizontal Movements

Horizontal soil movements are expected to occur due to yielding of the soil behind the underpinned wall during the basement excavation. For embedded retaining walls, this yielding has been found to extend to a distance approximately equivalent to 4 times the depth of excavation in front of the wall.

As a first approximation, the magnitude of the horizontal movement at the underpinned perimeter wall is assumed to be 10mm, which is equal to the vertical movement at the wall.

This horizontal movement is assumed to reduce to zero at a maximum distance of 4 x 6m = 24m behind the wall.

6.6 Impact on Neighbouring Structures

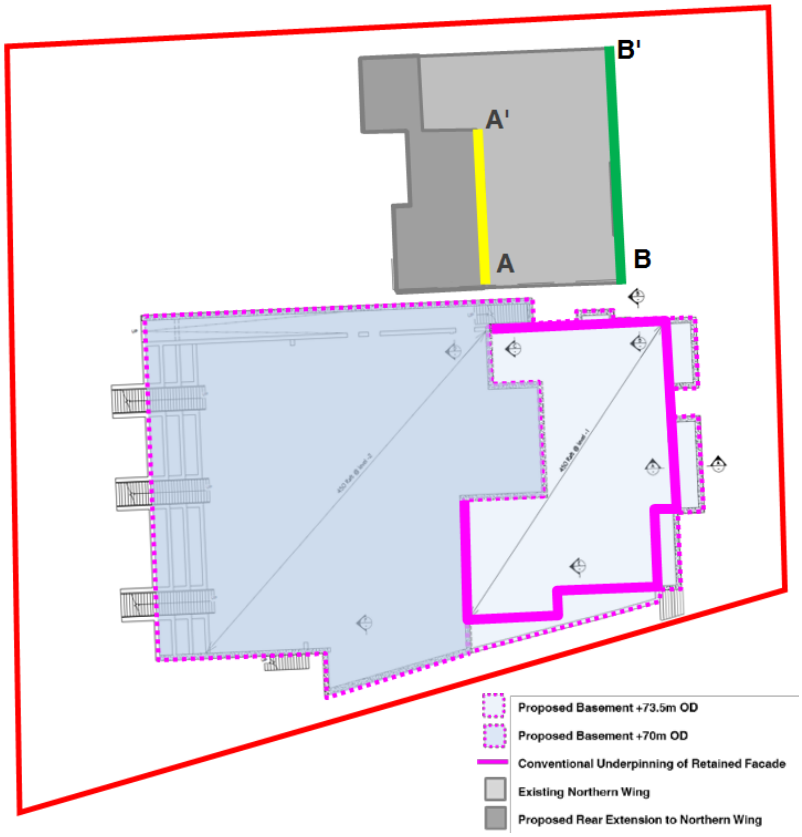
6.6.1 Impact on the Northern Wing Extension to No. 39 Fitzjohn's Avenue

In practice, although the various movements described above will interact so that the soil basement heave effects will tend to counteract the underpinning wall settlement movements, it is considered prudent to consider the worst case situation. Therefore, an analysis of potential damage to the neighbouring structure is based upon movement predictions that ignore basement soil heave.

The effect of these predicted vertical and horizontal deflections have been assessed using the Burland damage category assessment process, which is based upon consideration of a theoretical masonry panel of a given length (L) and height (H).

The potential degree of the predicted ground movements on the assessed structures can be estimated by the correlation of maximum horizontal strain, h, with the maximum deflection ratio, Δ/L, where Δ is the vertical distortion over the wall length under assessment (where the wall length L is actually less than the distance to the point at which zero vertical movement is assumed, a minimum distortion of 1mm is assumed).

The potential degree of damage due to the proposed basement construction has been assessed using two sections and a summary for each section is presented below.



Plan showing line of sections used for damage category

Rear Existing Wall Section (Section A - A')

The length of section (L) is taken as 13.5m and the wall height (H) as 10m.

The maximum horizontal strain, εh (Δh / L) is assessed as 0.04%, producing a maximum deflection ratio Δ / L = -0.03, within a limiting tensile strain of 0.07%, for a Burland Category 1 "Very Slight" condition.

Front Existing Wall Section (Section B - B')

The length of section (L) is taken as 19m and the wall height (H) as 10m.

The maximum horizontal strain, εh (Δh / L) is assessed as 0.04%, producing a maximum deflection ratio Δ / L = -0.025, within a limiting tensile strain of 0.075%, for a Burland Category 1 "Very Slight" condition.

6.6.2 Impact on the Network Rail Belsize Tunnels

The analysis suggest that the propose basement development will lead to approximately 2mm heave in the short term at the level of the crown for both Belsize Tunnels, with negligible long term movement expected to follow.

Furthermore, under the assumption that the inverts of the tunnels do not move at all, thereby creating the largest possible differential movement, it is envisaged that the proposed basement development will cause significantly less than 1% diametrical distortion of the tunnels.

Nevertheless, a detailed Asset Impact Assessment for Network Rail will be required in due course.

6.6.3 Public Highway

The pavement to Nutley Terrace lies approximately 1m from the southern boundary of the proposed basement, where there is expected to be excavation of around 4m.

Given reasonable standards of workmanship during the underpinning works, negligible movement (<5mm settlement) is anticipated and this may be counteracted in practice by some small amounts of heave.

7. Assessment of Potential Impacts

7.1 Potential Hydrogeological Impacts

No groundwater table is present at the site; hence the development is not expected to have any impact upon groundwater flow and there is additionally expected to be no cumulative impact.

7.2 Potential Hydrological Impacts

An outline SuDS Strategy is presented as a separate report (LBH4498suds Ver. 1.0). This report supersedes the SuDS assessment produced in the appendix 7 of the revised RWA BIA.

7.3 Potential Stability Impacts

7.3.1 Public Highway

Negligible movement (<5mm settlement) is anticipated beneath the pavement and Nutley Terrace.

7.3.2 London Clay

The London Clay soils beneath the site are suggested to be of high volume change potential.

However, the depth of the proposed construction will obviate concerns regarding potential seasonal shrink/swell movements.

7.3.3 Ground Movements

The Local Plan states that proposed basements should pose a risk of damage to neighbouring properties no higher than Burland scale Category 1 'Very Slight', and mitigation measures should be incorporated if the assessed damage is not acceptable.

The predicted building damage levels due to ground movements associated with the proposed development have been analysed and found to be acceptable; hence no specific mitigation measures are warranted.

Nevertheless, structural monitoring is proposed to ensure the movements remain within acceptable limits. An outline structural monitoring plan is presented in section 8.

7.3.4 Tunnels

A detailed assessment of any potential impact upon the Network Rail assets is being addressed separately and directly with Network Rail.

7.4 Residual Impacts

It is concluded that the proposed basement will have no residual unacceptable impacts upon the surrounding structures, infrastructure and environment. No cumulative impacts are envisaged.

8. Outline Structural Monitoring Plan

The ground movement assessment suggests Burland Scale Category 1 (very slight) damage may be expected to the northern wing extension. Nevertheless, structural monitoring should be undertaken to ensure the movements remain within acceptable limits and to enable mitigation to be effectively implemented in the event of agreed trigger values for movement being exceeded.

Monitoring positions should be located along the front and near-side elevations of the northern wing extension, as well along the retained façade.

Before any excavation or construction works commence, monitoring is to be undertaken in order to establish a baseline situation.

During all underpinning works and basement excavation works, monitoring should be undertaken daily at the start and end of every work shift. At other times monitoring should be undertaken weekly to cover a period prior to commencement of any works and ceasing after completion of the works, by agreement of all interested parties.

Precise survey equipment should be used to record all vertical and horizontal components of movement (in three perpendicular directions) to a minimum accuracy of 1mm.

8.1 Criteria for assessment of Monitoring data and Comparison with Predicted Movements

The cumulative movements in any direction of any monitoring point are to be compared with the predicted movements at any stage and using the following decision table:

MONITORING CRITERIA		
Total movement less than 5mm in any direction		Green
Total movement in excess of 5mm in any direction or additional movement of 5mm in any direction	Notify Structural Engineer and Party Wall Surveyor	Red

8.2 Contingent Actions

Contingency actions should be undertaken using the following decision table:

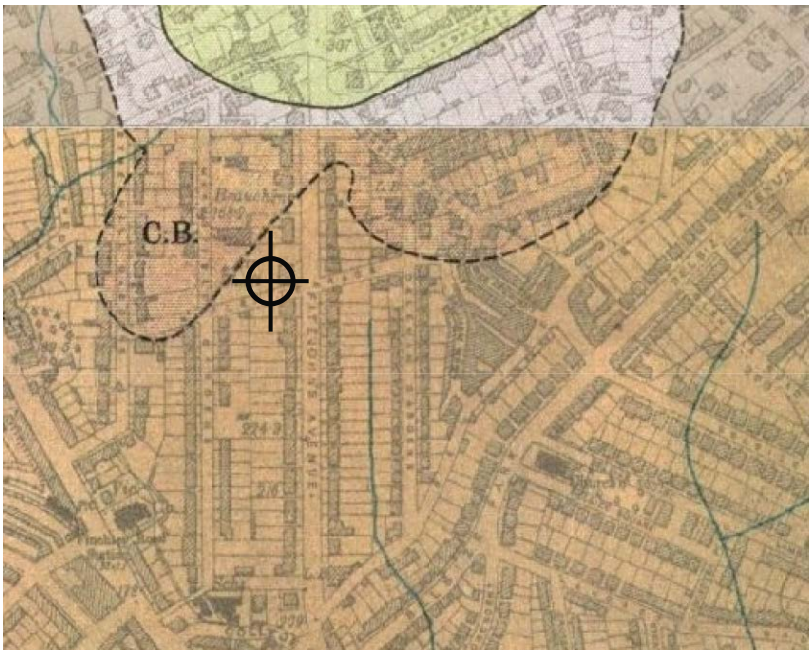
CONTINGENT ACTIONS	
Green	None
Red	Cease work and Notify Structural Engineer and Party Wall Surveyor immediately. Commence backfilling / installation of additional propping. Undertake repeated monitoring as necessary to ensure that movement has ceased. Works to commence only once a revised construction methodology has been agreed with the Structural Engineer

9. Audit Query Tracker

Audit Query No.	Audit Query	LBH Response	Status
1	Qualification of authors to be confirmed as required by Section 3.6 of CPG4.	Confirmed	**Addressed**
2	Answers to be provided for all screening questions set out in CPG Basements, and scoping revised accordingly.	Answers are now provided for all screening questions and scoping revised accordingly	**Addressed**
3	Retaining wall design parameters should be provided based on site specific geotechnical data. Retaining wall calculations should be provided to justify the feasibility of the proposed scheme.	See Appendix 6 of Revised BIA	**Addressed**
4	A formal ground movement assessment is required noting impacts to and protection of all neighbouring properties and infrastructure. Mitigation measures to be addressed to limit Damage to Category 1 on the Burland Scale. Impact and protection of infrastructure assets should be agreed with the asset owners.	A ground movement assessment has now been provided	**Addressed**
5	Once the geotechnical and structural design elements have been confirmed and the GMA updated, the monitoring strategy should be considered further. An outline monitoring plan should be provided to demonstrate that works will be controlled to protect surrounding structures / assets.	An outline monitoring plan has now been provided	**Addressed**
6	Evidence should be provided that Network Rail and other asset owners have been consulted and asset protection agreements entered into, as applicable.	An initial assessment of any potential impact upon the Belsize Tunnels is included in the GMA. Contact has been made with Network Rail and a more detailed assessment will be undertaken separately	**Addressed**
7	A SUDS assessment should be provided due the significant increase in hardstanding, which should be produced in accordance with The London Plan along with Camden planning policy.	An outline SuDS Strategy is now provided	**Addressed**
8	Further details of construction details including confirmation of underpinning depths and sequencing to be provided. Drawings should be clarified to confirm where the existing structure is to be underpinned and where the new retaining walls are to be constructed. Further detail to be provided for temporary propping proposals and construction methodology/sequencing.	Details of the temporary works proposals are described in section 5 of this document and drawings are included in Appendices 2 and 3 of the updated RWA document	**Addressed**
9	Non-technical summaries should be included in any updated BIA submissions.	A non-technical summary is now provided	**Addressed**
10	Site investigation document 'JAL BIA report J1135J1199' to be provided.	The site investigation report has now been provided	**Addressed**

10. Map Extracts

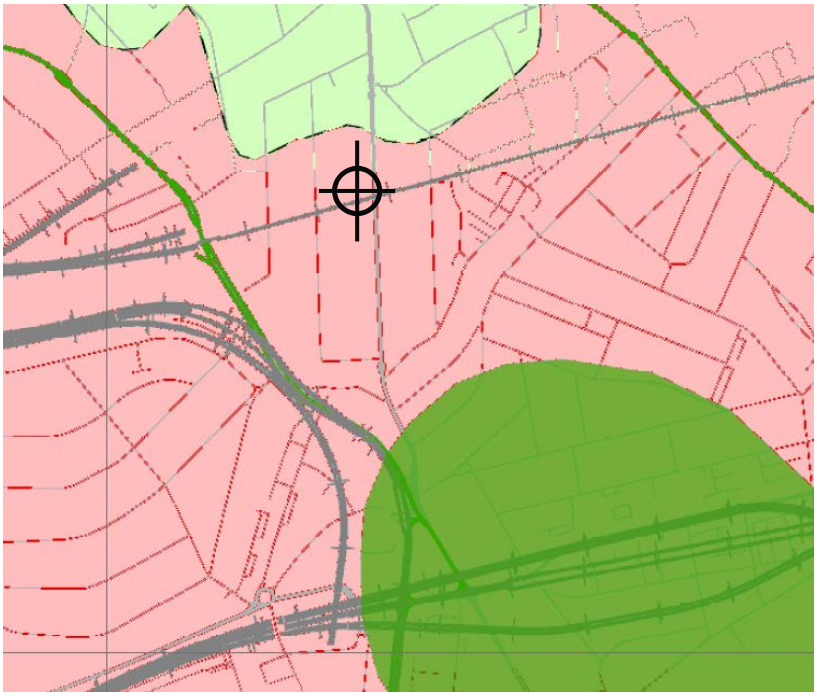
The relevant map extracts from the Camden Geological, Hydrogeological and Hydrological Study are presented below.



Camden 1920 Geological Map (Figure 2, CGHHS 2010)

London Clay is shown to underlie the site.

A tributary of the River Tyburn is shown 75m to the east of the site.



Camden Aquifer Designation Map (Figure 8, CGHHS 2010)

Site is located above Unproductive Strata

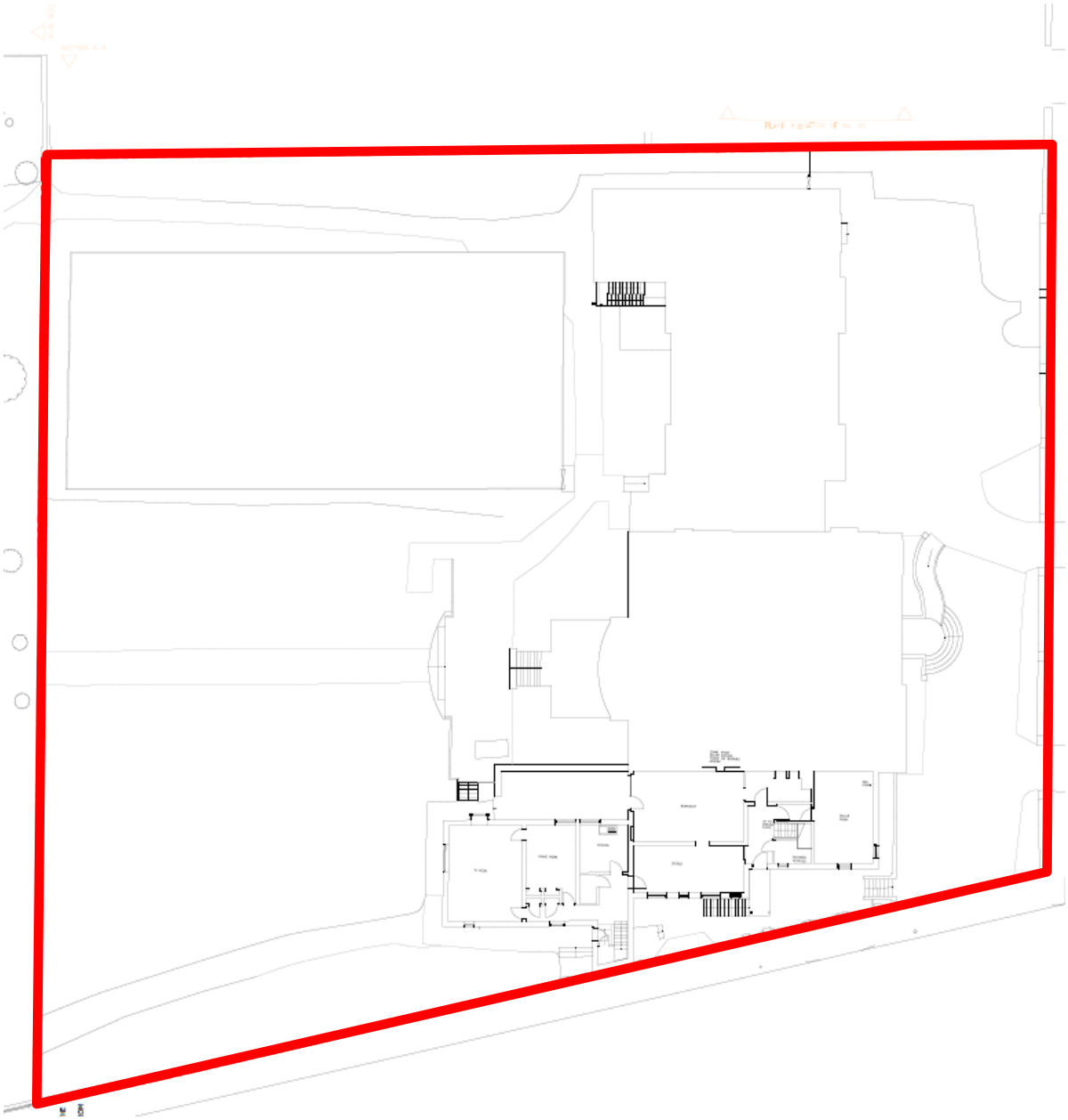
Camden Flood Map (Figure 15, CGHHS 2010)

No historical flooding recorded

Slope Angle Map (Figure 16, CGHHS 2010)

The site and surrounding area lie on a slope of less than 7°

11. Existing Lower Ground Floor Plan



Existing Lower Ground Floor Plan (Bchitecture, Dwg. No. 101/B, 16 Aug 2017)