WE ARE SYMMETRYS

BASEMENT IMPACT ASSESSMENT

70 LADY MARGARET ROAD
LONDON
NW5 2NP
22276-SYM-XX-XX-RPT-S-0001

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REVISION HISTORY

Revision	Date	Purpose/Status	File Ref	Author	Check	Review
A	07/03/23	For comments	22276	KL	EB	JE
B	15/05/23	Submission	22276	KL	EB	AH
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E	21/09/23	CR Comments	22276	KL	EB	AH
F	13/10/23	CR Comments	22276	KL	EB	AH

APPENDICES

1.0 Executive Summary

The proposed development involves the demolition of the existing three storey rear extension structure and the construction of a three-storey rear extension. A new basement excavated 1-level underground.

1.1 Ground Investigation

A desk study and site investigation has been undertaken by GEA, the full details of which can be found in their report contained as part of this planning application. As a summary of the site investigation findings, the ground was found to be made ground to 0.8m underlaid by London clay proven to a depth of 9.5m

1.2 Engineering Desk Work

Symmetrys Limited has been instructed to undertake this BIA report.

The proposal is to form a new one-storey basement beneath the rear new replacement extension of the structure.

1.3 Ground Movements

A ground movement assessment has been undertaken and this concludes that the proposed basement construction will result in limited movement of the surrounding structures and predicts a damage category in accordance with the Burland scale of Category 0 (Negligible).

1.4 Flooding

The site lies within a flood risk Zone 1, an area with a low probability of flooding. In terms of surface water flood, the site lies within a very low risk zone.

1.5 Drainage and Surface Water

The site is underlain by clay soil and is unlikely to be suitable for a soakaway or similar SUDS based system the existing drainage will be retained and the connection to the sewer will be re-used. Site drainage will therefore be designed to generally maintain the existing situation.

Green roofs to the replacement extension (footprint of basement) and lined permeable paving for the external areas will provide attenuation and therefore a reduction of the existing runoff rates.

1.6 Existing Trees

Existing trees on site will be removed as determined as an outcome of the Tree Survey undertaken by Crown Surveys, submitted as part of this planning application.

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2.0 Introduction

Symmetrys Limited has been engaged by the applicant to carry out a basement impact assessment for the proposed development at 70 Lady Margaret Road. The proposed development consists of ground plus two storeys extension attached to the existing retaining structure and single storey basement underneath the proposed extension. The superstructure design of the building is not discussed at length in this report. Refer to the structural survey produced as part of this application for information on the impact the proposals have on the existing building.

To prepare this Basement Impact Assessment, the following baseline data have been referenced to complete the BIA in relation to the proposed development:

- Current/historical mapping;
- Geological mapping;
- Hydrogeological data;
- Current/historical hydrological data;
- LB Camden, Strategic Flood Risk Assessment (produced by URS, 2014);
- LB Camden, Floods in Camden, Report of the Floods Scrutiny Panel (2013);
- LB Camden, Planning Guidance (CPG) – Basements (March 2018);
- LB Camden, Camden Geological, Hydrogeological and Hydrological Study – Guidance for Subterranean Development (produced by Arup, 2010);
- LB Camden, Local Plan Policy A5 Basements (2017);
- LB Camden's Audit Process Terms of Reference;
- The History of Lost Rivers in Camden (March 2010);
- Association of Specialist Underpinning Contractors (ASUC), Guidelines of safe and efficient basement construction directly under or near to existing structures. (October, 2013).

Figure 1- Site view showing the site highlighted (Novak Hiles Architects Planning Material)

Our drawing and this report together with a structural survey will be included as part of the client's planning application.

Our documents are not intended for and should not be relied upon by, any third party for any other purpose.

Existing site surveys have been provided by GEA and proposed site layout plans of the site have been supplied to Symmetrys by Novak Hiles Architects following a measured building survey by Geotop Surveys.

3.0 Existing Condition

The site is bound by Lady Margaret Road to the North-West, attached to 68C Lady Margaret Road structure to the South-West and close distance to 70A Lady Margaret Road structure. The surrounding uses comprise commercial and residential. The site is currently occupied by a four-storey building with single storey small cellar at the North-West end of the site and three-storey rear extension attached to the existing structure. Although there is an existing cellar under the front of the main building, there is no basement under the existing three storey rear extension. According to the Building Survey by RICS, the building is of traditional construction with multi-pitched tiled roof and upper flat roof over solid brick.

Figure 2 - Street view from Lady Margaret Road looking south-West with building highlighted.

4.0 Ground Investigation and Hydrogeology

4.1 Ground Conditions Geology

4.1.1 British Geology Survey online data was consulted to determine the site geology. The records show multiple boreholes records are available around the site.

A site-specific ground investigation and interpretative report has been undertaken by GEA. The logs indicate the site geology to be made ground to a depth of 0.8m overlying the London clay formation to depth.

4.2 Ground Investigation

A site-specific ground investigation and interpretative report has been undertaken by GEA and their findings and recommendations are described in their report included within this planning application.

4.2.1 The site investigation comprised one 10m deep borehole (BH1) and three trial pit (Trial Pit 1, Trial Pit 2 and Trial Pit 3). The ground conditions are summarised in Table 1.

Table 1: Ground conditions

Borehole	Depth	Description
BH1	GL-0.1m	Decorative gravel
	0.1m-0.8m	Made Ground
	0.8m-5.0m	Firm / Stiff brown Slightly Sandy **Clay**
	5.0m-9.5m	Stiff becoming Very Brown **Clay**
Trial Pit 1	GL-0.1m	Decorative gravel
	0.1m-1.0m	Made Ground
	1.0m-1.45m	Firm orange brown slightly sandy CLAY
Trial Pit 2	GL-0.06m	Paving slab
	0.06m-0.1m	Made Ground (orange brown coarse sand)
	0.1m-0.6m	Made Ground (dark brown sandy gravelly clay)
	0.6m-0.96m	Firm orange brown silty CLAY
Trial Pit 3	GL-0.06m	Paving slab
	0.06m-0.1m	Made Ground (orange brown coarse sand)
	0.1m-0.6m	Made Ground (dark brown sandy gravelly clay)
	0.6m-0.78m	Soft orange brown silty CLAY

See Appendix C for the full site investigation information.

4.2.2 Based on the geotechnical testing results, the proposed basement can be founded on the London Clay with a reported safe bearing pressure of 150kN/m^2.

4.2.3 Hydrogeology

The London Clay Formation has been designated as Unproductive – rock layers that have negligible significance for water supply or river base flow. The site is not located within a groundwater source protection zone and there are no groundwater abstraction zones located within 1 km of the site.

4.2.4 Ground water

Groundwater was not encountered in the borehole. Groundwater seepages were present at the base of Trial Pit No. 2 and at a depth of 0.5m in Trial Pit No.3. Localised Perched water would be expected in London Clay.

1 subsequent monitoring visit. monitoring has been undertaken by GEA and dry ground has been found on BH1.

4.2.5 Dewatering Strategy

As the London Clay cannot support a continuous water table. Refer to GEA report 3.1.2 q.10b. A Dewatering method statement may be required during construction to deal with localised perched water, see below some commonly used methods.

4.2.6 Local Dewatering – simple sump method

All underpinning excavations shall be kept clear of water by submersible pump. Should large quantities of water be encountered, this will be pumped into the existing drainage system using a larger sump pump via a sediment settling tank. Long period of pumping will be avoided and regular inspections of the work area to ensure de-watering is carried out only when necessary.

4.2.7 Jetted Sumps

This method achieves the same objective as the simple sump methods of dewatering but will minimise the soil movement associates with this and other open sump methods. A borehole is formed in the subsoil by jetting a metal tube into the ground by means of pressurised water, to depth within the maximum suction lift of the extract pump. The metal tube is withdrawn to leave a void for placing a disposable well point and plastic suction pipe. The area surrounding the pipe is filled with coarse sand to function as filtering media.

4.2.8 Other dewatering

Strategies such as grouting and ground freezing may be suitable for a project of this size. However, this is to the discretion of the main contractor.

4.3 Hydrology

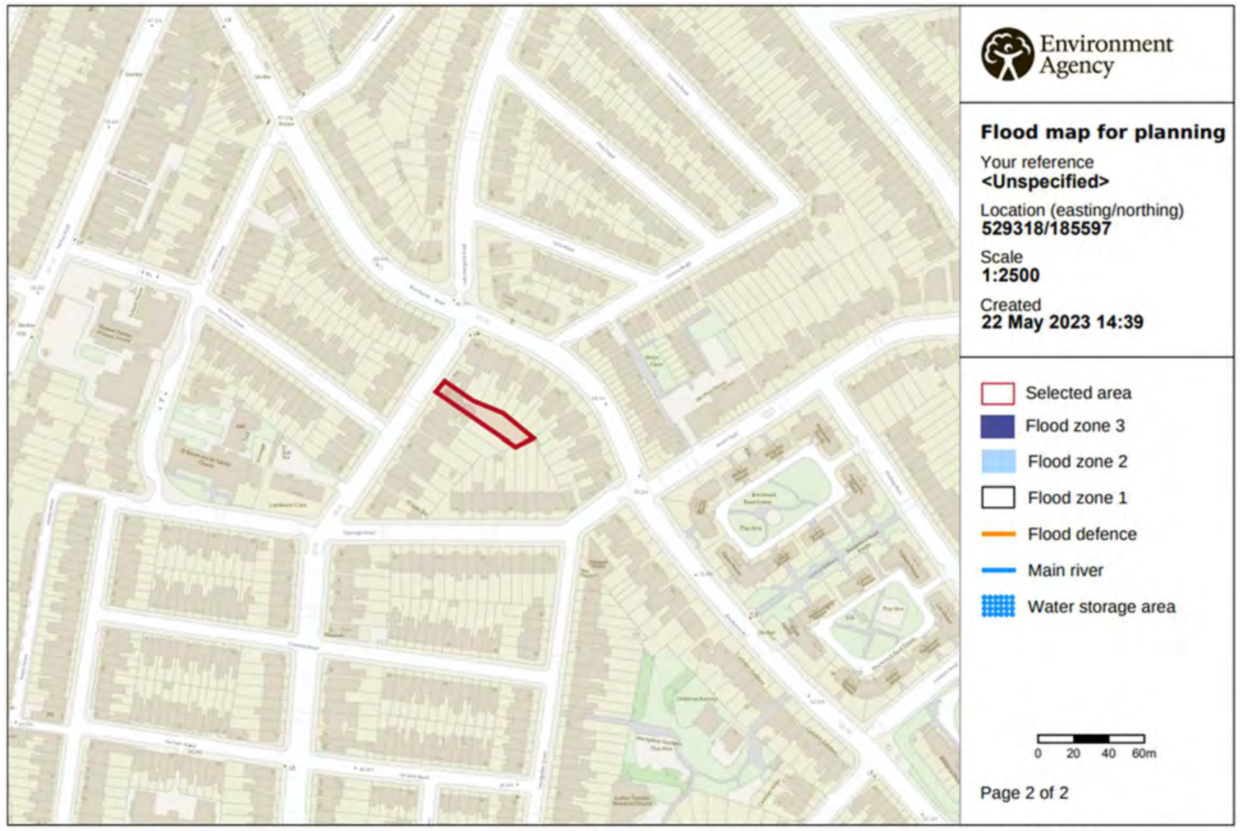
The site is not located within a groundwater Source Protection Zone (SPZ) and there are no groundwater abstraction zones located within 1km of the site.

5.0 Flood Risk and Sustainable Drainage Systems (SuDS)

The flood desk study undertaken for planning from GOV.UK has identified the site falls within flood risk Zone 1. It also indicates a very low risk from Surface Water Flooding.

According to the London Borough of Camden (2003) Floods in Camden, *Report of the Floods Scrutiny Panel*, Lady Margaret Road was identified as a location affected by surface water flooding during the 2002 flooding event. However, the report clarifies that the Road remained free from surface water flooding at the site during the 1975 event.

Figure 3 – Flood Map for Planning from EA



Surface Flow and Flooding Screening Assessment included on GEA Report determines the flood risk from all sources is low.

The proposed development will reduce flood risk on site and elsewhere even further by reducing impermeable areas by 45%. Green roofs and lined permeable paving are proposed.

5.1 SuDS

The introduction of Sustainable Drainage Systems (SuDS) will also contribute to mitigate the risk of flood risk by reducing the impact of large rainfall events. By lowering runoff rates, SuDS help to decrease of risk of surface water and sewer flooding.

Permeable paving with lined 150mm type 3 sub-base will provide up to 3.15m3 of attenuation. A flow control chamber will limit runoff rates to 1.4 l/s for all storm events up to the 1 in 100 +40%, providing a 56% reduction of existing rates.

Interception, the capacity of the system to not to contribute to runoff for rainfall depths up to 5mm, will also be improved by the inclusion of the permeable paving and the green roof.

SuDS Strategy Layout and Calculations can been in Appendix D.

6.0 Proposed Structure

6.1 Basement Construction

The proposed basement will consist of one level and will be formed using a retaining wall formed in an underpin sequence at the perimeter. The retaining wall will have a 300mm thickness with a ground bearing reinforced concrete slab with heave protection.

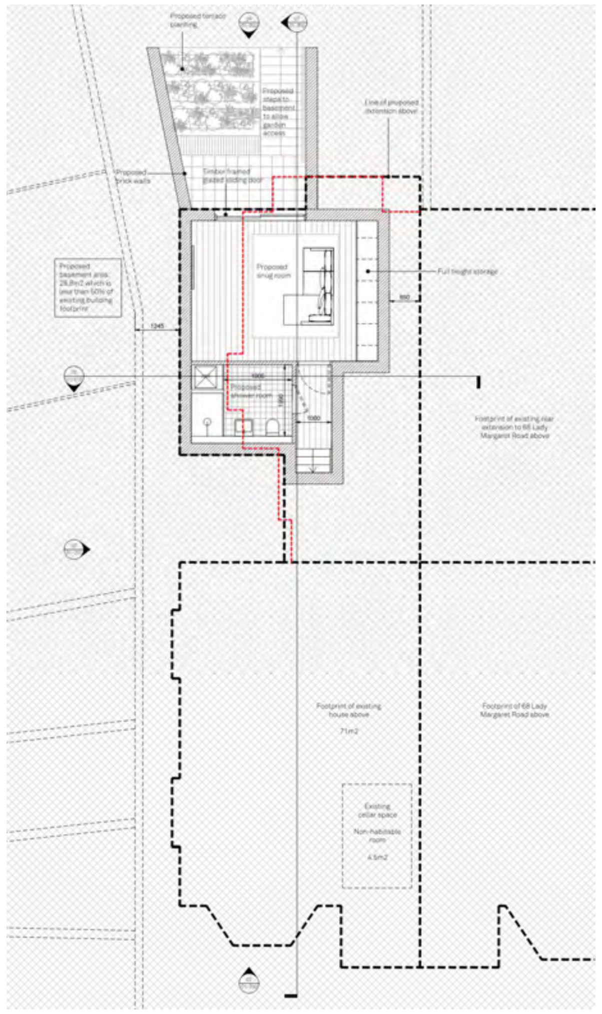


Figure 4 – Proposed basement

The basement construction will be propped in the temporary case and in the permanent case a reinforced concrete ground floor slab will prop the basement wall via retaining wall. The bottom of new basement will be around 3.0m underground.

6.2 Foundations

It is recommended that moderate width spread foundations, bearing beneath the proposed basement at a depth of 3.0m within firm clay of the London Clay may be designed to apply a net allowable bearing pressure of about 150 kN/m^2. Spread foundations will need to bypass the made ground.

The proposed ground bearing slab with heave protection will be founded at a depth of -3.0m below ground level.

The above value incorporates an adequate factor of safety against bearing capacity failure and should ensure that settlements remain within normal tolerable limits.

7.0 Stability of Neighbouring Properties

7.1 Existing Neighbouring Structures

There are a number of properties in close proximity to the site, described in the table below.

Address	Location relative to proposed building	Description
68 Lady Margaret Road	NE	Formed of three-storeys and also probably includes a single level part-basement similar to the subject site. Sharing a wall with the 70 Lady Margaret Road.
70A Lady Margaret Road	SW	Small, single storey building, constructed on a level considerably lower than No 70 Lady Margaret Road. Staying in a very close distance with 70 Lady Margaret Road.

The properties on Brecknock Road and Ospringe Road are in a considerable distance from the basement extension and won't be affected by the excavation.

7.2 Ground Movement Assessment

The ground movement assessment can be found in Appendix C and concludes that the proposed basement construction will result in limited movement of the surrounding structures. The predicted damage category in accordance with the Burland scale is Category 0 (Negligible). The summary of the different damage categories is provided below:

Category	Description
0 (Negligible)	Hairline cracks of less than about 0.1mm are classed as negligible.
1 (Very slight)	Fine cracks that can easily be treated during normal decoration (crack width <1mm).
2 (Slight)	Cracks easily filled; redecoration probably required. Some repointing may be required externally (crack width <5mm).
3 (Moderate)	The cracks require some opening up and can be patched by a mason. Repointing of external brickwork and possibly a small amount of brickwork to be replaced (crack width 5 to 15mm or a number of cracks >3mm).
4 (Severe)	Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows (crack width 15 to 25mm but also depends on number of cracks).
5 (Very Severe)	This requires a major repair involving partial or complete re-building (crack width usually >25mm but depends on number of cracks).

8.0 Screening

8.1 Subterranean groundwater flow

8.1.1 A screening process has been undertaken and the findings are described below.

Question	Response	Details
1a. Is the site located directly above an aquifer?	No	According to London MagicMap, the site is not lying on any aquifer.
1b. Will the proposed basement extend beneath the water table surface?	No	Groundwater seepages were present at the base of trial Pit 2 and 0.5m below ground in Trial Pit 3. The seepages are thought to be due to the water building up against the foundations of the existing building. It is believed that the London Clay and clay dominated Head Deposits cannot support groundwater flow and cannot therefore support a water table consistent with a permeable water bearing strata.
2. Is the site within 100m of a watercourse, well (used / disused) or potential spring line?	No	There are no surface water features within 450m of the site and the site does not lie in close proximity to any of the lost rivers of London.
3. Is the site within the catchment of the pond chains on Hampstead Heath?	No	According to Camden Geological, Hydrogeological and Hydrological Study by ARUP, the site is not located on any Chain Catchment,
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	Yes	The proposed basement extension includes an increase of the roof and hardstanding areas of 20.3m2 However, the provision of green roof and lined permeable paving will reduce the total impermeable area by 45%, contributing also to the mitigation of flood risk on site and elsewhere. *SuDs and green roof have been proposed in response to the decrease of impermeable surfaces.*
5. As part of site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or SUDS)?	No	Given that the site is underlain by clay soils and is unlikely to be suitable for a soakaway or any infiltration techniques, the existing drainage will be retained and the connection to the sewer will be re-used. Green roofs to the replacement extension (footprint of basement) and lined permeable paving for the external areas will provide attenuation and therefore a reduction of the existing runoff rates. Water butts are also proposed to re-use rainwater and reduce water use.
6. Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to, or lower than, the mean water level in any local pond (not just the pond chains on Hampstead Heath) or spring line?	No	The site is located approximately 900m from the catchment of the pond chains on Hampstead Heath. No live spring line have been recorded on the site.

8.2 Slope Stability

Question	Response	Details
1. Does the existing site include slopes, natural or man-made greater than 7 degrees (approximately 1 in 8)?	No	The site gradually slopes falling to the North West. The front and rear access to the basement will be via stairs, with structure consisting of RC retaining walls.
2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7 degrees (approximately 1 in 8)?	No	There are no proposed changes in slope. The front and rear access to the basement will be via stairs, with structure consisting of RC retaining walls.
3. Does the development neighbour land, including railway cuttings and the like, have a slope greater than 7 degrees (approximately 1 in 8)?	No	The adjoining properties gradually slope falling to the North West, similarly to the 70 Lady Margaret Road site land.
4. Is the site within a wider hillside setting in which the general slope is greater than 7 degrees (approximately 1 in 8)?	No	The site gradually slopes falling to the North West
5. Is the London Clay the shallowest strata at the site?	Yes	Site Investigation Reports indicate that below the moderate thickness of made ground, the London Clay Formation was proved to the maximum depth investigated of 9.5m.
6. Will any trees be felled as part of the development and/or are any works proposed within any tree protection zones where trees are to be retained?	Yes	*Trees will be felled during the development.* The tree will be removed regardless of the proposed work due to previous subsidence issues, replacement planting is proposed a distance from the proposed extension. Refer to Tree Survey submitted as part of this planning application. *According to NHBC standards section 4.2.13, the foundation of the proposed structure must be min 2.5m BGL, and the proposed foundations are under 3m BGL. No damage is expected to the neighbour properties according to GEA analysis.*
7. Is there a history of seasonal shrink-swell subsidence in the local area and/or evidence of such effects at the site?	Yes	The area is prone to these effects as a result of the presence of shrinkable London Clay.
8. Is the site within 100m of a watercourse or a potential spring line?	No	There are not surface water features or Lost Rivers of London located within 100m of the site.
9. Is the site within an area of previously worked ground?	Yes	The geological map of the area and Figures 3,4 and 8 of LB Camden, Camden Geological, Hydrogeological and Hydrological Study – Guidance for Subterranean Development produced by Arup, 2010, do indicate the site to be underlain by worked ground.
10a. Is the site within an aquifer.	No	According to London MagicMap, the site is not lying on any aquifer.
10b If so, will the proposed basement extend beneath the water table such that dewatering may be required during construction?	/	Not applicable
11. Is the site within 50m of the Hampstead Heath Ponds?	No	According to Camden Geological, Hydrogeological and Hydrological Study by ARUP, the site is not located on any Chain Catchment.
12. Is the site within 5m of a highway or pedestrian right of way?	Yes	While the site faces Lady Margaret Road, the proposed basement development is located at the rear of the building and does not extend within 5m from the roadway.
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Yes	The maximum dig will be approximately 2.9m, adjacent to the boundary of 68 Lady Margaret Road. The foundation of the adjacent structure in 68 Lady Margaret Road will be underpinned.
14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	No	The site is not located on any railway or tube line.

8.3 Surface Water and Flooding

Question	Response	Details
1. Is the site within the catchment of the pond chains on Hampstead Heath?	No	According to Camden Geological, Hydrogeological and Hydrological Study by ARUP, the site is not located on any Chain Catchment.
2. As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route?	No	Any additional surface water from the marginal increase in hardstanding area will be attenuated and discharged into the sewers to ensure the surface water flow regime will be unchanged. The basement will mainly be beneath the footprint of the building and existing hardstanding areas, and the 1m distance between the roof of the basement and ground surface as recommended by section 3.2 of the CPG Basements 2021 does not apply across these areas. *SuDs and green roof have been proposed in response to the decrease of impermeable surfaces.*
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?	Yes	The proposed basement extension includes an increase of the roof and hardstanding areas of 20.3m2 However, the provision of green roof and lined permeable paving will reduce the total impermeable area by 45%, contributing also to the mitigation of flood risk on site and elsewhere.
4. Will the proposed basement result in changes to the profile of the inflows (instantaneous and long-term) of surface water being received by adjacent properties or downstream watercourses?	No	Any additional surface water from the marginal increase in hardstanding area will be attenuated and discharged into the sewers to ensure the surface water flow regime will be unchanged. The basement will be beneath the footprint of the building, and the 1 m distance between the roof of the basement and ground surface as recommended by section 3,2 of the CPG Basements 2021 does not apply across these areas.
5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	No	There will be no changes in the quality of surface water received by neighbouring properties of downstream watercourses. The surface water drainage regime will be unchanged, and the land uses will remain the same.

6. Is the site in an area identified to have surface water flood risk according to either the Local Flood Risk Management Strategy or the Strategic Flood Risk Assessment or is it at risk from flooding, for example because the proposed basement is below the static water level of nearby surface water feature.	Yes	The Camden Flood Risk Management Strategy dated 2013, together with Figures 3v, 4e, 5a and 5b of the SFRA dated 2014, and Environment Agency online flood maps show that the site has a very low flooding risk from sewers, reservoirs (and other artificial sources), groundwater and fluvial/tidal watercourses. The site is identified as very low risk by GOV.UK

8.4 Non-Technical Summary of Screening Process

8.4.1 The screening process identifies the following issues to be carried forward to scoping for further assessment:

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

8.5 Is the London Clay the shallowest strata at the site?

- Will any trees be felled as part of the development and/or are any works proposed within any tree protection zones where trees are to be retained?
- Is there a history of seasonal shrink-swell subsidence in the local area and/or evidence of such effects at the site?
- Is the site within 5m of a highway or pedestrian right of way?
- Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?
- As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route?
- Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?
- Is the site in an area identified to have surface water flood risk according to either the Local Flood Risk Management Strategy or the Strategic Flood Risk Assessment or is it at risk from flooding, for example because the proposed basement is below the static water level of nearby surface water feature.

8.5.1 The other potential concerns considered within the screening process have been demonstrated to be not applicable or insignificant when applied to the proposed development.

9.0 Scoping

The following issues have been brought forward from the Screening process for further assessment:

9.1 Will the proposed basement development result in a change in the proportion of hard surfaced/paved areas?

The proposed basement extension includes the construction of a new rear extension at the back of the house, resulting in increase of the total impermeable area. However, this is to replace the existing extension therefore the change is limited, besides the London Clay under the site has a low permeability, which in result a low recharge in any case and consequently there would be little or no effect on ground water. The use of green roof in the proposed extension roof will provide a degree of water attenuation, additionally the increase of the permeable area with the replacement of the impermeable paving by permeable paving around of the extension.

9.2 Is the London Clay the shallowest strata at the site?

Site Investigation Reports indicate that below the moderate thickness of made ground, the London Clay Formation was proved to the maximum depth investigated of 9.5m.

9.3 Will any trees be felled as part of the development and/or are any works proposed within any tree protection zones where trees are to be retained?

Trees will be felled during the development. The tree will be removed regardless of the proposed work due to previous subsidence issues, replacement planting is proposed a distance from the proposed extension. Refer to Tree Survey submitted as part of this planning application.

According to NHBC standards section 4.2.13, the foundation of the proposed structure must be min 2.5m BGL, and the proposed foundations are under 3m BGL. No damage is expected to the neighbour properties according to GEA analysis.

9.4 Is there a history of seasonal shrink-swell subsidence in the local area and/or evidence of such effects at the site?

The area is prone to these effects as a result of the presence of shrinkable London Clay. There was subsidence in relation to the rear extension.

9.5 Is the site within an area of previously worked ground?

The geological map of the area and Figures 3,4 and 8 of LB Camden, Camden Geological, Hydrogeological and Hydrological Study – Guidance for Subterranean Development produced by Arup, 2010, do indicate the site to be underlain by worked ground.

9.6 Is the site within 5m of a highway or pedestrian right of way?

While the site faces Lady Margaret Road, the proposed basement development is located at the rear of the building and does not extend within 5m from the roadway.

9.7 Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?

The maximum dig will be approximately 2.9m, adjacent to 68C Lady Margaret Road. The foundation of the Adjacent will be underpinned.

9.8 Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?

The proposed basement extension includes an increase of the roof and hardstanding areas of 20.3m2 However, the provision of green roof and lined permeable paving will reduce the total impermeable area by 45%, contributing also to the mitigation of flood risk on site and elsewhere.

SuDs and green roof have been proposed in response to the decrease of impermeable surfaces.

9.9 Is the site in an area identified to have surface water flood risk according to either the Local Flood Risk Management Strategy or the Strategic Flood Risk Assessment or is it at risk from flooding, for example because the proposed basement is below the static water level of nearby surface water feature.

The Camden Flood Risk Management Strategy dated 2013, together with Figures 3v, 4e, 5a and 5b of the SFRA dated 2014, and Environment Agency online flood maps show that the site has a very low flooding risk from sewers, reservoirs (and other artificial sources), groundwater and fluvial/tidal watercourses. The site is identified as very low risk by GOV.UK

10.0 Ground Movement and Damage Impact Assessment

10.1 An analysis of the ground movement have been carried out in accordance with CIRIA publication C760 'Guidance by P-Disp and X-Disp computer programs. Following confirmation of the neighbouring property location in relation to the proposed development, the analysis shall be carried out taking into account the construction methodology presented in this report, the structural loads throughout the design and the site-specific ground and groundwater conditions. Refer to Appendix C for details.

10.2 The report has concluded that the Damage Impact to surrounding structures within the zone of influence will be within Category 0 in accordance with the Burland Scale. Refer to the GEA report for details.

Category	Description
0 (Negligible)	Hairline cracks of less than about 0.1mm are classed as negligible.
1 (Very slight)	Fine cracks that can easily be treated during normal decoration (crack width <1mm).
2 (Slight)	Cracks easily filled; redecoration probably required. Some repointing may be required externally (crack width <5mm).
3 (Moderate)	The cracks require some opening up and can be patched by a mason. Repointing of external brickwork and possibly a small amount of brickwork to be replaced (crack width 5 to 15mm or a number of cracks >3mm).
4 (Severe)	Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows (crack width 15 to 25mm but also depends on number of cracks).
5 (Very Severe)	This requires a major repair involving partial or complete re-building (crack width usually >25mm but depends on number of cracks).

11.0 Construction Method Statements and Sequence of Works

The below section provides an outline description of the demolition and basement works that will be developed by the contractor. This covers the works up to the point at which the ground floor slab has been cast. Once the ground floor slab has been constructed and has sufficiently cured the temporary propping to the liner walls can be removed leaving a rigid concrete basement box that will provide additional lateral support to the soil and foundation, which in turn provide lateral restraint to the surrounding ground and adjacent buildings.

- Demolish partially ground floor existing extension. Party wall to be retained and underpinned as well as main house structure.
- Build a temporary structure to support existing building.
- Underpinning the existing and adjacent building to give more foundation support.
- Excavating soil for foundation
- Build basement retaining wall.
- Build basement ground bearing slab.
- Build super structure.

Our suggested sequence of works can be found in appendix A along with scheme calculations.

12.0 Sustainability

As the basement construction will involve significant amounts of concrete, cement replacement alternatives should be considered. Cement replacements can be used to replace up to 40% of the cement in concrete mix. These replacements are typically waste products from the energy production industry such as PFA (pulverised fuel ash) and GBFS (granulated blast furnace slag) are recycled and not sent to landfill sites; furthermore, this also reduces the amount of cement that needs to be mined. Concrete should be bought from a local supplier to further reduce the carbon footprint of transport.

There is a large amount of reinforced concrete on the project for which steel reinforcement bars will be required and specifying reinforcement from a UK supplier ensures that the bars are made from 100% recycled steel. Any structural steelwork should be sourced from a British manufacturer to ensure that rolled sections are made from at least 60% recycled steel. Sourcing the steel from a local supplier will further reduce the transport carbon footprint.

The use of timber as a structural element is to be maximised as timber production actively negates greenhouse gas production; furthermore, all timber is to be FSC certified insuring that the timber is produced from a sustainable source.

13.0 Construction Management Plan

The contractor will be required to submit their own Construction Management Plan and Site Waste Management Plan prior to the work commencing on site. The contents of this plan must be in accordance with the London Borough of Camden's guidance and be agreed by them. The Contractor will be required to follow the following principles and adhere to The London Borough of Camden's Code of Practice for Construction Sites as well as the requirements of this basement impact assessment in relation to sequencing and temporary works.

14.0 Noise Mitigation

Working hours to be restricted to those set out in Camden's Code of Practice for Construction Sites.

The contractor will be required to identify and implement measures to minimise noise and vibration impacts, to within the best practicable means, to be agreed with the Council prior to works commencing on site. Measures will include but not be limited to;

- Selection of plant with regard to its published sound level.
- Consider the use of acoustic screens and covers.

15.0 Traffic Management Plan

This will provide details of how construction traffic impact on the surrounding areas, including: pedestrians, other road users, surrounding properties and the environment. This should take measures to avoid road closures and make use of the access yard to the rear of the property for deliveries and unloading.

16.0 Dust Mitigation

Noise, dust and vibration will be controlled by employing best practicable means as prescribed in legislation such as; The Control of Pollution Act, 1972; The Health & Safety at Work Act, 1974; The Environmental Protection Act, 1990; Construction Design and Management Regulations, 1994 and The Clean Air Act, 1993. The following is recommended to be adopted by the contractor:

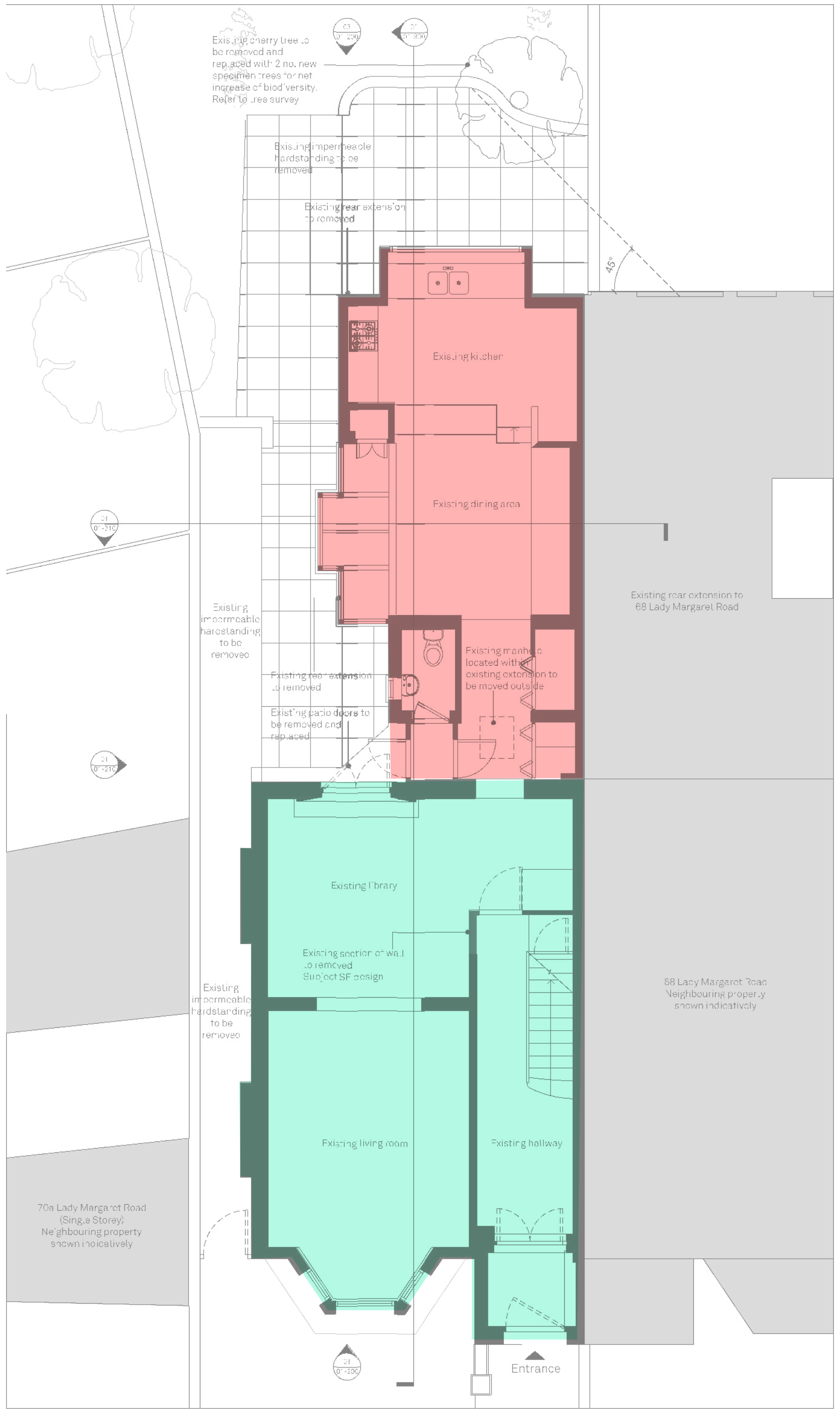
- Noise, vibration and dust monitoring to be implemented.
- Water shall be used as a dust suppressant where applicable.
- Skips should be covered.

17.0 Summary

It is essential that a thorough review of all temporary works, contractors' method statements and calculations for these works is undertaken by a suitable qualified structural engineer prior to works starting. The permanent works will also be submitted to Building Control and the necessary Party Wall Surveyors for approval prior to the works commencing on site.

The proposed basement has been designed with robust structural principles and methods of construction that are widely used and known. This will ensure the integrity of neighbouring structures and roadways are not compromised during its construction.

APPENDIX A
PROPOSED DEVELOPMENT DRAWINGS

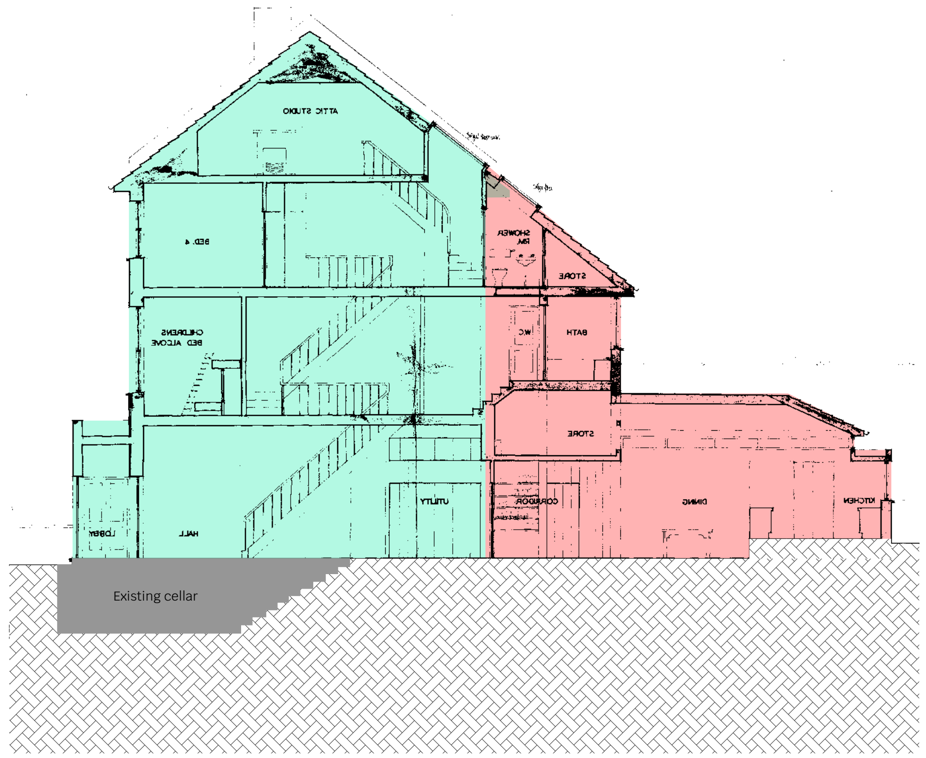


Existing Plan

KEY:

Building to be demolished

Building to be retained



Existing Section

Outline Construction Sequence

1. Demolish partially ground floor plus 2 storey existing extension. Party wall to be retained and underpinned as well as main house structure.
2. Build a temporary structure to support existing building
3. Underpinning the existing and adjacent building to give more foundation support
4. Excavating soil for foundation
5. Build basement retaining wall
6. Build basement suspended slab
7. Build super structure

Notes

1. This drawings is to be read in conjunction with all relevant architects & engineers drawings and specifications
2. Do not scale from this drawing

Rev	Date	Drwn	Chkd	Amendments
P1	08.03.23	KL	EB	For Comment

Drawing status For Comments

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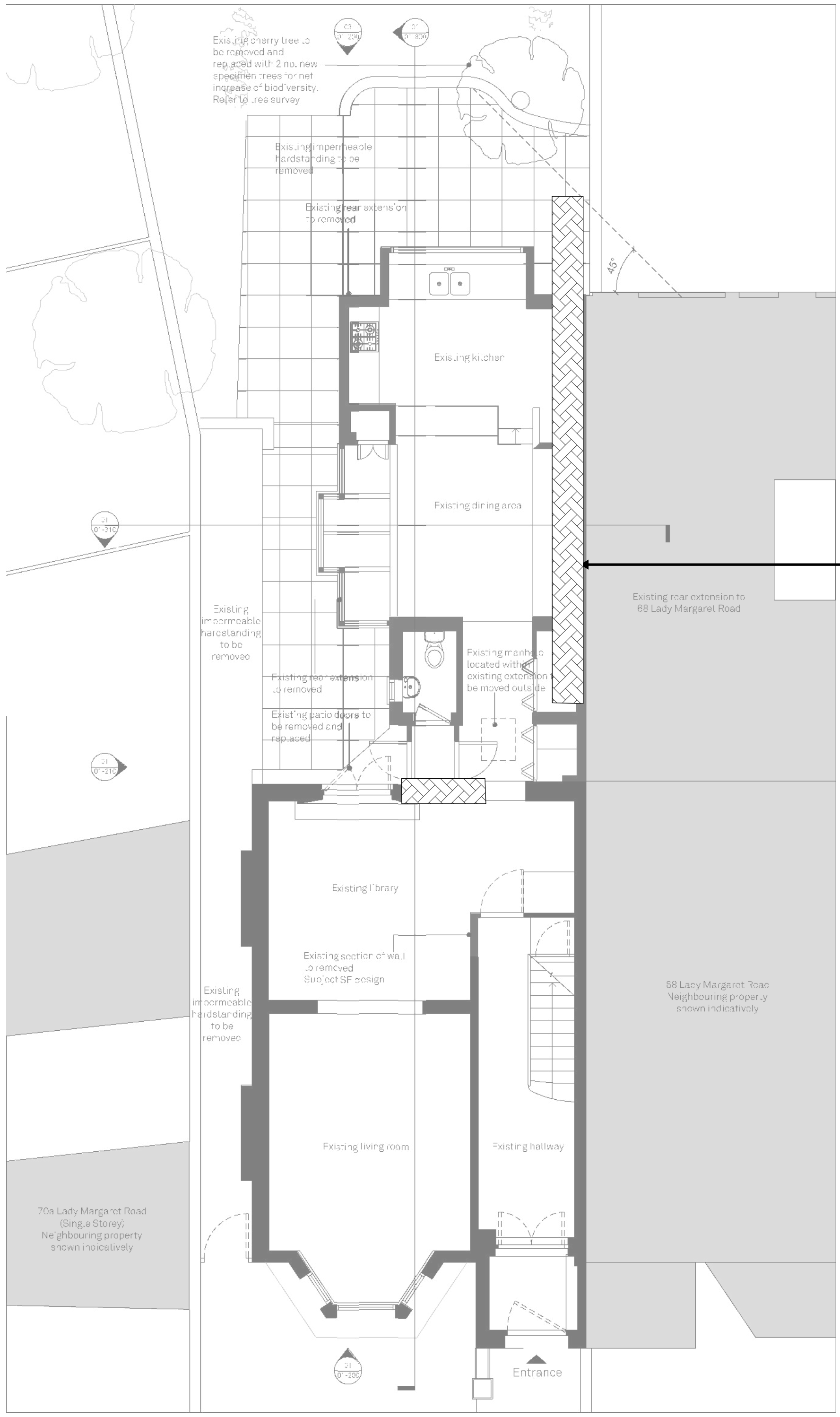
Job Title
70 Lady Margaret Road
London
NW5 2NP

Sketch Title
Basement Impact Assessment
Existing Building

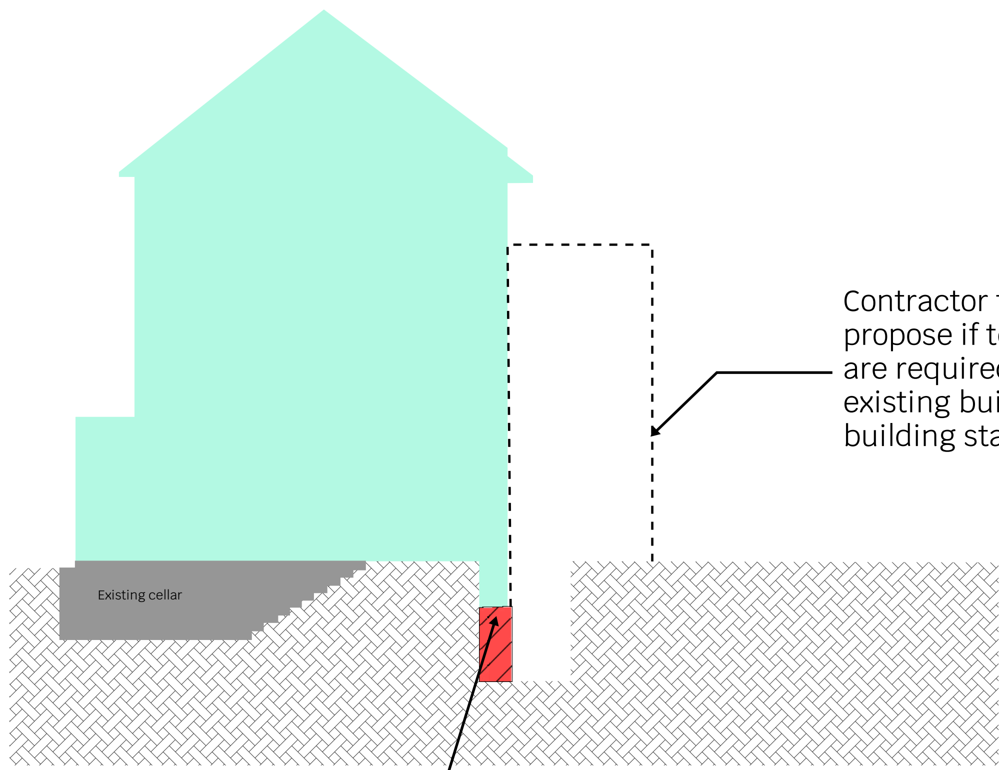
Project	Company	Zones	Level	Type	Role	Number
22276	SYM	XX	XX	SK	S	0002

Scale: NTS
Date: Mar 2023
Drawn by: KL
Checked: EB
Revision: P1



In order to provide full stability avoiding undermining the existing remaining building and adjoining building the area indicated will require sequencing underpinning wall

Existing Plan



Contractor to assess and propose if temporary works are required to prop the existing building to ensure building stability

According to the Site Investigation the existing foundation extends beyond 1.4m depth into the stiff clay layer, existing foundation to be preserved and underpinning wall to be provided to support the existing structure

Existing Section

Notes

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2. Do not scale from this drawing

Rev	Date	Drwn	Chkd	Amendments
P1	08.03.23	KL	EB	For Comment

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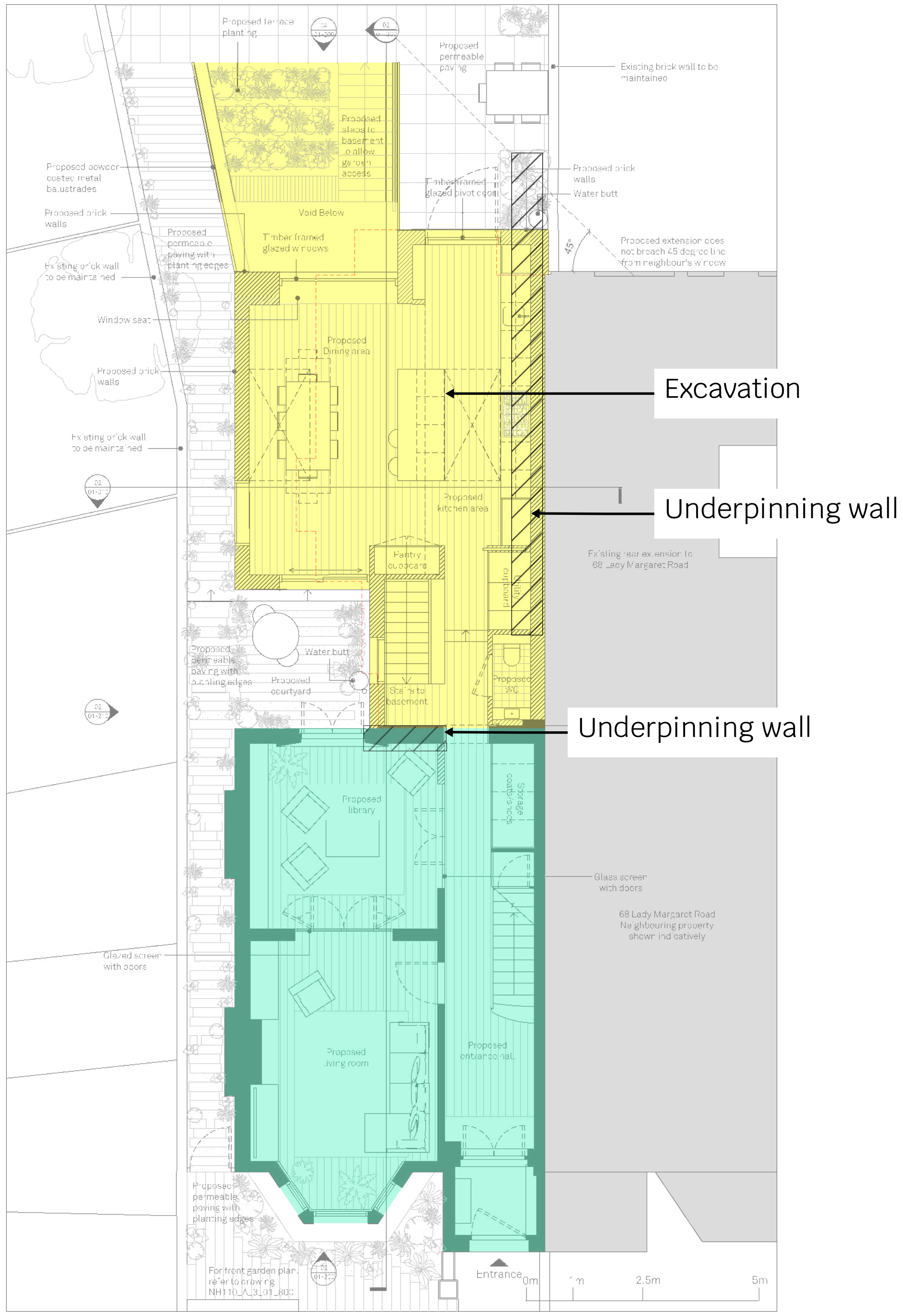
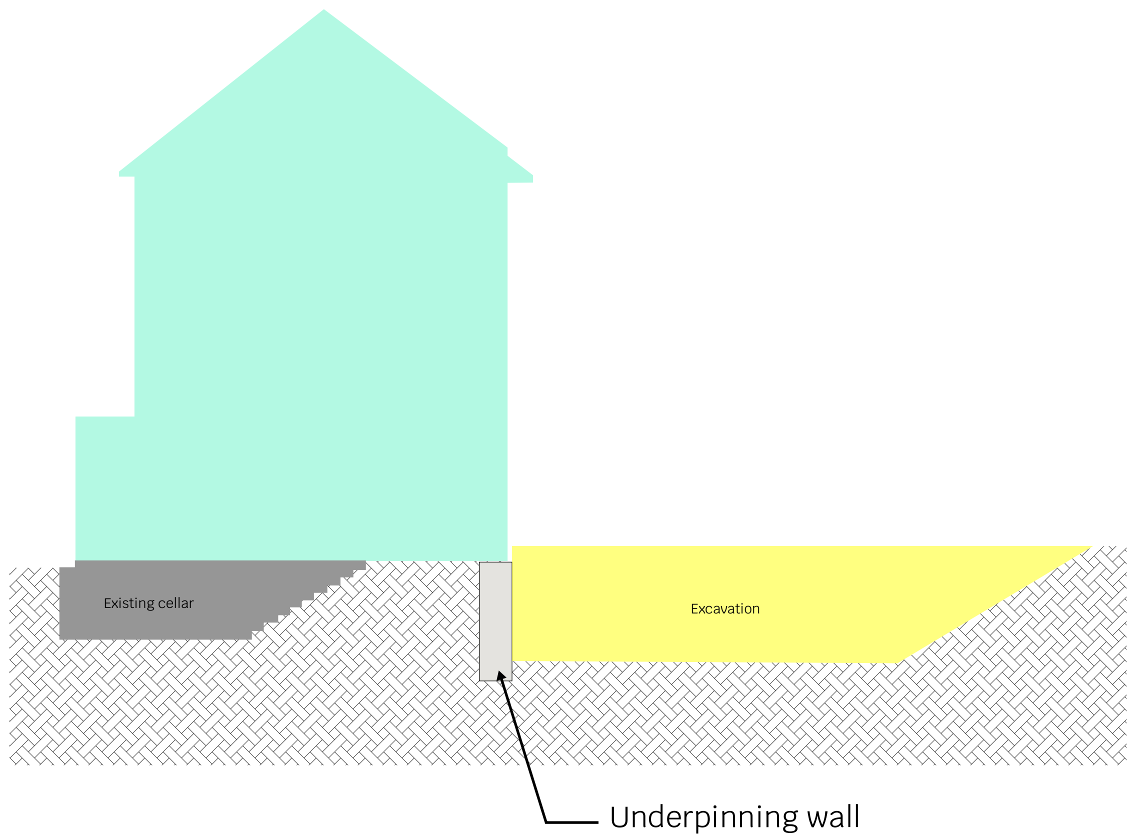


Proposed Plan



Existing Section

KEY:

Proposed excavation

Building to be retained

Notes

1. This drawings is to be read in conjunction with all relevant architects & engineers drawings and specifications
2. Do not scale from this drawing

Rev	Date	Drwn	Chkd	Amendments
P1	08.03.23	KL	EB	For Comment

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Project	Company	Zones	Level	Type	Role	Number
22276	SYM	XX	XX	SK	S	0002

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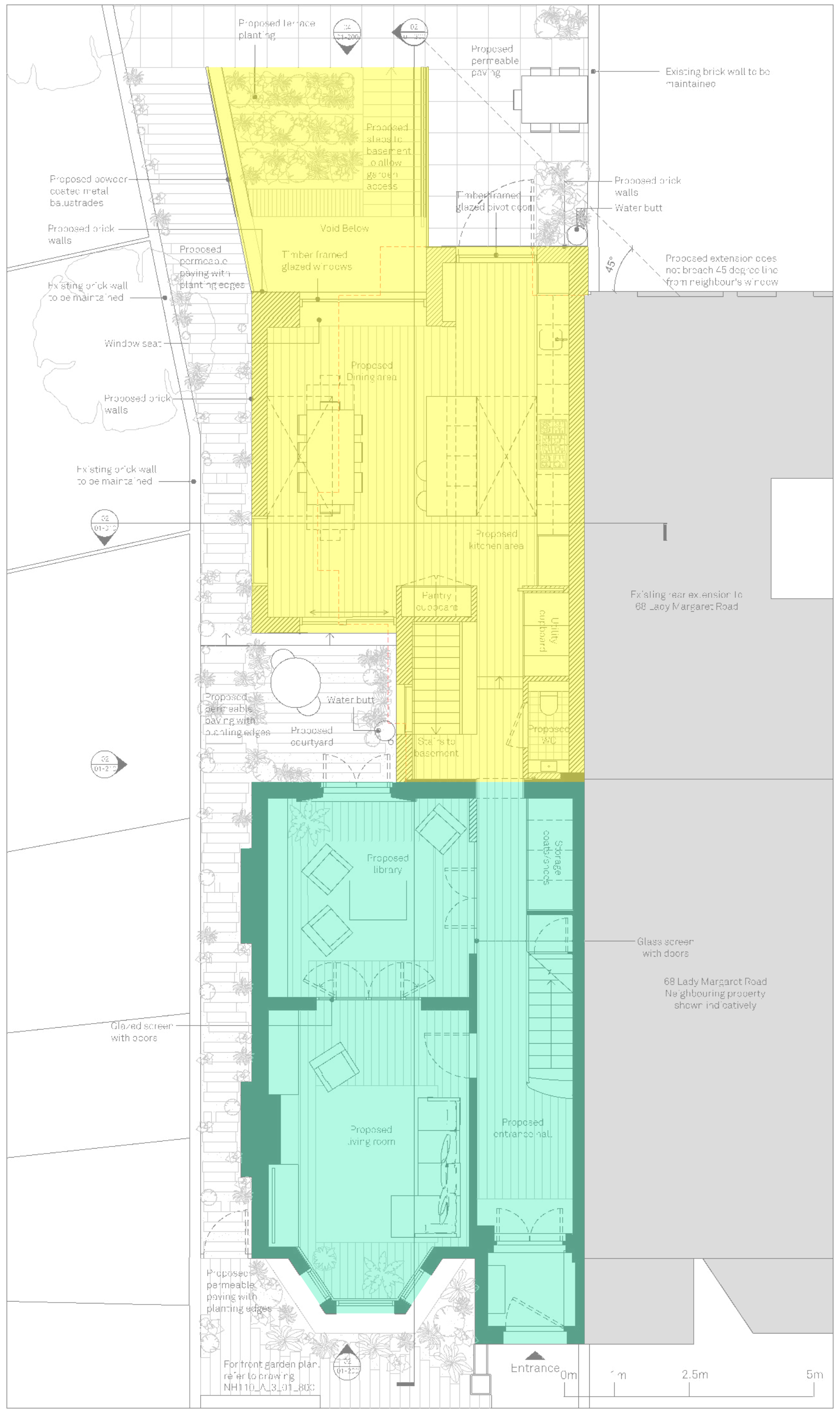
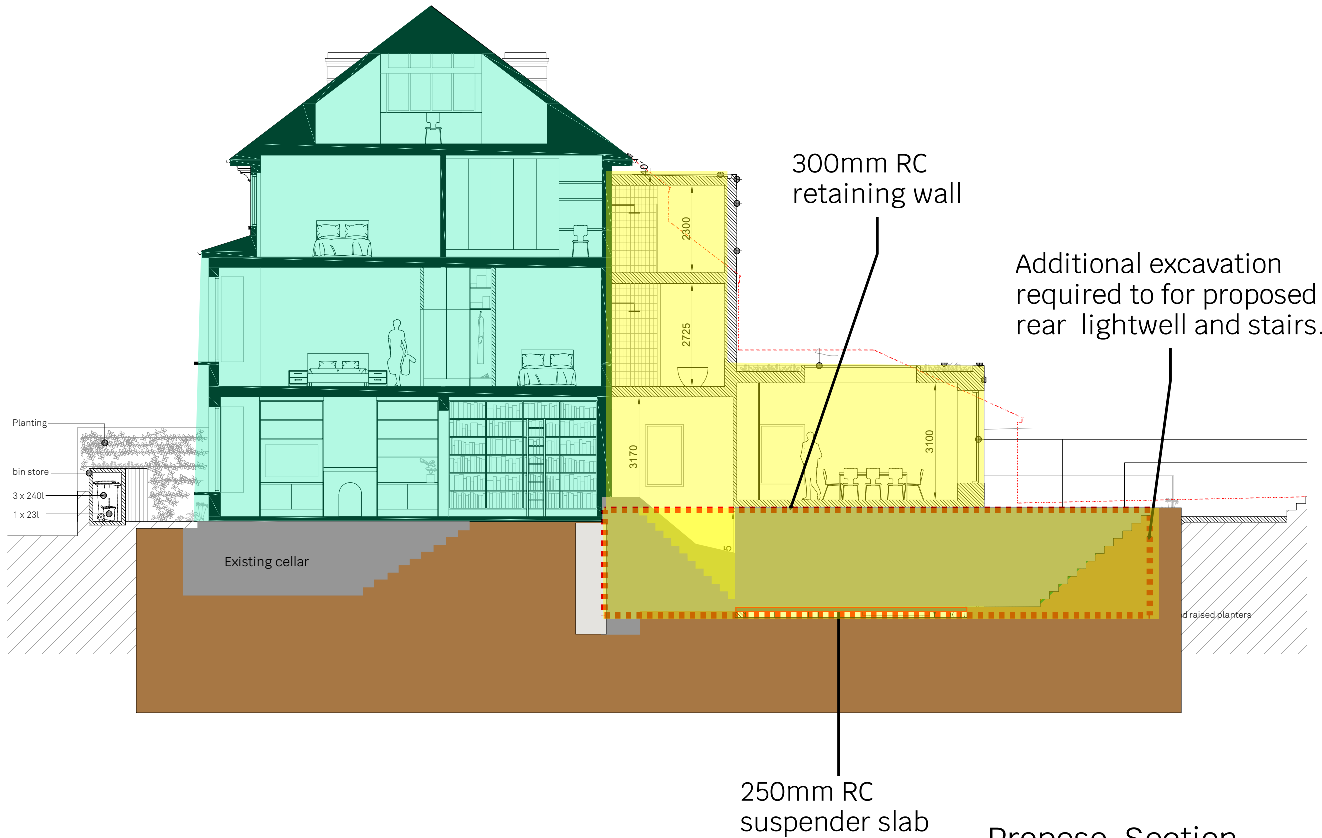


Proposed Plan



Propose Section

KEY:

Proposed extension

Building to be retained

Notes

1. This drawings is to be read in conjunction with all relevant architects & engineers drawings and specifications
2. Do not scale from this drawing

Rev	Date	Drwn	Chkd	Amendments
P1	08.03.23	KL	EB	For Comment

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Sketch Title
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Assessment
Existing Building

Project	Company	Zones	Level	Type	Role	Number
22276 -	SYM -	XX -	XX -	SK -	S -	0002

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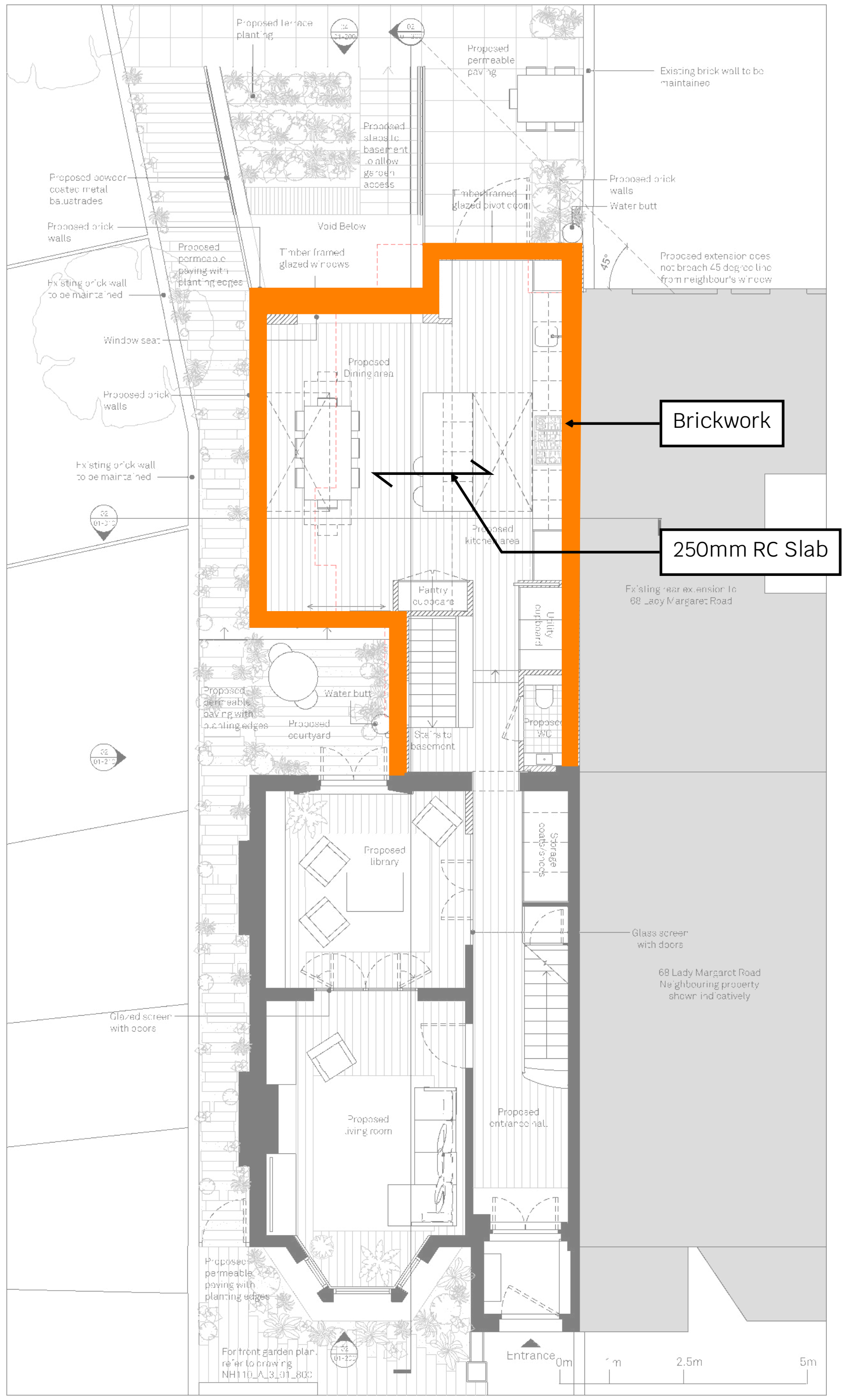
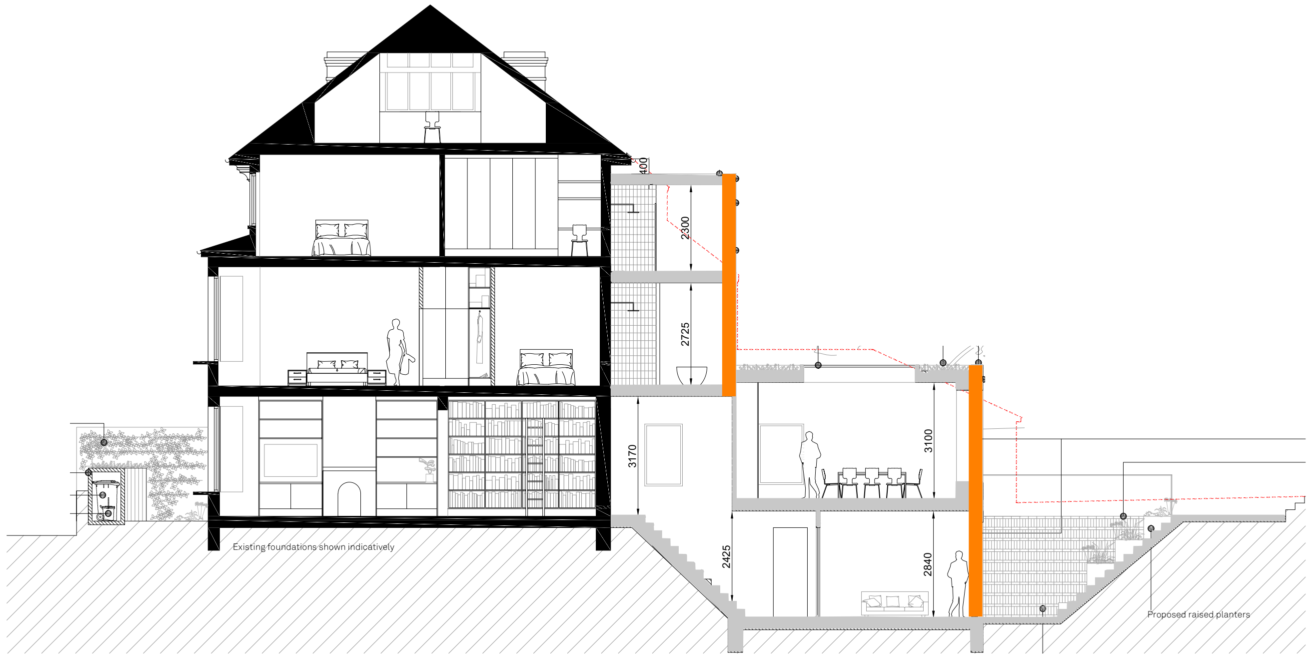
Revision: P1



Proposed Plan



KEY:

Proposed extension masonry walls

Notes

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2. Do not scale from this drawing

Rev	Date	Drwn	Chkd	Amendments
P1	08.03.23	KL	EB	For Comment

Drawing status For Comments

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Sketch Title
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Existing Building

Project	Company	Zones	Level	Type	Role	Number
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Scale: NTS
Date: Mar 2023
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Checked: EB
Revision: P1

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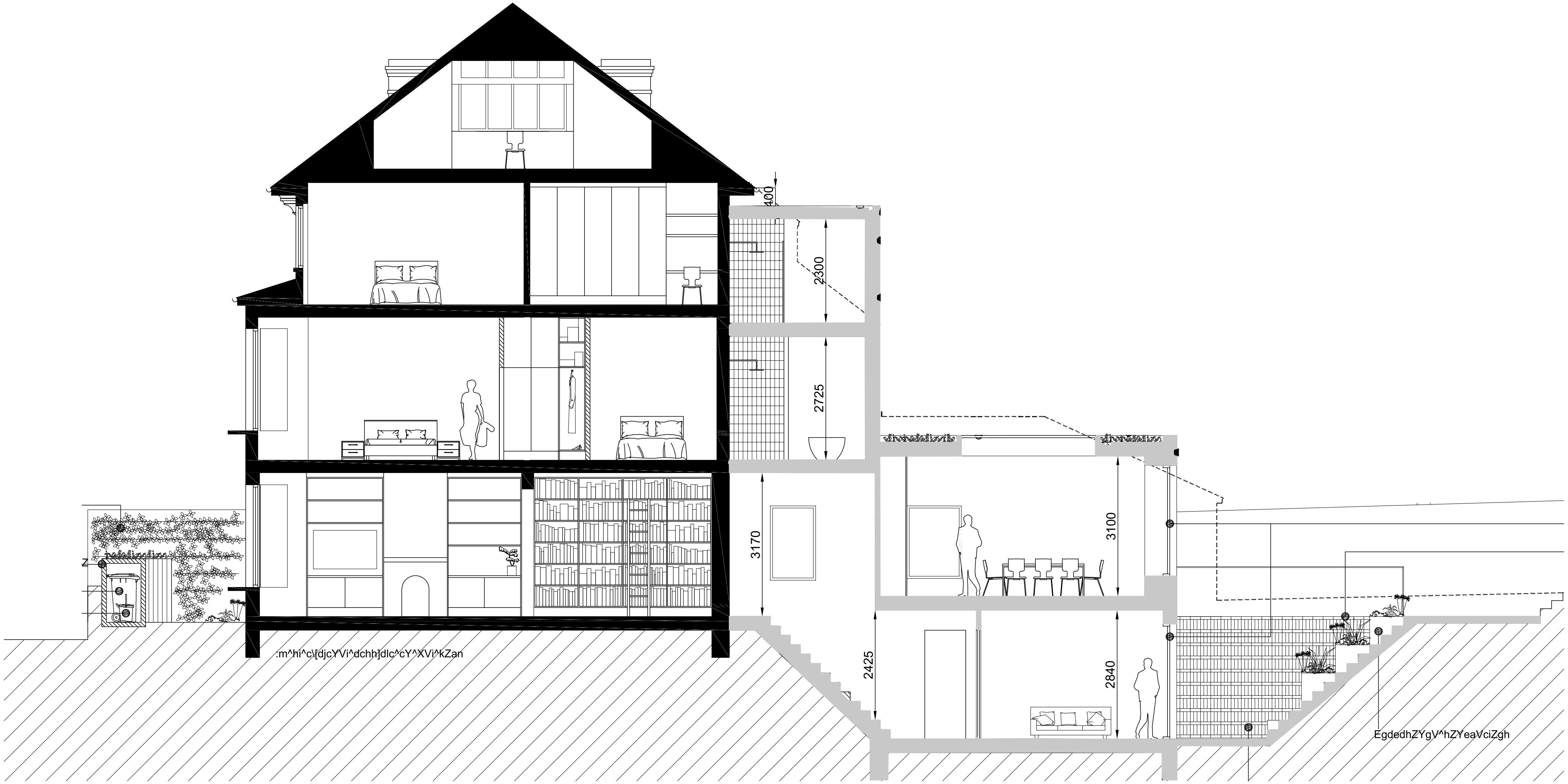
Registered In England And Wales



Proposed Section

Notes

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Rev	Date	Drwn	Chkd	Amendments
P1	08.03.23	KL	EB	For Comment

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22276 -	SYM -	XX -	XX -	SK -	S -	0002

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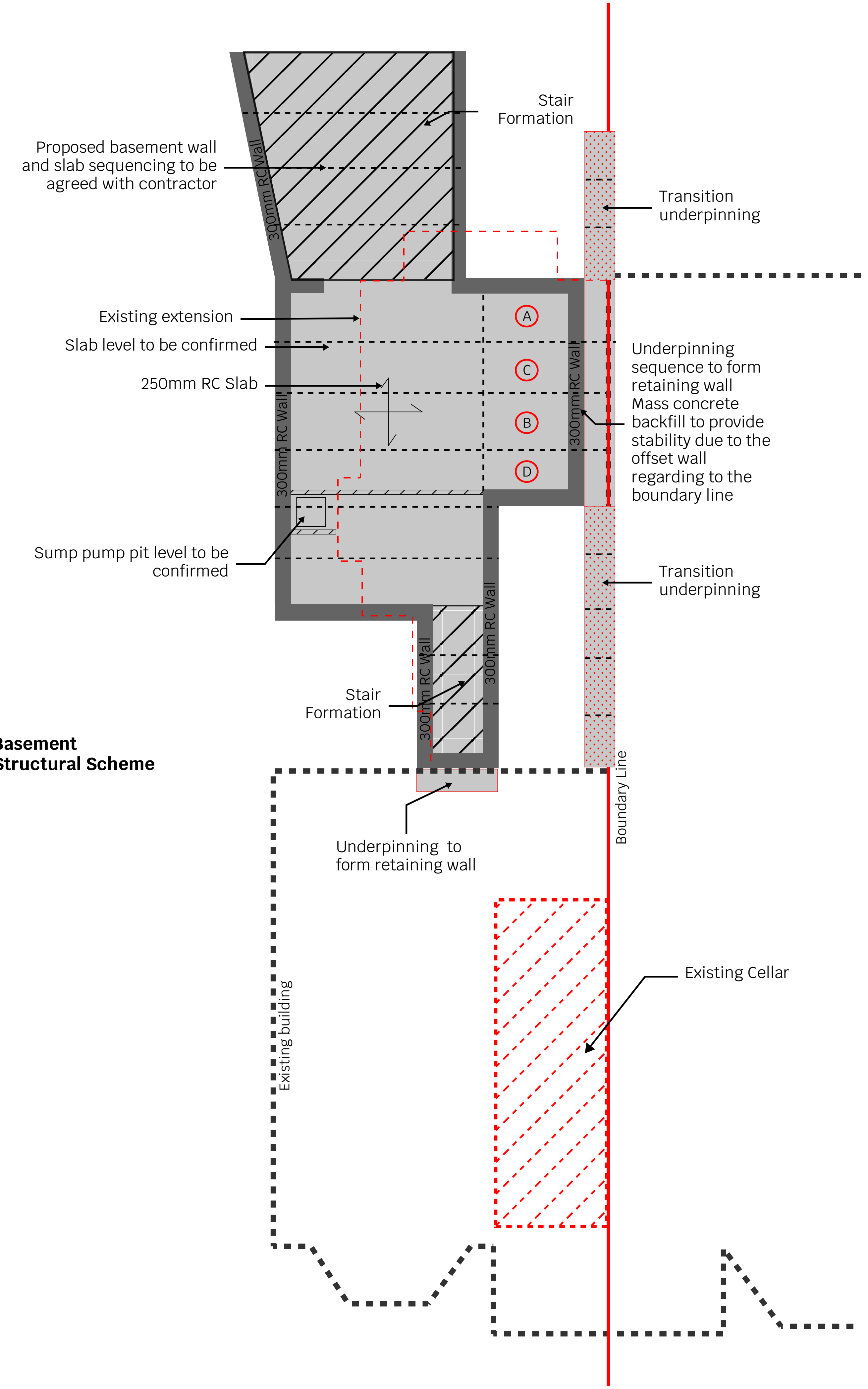

Basement Structural Scheme

Notes:

-Refer to Architects drawings for all setting out details.

-Foundations have been sized based on a safe ground bearing pressure of 150 kN/m² on London clay. The engineer an local authority Building Control Officer are to be afforded the opportunity of inspecting the foundations prior to concreting. The contractor should allow a suitable contingency for pouring deeper foundations following the inspection of the Building Control Officer. The contractor should also be aware of the water table and soil conditions noted in the site investigation report.

-The contractors waterproofing specialist will be responsible for the design and installation of all below ground tanking.

-For above ground tanking and all damp proof coursing details refer to Architects drawings.

-Contractor to provide water bars at all joints.

-All steelwork in the external walls is to be galvanised (125 microns).

-Location of existing and proposed drain runs are to be confirmed by the service engineer.

-Please refer to Architects drawings for all setting out details, insulation and ventilation details, damp proof courses and all tanking details.

-For all fire work protection to steelwork refer to the Architects drawings.

-Contractor should review Architects drawings for exact location of service penetration and confirm

-All steelwork below ground is to be wrapped with a D98 wrapping fabric and to be encased with concrete, 75mm min.

-All steelwork to be encased in concrete is to be un-painted.

-The contractor shall be responsible for the design, installation and sequencing of all temporary works and must ensure that the stability of the structure is not compromised during the works

Sub Contractor/Specialist Design Elements

1. All temporary works
2. All reinforcement drawings and bar bending schedules
3. Design of all steelwork connections. the fabricator is to submit their calculations to building approval
4. Design of all tanking/waterproofing
5. Steel fabrication drawings
6. All stairs by others to support 5kN/m

Bay numbers denote typical sequence of works to underpinning. Should the contractor discover existing footings to be different from those shown the structural engineer is to be informed immediately.

Notes

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2. Do not scale from this drawing

Rev	Date	Drwn	Chkd	Amendments
P1	08.03.23	KL	EB	For Comment

Drawing status For Comments

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Job Title
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NW5 2NP

Sketch Title
Basement Impact Assessment Structural Scheme

Project	Company	Zones	Level	Type	Role	Number
22276 -	SYM -	XX -	XX -	SK -	S -	0002

Scale: NTS
Date: Mar 2023
Drawn by: KL
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Revision: P1

Company No. 5873122 VAT Registration No. 894 2993 61
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APPENDIX B
STRUCTURAL CALCULATIONS

WE ARE SYMMETRYS

STRUCTURAL CALCULATION PACKAGE

70 LADY MARGARET ROAD

22276-SYM-XX-XX-RP-S-0001
MAY 2023
REV B

INTRODUCTION

The structure comprises a four-storey retaining structure and proposed three-storey extension structure. It is proposed to demolish the existing extension, replace by excavting and forming a new one-storey basement with three-storey superstructure, with 2 No. of stair, one to rear garden and one to retaining structure.

CODES OF PRACTICE

The following codes and standards have been used within this document:

BS EN 1990	Eurocode: Basis of structural design
BS EN 1991	Eurocode 1: Action on structures

EXECUTIVE SUMMARY

The proposed development involves the demolition of the existing extension structure. A new basement excavated 1-level underground. Above ground the proposed extension consists of ground plus 3 storeys attached to existing retained structure.

Prepared by:

Ka Ka Lo
Beng(Hons), GIStructE
Graduate Structural Engineer at Symmetrys

Checked and Signed by:

Ernest Bohm
BArch(Hons), MSc
Senior Structural Engineer at Symmetrys

Vertical Loads

for

70 Lady Margaret Road

SYMMETRYS
STRUCTURAL / CIVIL ENGINEERS

		Job No.	Sheet No.	Revision
		22276	4	1
Job Title	70 Lady Margaret Road	Date	Made by	Checked By
Section	Vertical Loads	01/05/2023	KL	EB

Loading

The retaining and propose structure for a multi-level structure. This four-storey building is divided into four sections with different and determine the appropriate load acting on each section.

live load

Area	Qk(kN/m^2)
Floors	1.5
Stairs	2.5
Balconies	2.5

Façade material	Loading (m^2)
Concrete	2.5
Brickwork	1

Proposed Structure

Storey	Height(m)	Floor material	Trib Area (m^2)	Dead Load (kN/m^2)	Live Load (kNm^2)	SSL (kN/m^2)	UDL(kN/m^2)
New Basement	2.84	250mm RC Slab	38.3	6.25	2	8.25	11.4375
Existing Basement	1.9	250mm RC Slab	19.87	6.25	2	8.25	11.4375
Ground	3.1	250mm RC Slab	131.74	6.25	2	8.25	11.4375
1st	3.1	250mm RC Slab	79.67	6.25	2	8.25	11.4375
2nd	3.1	250mm RC Slab	76.88	6.25	2	8.25	11.4375
3rd	3.1	250mm RC Slab	63.6	6.25	2	8.25	11.4375
Roof	/	250mm RC Slab	131.74	6.25	0.6	6.85	9.3375

Storey	Material	Height	Loading
New Basement	Concrete	2.84	7.1
Existing Basement	Concrete	1.9	4.75
Ground	Brickwork	3.1	3.1
1st	Brickwork	2.7	2.7
2nd	Brickwork	2.3	2.3
3rd	Brickwork	2.3	2.3

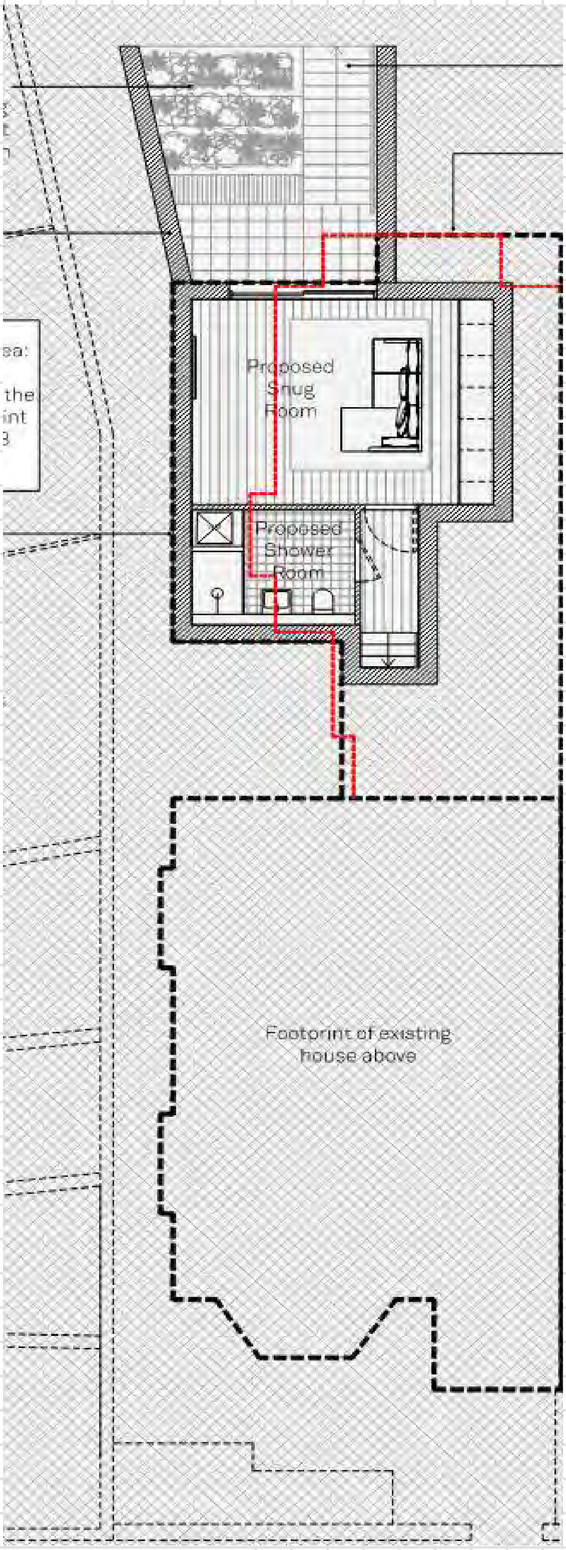
Loading Storey	Trib Area (m2)	Total SSL (kN/m^2)	Total USL (kN/m^2)
Basement & Ground floor	37.81	23.35	32.2125
Ground floor	9.56	15.1	20.775
Ground floor to 2nd floor	12.72	31.6	43.65
Ground to 3rd floor	70.89	39.85	55.0875
Basement to 3rd floor	19.87	48.1	66.525
Existing Stairs	4.87	47.5	65.625
New Stairs	1.98	23.75	32.8125

Wall	Loading Storey	Length	Façade Load (kN/m)
A	GF	3.3	3.1
B	GF	0.9	3.1
C	B1+GF	3.5	10.2
D	B1	2.7	7.1
E	B1+GF	6.8	10.2
F	B1	4.7	7.1
G	GF	7.4	3.1
H	B1	1.8	7.1
I	B1	1.9	7.1
J	B1+GF	2.8	10.2
K	GF+1F+2F	1.5	8.1
L	GF+1F+2F	2.3	8.1

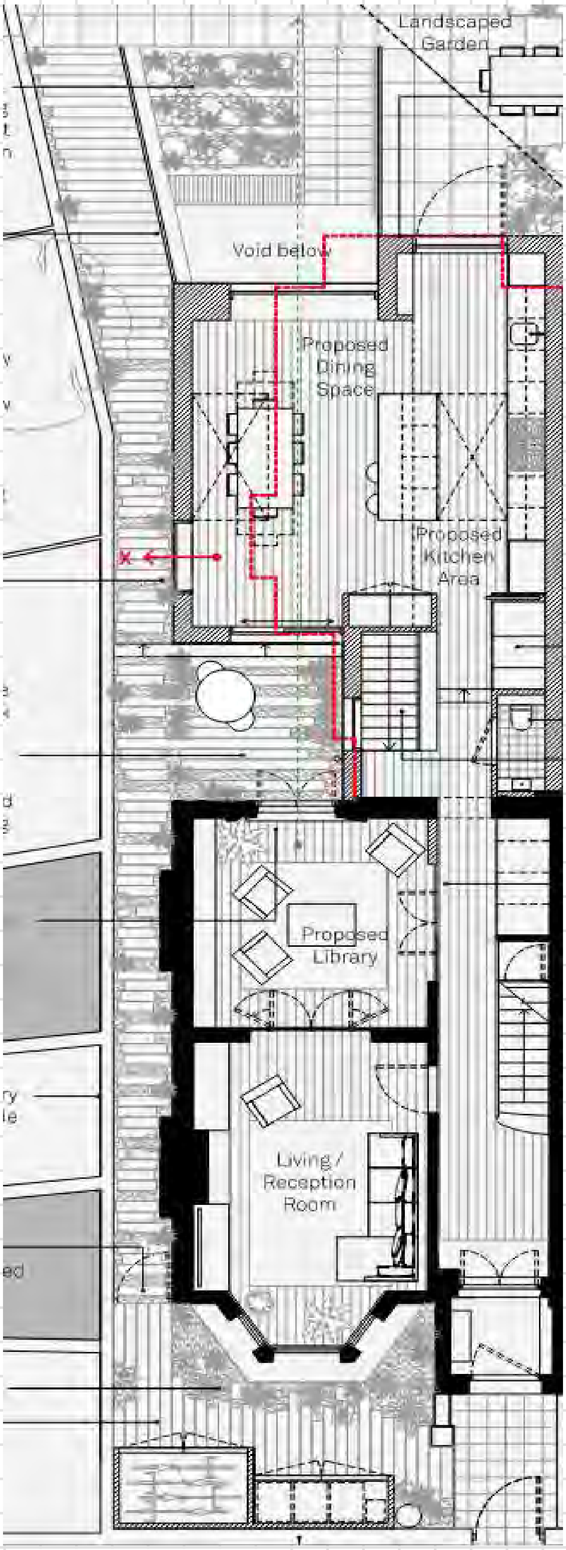
Wall	Loading Storey	Length	Façade Load (kN/m)
M	GF+1F+2F	3.3	8.1
N	GF+1F+2F	3.3	8.1
O	GF+1F+2F+3F	2.8	10.4
P	GF+1F+2F+3F	3.8	10.4
Q	GF+1F+2F+3F	9.6	10.4
R	GF+1F+2F+3F	2.6	10.4
S	B1+GF+1F+2F+3F	2.3	15.15
T	B1+GF+1F+2F+3F	7.0	15.15
U	B1+GF+1F+2F+3F	8.7	15.15
V	GF+1F+2F+3F	4.4	10.4
W	B1+GF+1F+2F+3F	1.7	15.15
X	B1+GF+1F+2F+3F	2.2	15.15

SYMMETRYS STRUCTURAL / CIVIL ENGINEERS	Job No.	Sheet No.	Revision
	22276	5	1
Job Title: 70 Lady Margaret Road	Date	Made by	Checked By
Section: Vertical Loads	01/05/2023	KL	EB

Site Plan



Proposed Basement Plan

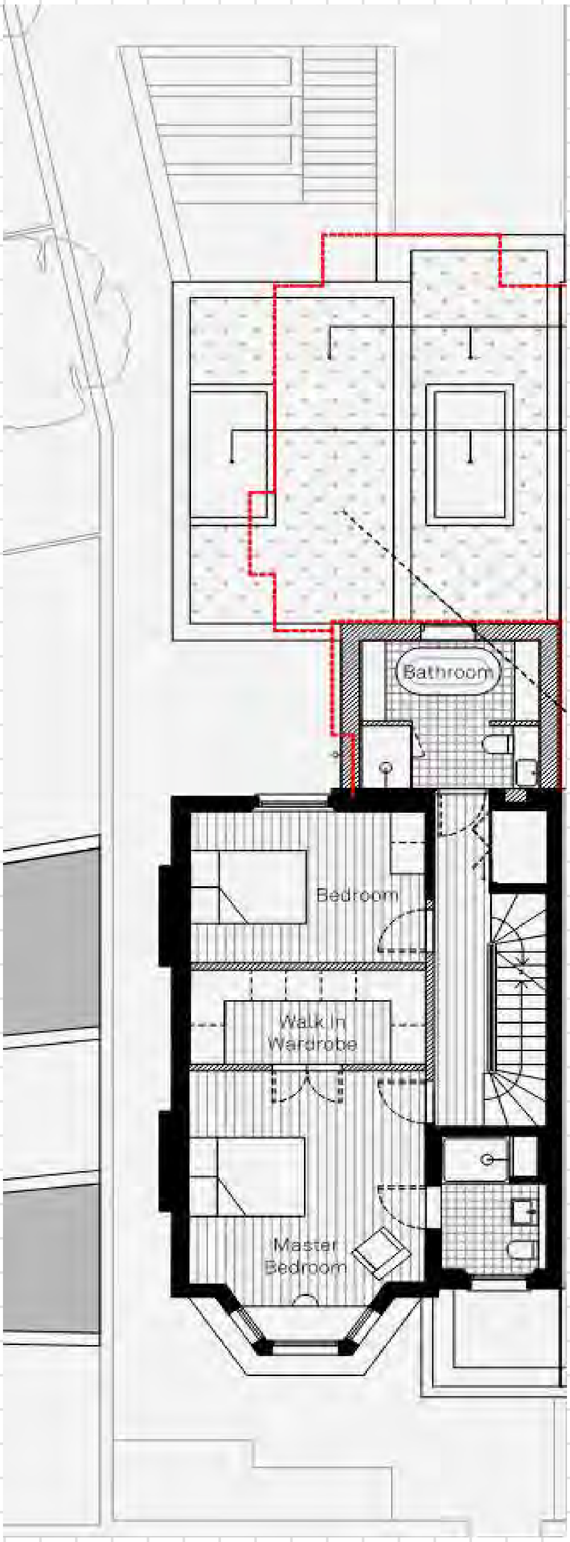


Proposed Ground Floor Plan

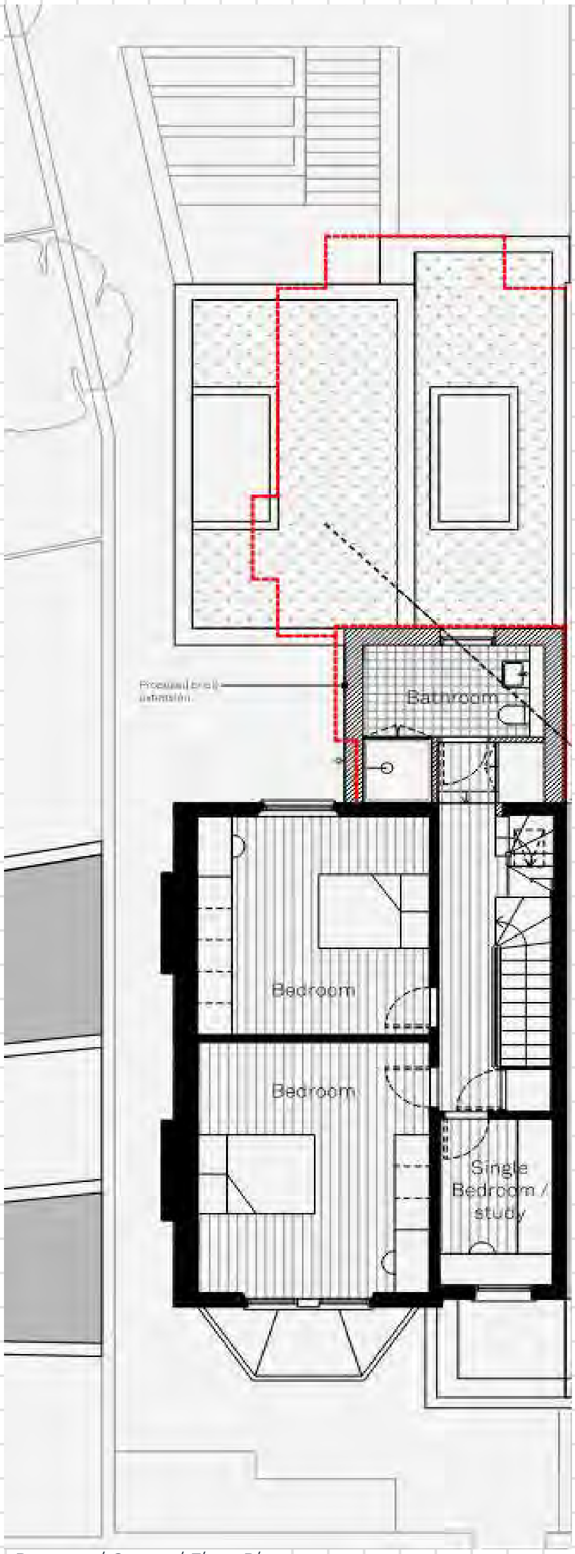
SYMMETRYS
STRUCTURAL / CIVIL ENGINEERS

		Job No.	Sheet No.	Revision
		22276	6	1
Job Title	70 Lady Margaret Road	Date	Made by	Checked By
Section	Vertical Loads	01/05/2023	KL	EB

Site Plan



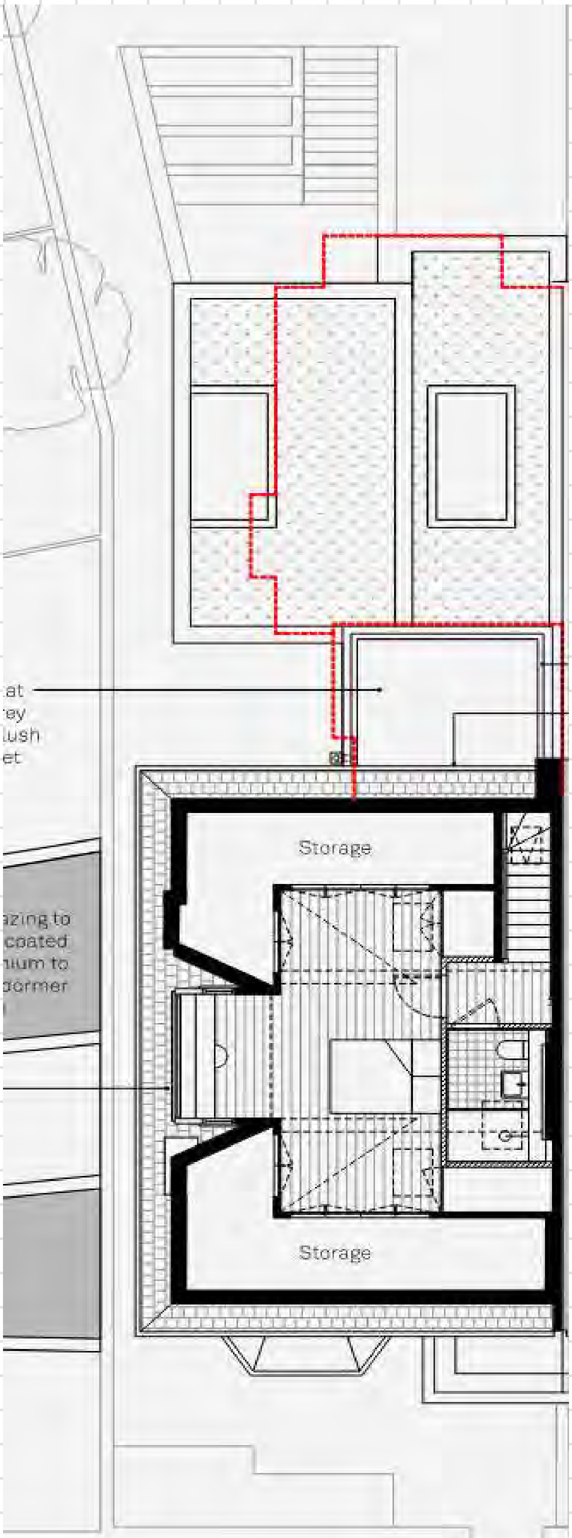
Proposed First Floor Plan



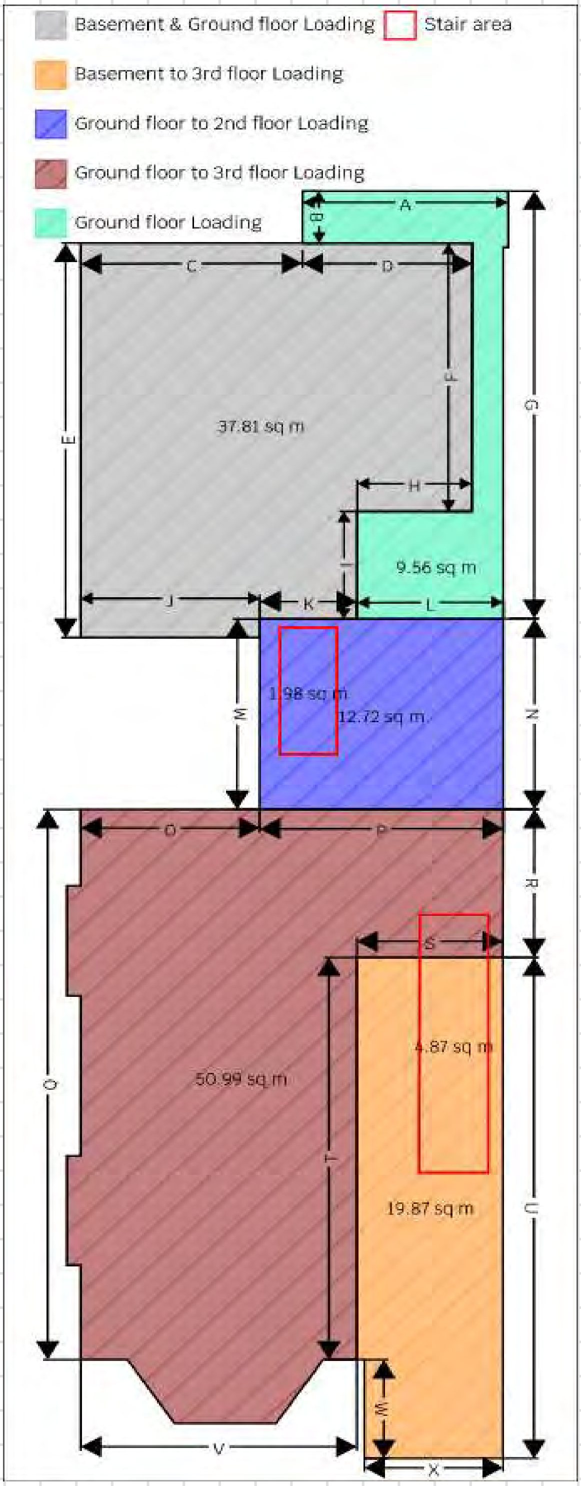
Proposed Second Floor Plan

SYMMETRYS STRUCTURAL / CIVIL ENGINEERS	Job No.	Sheet No.	Revision
	22276	7	1
Job Title: 70 Lady Margaret Road	Date	Made by	Checked By
Section: Vertical Loads	01/05/2023	KL	EB

Loading Plan



Proposed Third Floor Plan



Loading section

Structural Calculations

for

70 Lady Margaret Road

Design of a basement slab for heave

Expected heave forces

Detailed analysis has been undertaken by GEA

Approximate conservative heave forces

Excavation depth	=	2.8	m					
Hydroestatic pressure	=	2.8	x	10	=	28	kN/m2	
Oberburden pressure	=	2.8	x	18	=	51	kN/m2	
Therefore expected heave	=	28	+	0.5*(51.12-28.	=	40	kN/m2	

Basement Slab Selfweight

Selfweight	=	0.3	x	25	=	6.3	kN/m2
Screed	=	0.075	x	24	=	1.8	kN/m2
		Total		=		8.1	kN/m2

Uplift Design

Overal Uplift	=	40	-	8.05	=	31.7	kN/m2
Therefore - ULS	=	31.7	x	1.5	=	47.6	kN/m2

The basement slab will be designed to transmit forces to the retaining wall foundtations spanning between both sides of the retaining walls.

The distance between the fondations is = 3.2 m

Therefore: Mmax = $\frac{47.565X(3.2^2)}{8}$ = **60.86kNm**

Design of a baement slab for heave

Slab Properties

Design Moment, M	=	60.86	kNm	fcu	=	30	N/mm^2	$\gamma c =$	1.50
ßb	=	1.00		fy	=	500	N/mm^2	$\gamma \sigma =$	1.15
span	=	3200	mm	Steel Class	=	A			
Slab thickness, h	=	250	mm						
Bar Ø	=	12							
cover	=	50	mm						

<u>Check</u>

d = 250 - 50 - 12/2 = 194.0 mm

K' = 0.156 > K = 0.054 ok

z = 194.0 [0.5 + (0.25 - 0.054 /0.893)]^½ = 181.6 < 0.95d = 184.3 mm

As = 60.86E6 /500 /181.5 x 1.15 = 771 > min As = 325 mm²/m

PROVIDE H12 @ 150 = 754 mm²/m

fs = 2/3 x 500 x 771 /754 /1.00 = 341.0 N/mm²

Tens mod factor = 0.55 + (477 - 341.0) /120 /(0.9 + 1.617) = 1.000

Comp mod factor = 1 + 0.691/(3 + 0.691) = 1.187

Permissible L/d = 20.0 x 1.000 x 1.187 = 23.750

Actual L/d = 3200 /194.0 = 16.495 ok

Therefore:

Deflection is ok

Maximum spacing is ok

Minimum spacing is ok

ELEMENT DESIGN to BS 8110:2005
SOLID SLABS
Originated from RCC11.xls v4.0 © 2006 - 2010 TCC
mpa The Concrete Centre

INPUT Location 70 Lady Margaret Road NW5 2NP
Design moment, M 60.86 kNm/m fcu 30 N/mm² γc = 1.50
ßb 1.00 fy 500 N/mm² γs = 1.15
span 3200 mm steel class A
Height, h 250 mm Section location SIMPLY SUPPORTED SP
Bar Ø 12 mm Compression steel SPECIFY
cover 50 mm to these bars (deflection control only)
ONE or TWO WAY SLAB

OUTPUT 70 Lady Margaret Road NW5 2NP Compression steel = H16@150(0.691%)
d = 250 - 50 - 12/2 = 194.0 mm
(3.4.4.4) K' = 0.156 > K = 0.054 ok
(3.4.4.4) z = 194.0 [0.5 + (0.25 - 0.054 /0.893)]^½ = 181.6 < 0.95d = 184.3 mm
(3.4.4.1) As = 60.86E6 /500 /181.5 x 1.15 = 771 > min As = 325 mm²/m
PROVIDE H12 @ 150 = 754 mm²/m
(Eqn 8) fs = 2/3 x 500 x 771 /754 /1.00 = 341.0 N/mm²
(Eqn 7) Tens mod factor = 0.55 + (477 - 341.0) /120 /(0.9 + 1.617) = 1.000
(Equation 9) Comp mod factor = 1 + 0.691/(3 + 0.691) = 1.187
(3.4.6.3) Permissible L/d = 20.0 x 1.000 x 1.187 = 23.750
Actual L/d = 3200 /194.0 = 16.495 ok

RETAINING WALL ANALYSIS

In accordance with EN1997-1:2004 incorporating Corrigendum dated February 2009 and the UK National Annex incorporating Corrigendum No.1

Tedds calculation version 2.9.14

Retaining wall details

Stem type	Cantilever
Stem height	h_{stem} = **2850** mm
Stem thickness	t_{stem} = **300** mm
Angle to rear face of stem	α = **90** deg
Stem density	γ_{stem} = **25** kN/m^3
Toe length	l_{toe} = **2800** mm
Base thickness	t_{base} = **300** mm
Base density	γ_{base} = **25** kN/m^3
Height of retained soil	h_{ret} = **2850** mm
Angle of soil surface	β = **0** deg
Depth of cover	d_{cover} = **0** mm
Height of water	h_{water} = **2000** mm
Water density	γ_w = **9.8** kN/m^3

Retained soil properties

Soil type	Firm clay
Moist density	γ_{mr} = **19.5** kN/m^3
Saturated density	γ_{sr} = **19.5** kN/m^3
Characteristic effective shear resistance angle	$\phi'_{r.k}$ = **23** deg
Characteristic wall friction angle	$\delta_{r.k}$ = **11** deg

Base soil properties

Soil type	Stiff silty clay
Soil density	γ_b = **19.5** kN/m^3
Characteristic effective shear resistance angle	$\phi'_{b.k}$ = **23** deg
Characteristic wall friction angle	$\delta_{b.k}$ = **11** deg
Characteristic base friction angle	$\delta_{bb.k}$ = **14.7** deg
Presumed bearing capacity	$P_{bearing}$ = **150** kN/m^2

Loading details

Variable surcharge load	$Surcharge_Q$ = **5** kN/m^2
Vertical line load at 2950 mm	P_{G1} = **60** kN/m
	P_{Q1} = **9** kN/m

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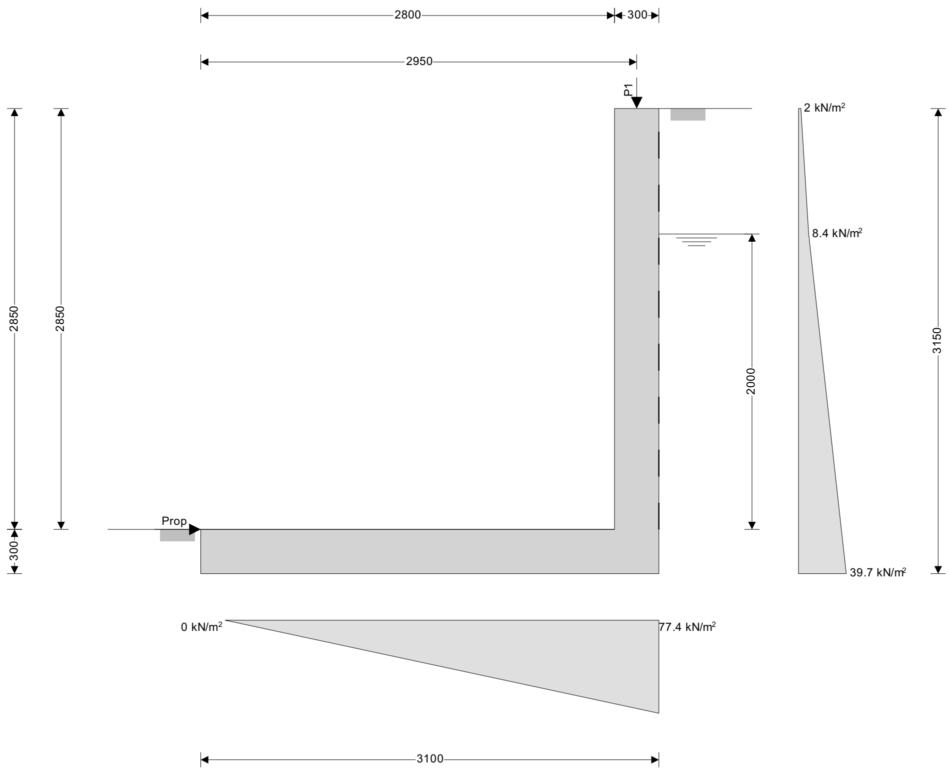

General arrangement

Calculate retaining wall geometry

Base length	$l_{base} = l_{toe} + t_{stem} = \mathbf{3100}$ mm
Saturated soil height	$h_{sat} = h_{water} + d_{cover} = \mathbf{2000}$ mm
Moist soil height	$h_{moist} = h_{ret} - h_{water} = \mathbf{850}$ mm
Length of surcharge load	$l_{sur} = l_{heel} = \mathbf{0}$ mm
- Distance to vertical component	$x_{sur\_v} = l_{base} - l_{heel} / 2 = \mathbf{3100}$ mm
Effective height of wall	$h_{eff} = h_{base} + d_{cover} + h_{ret} = \mathbf{3150}$ mm
- Distance to horizontal component	$x_{sur\_h} = h_{eff} / 2 = \mathbf{1575}$ mm
Area of wall stem	$A_{stem} = h_{stem} \times t_{stem} = \mathbf{0.855}$ m^2
- Distance to vertical component	$x_{stem} = l_{toe} + t_{stem} / 2 = \mathbf{2950}$ mm
Area of wall base	$A_{base} = l_{base} \times t_{base} = \mathbf{0.93}$ m^2
- Distance to vertical component	$x_{base} = l_{base} / 2 = \mathbf{1550}$ mm

Using Coulomb theory

Active pressure coefficient	$K_A = \sin(\alpha + \phi'_{r.k})^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta_{r.k}) \times [1 + \sqrt{[\sin(\phi'_{r.k} + \delta_{r.k}) \times \sin(\phi'_{r.k} - \beta) / (\sin(\alpha - \delta_{r.k}) \times \sin(\alpha + \beta))]}]^2) = \mathbf{0.398}$
Passive pressure coefficient	$K_P = \sin(90 - \phi'_{b.k})^2 / (\sin(90 + \delta_{b.k}) \times [1 - \sqrt{[\sin(\phi'_{b.k} + \delta_{b.k}) \times \sin(\phi'_{b.k}) / (\sin(90 + \delta_{b.k}))]}]^2) = \mathbf{3.094}$

Bearing pressure check

Vertical forces on wall

Wall stem	$F_{stem} = A_{stem} \times \gamma_{stem} = \mathbf{21.4}$ kN/m
Wall base	$F_{base} = A_{base} \times \gamma_{base} = \mathbf{23.3}$ kN/m

Line loads	$F_{P\_v} = P_{G1} + P_{Q1} = \mathbf{69}$ kN/m
Total	$F_{total\_v} = F_{stem} + F_{base} + F_{P\_v} + F_{water\_v} = \mathbf{113.6}$ kN/m

Horizontal forces on wall

Surcharge load	$F_{sur\_h} = K_A \times \cos(\delta_{r.k}) \times Surcharge_Q \times h_{eff} = \mathbf{6.2}$ kN/m
Saturated retained soil	$F_{sat\_h} = K_A \times \cos(\delta_{r.k}) \times (\gamma_{sr} - \gamma_w) \times (h_{sat} + h_{base})^2 / 2 = \mathbf{10}$ kN/m
Water	$F_{water\_h} = \gamma_w \times (h_{water} + d_{cover} + h_{base})^2 / 2 = \mathbf{25.9}$ kN/m
Moist retained soil	$F_{moist\_h} = K_A \times \cos(\delta_{r.k}) \times \gamma_{mr} \times ((h_{eff} - h_{sat} - h_{base})^2 / 2 + (h_{eff} - h_{sat} - h_{base}) \times (h_{sat} + h_{base})) = \mathbf{17.7}$ kN/m
Base soil	$F_{pass\_h} = -K_P \times \cos(\delta_{b.k}) \times \gamma_b \times (d_{cover} + h_{base})^2 / 2 = \mathbf{-2.7}$ kN/m
Total	$F_{total\_h} = F_{sur\_h} + F_{sat\_h} + F_{water\_h} + F_{moist\_h} + F_{pass\_h} = \mathbf{57.1}$ kN/m

Moments on wall

Wall stem	$M_{stem} = F_{stem} \times x_{stem} = \mathbf{63.1}$ kNm/m
Wall base	$M_{base} = F_{base} \times x_{base} = \mathbf{36}$ kNm/m
Surcharge load	$M_{sur} = -F_{sur\_h} \times x_{sur\_h} = \mathbf{-9.7}$ kNm/m
Line loads	$M_P = (P_{G1} + P_{Q1}) \times p_1 = \mathbf{203.6}$ kNm/m
Saturated retained soil	$M_{sat} = -F_{sat\_h} \times x_{sat\_h} = \mathbf{-7.7}$ kNm/m
Water	$M_{water} = -F_{water\_h} \times x_{water\_h} = \mathbf{-19.9}$ kNm/m
Moist retained soil	$M_{moist} = -F_{moist\_h} \times x_{moist\_h} = \mathbf{-24.3}$ kNm/m
Total	$M_{total} = M_{stem} + M_{base} + M_{sur} + M_P + M_{sat} + M_{water} + M_{moist} = \mathbf{241.1}$ kNm/m

Check bearing pressure

Propping force	$F_{prop\_base} = F_{total\_h} = \mathbf{57.1}$ kN/m
Distance to reaction	$\bar{x} = M_{total} / F_{total\_v} = \mathbf{2122}$ mm
Eccentricity of reaction	$e = \bar{x} - l_{base} / 2 = \mathbf{572}$ mm
Loaded length of base	$l_{load} = 3 \times (l_{base} - \bar{x}) = \mathbf{2934}$ mm
Bearing pressure at toe	$q_{toe} = \mathbf{0}$ kN/m^2
Bearing pressure at heel	$q_{heel} = 2 \times F_{total\_v} / l_{load} = \mathbf{77.4}$ kN/m^2
Factor of safety	$FoS_{bp} = P_{bearing} / \max(q_{toe}, q_{heel}) = \mathbf{1.937}$

PASS - Allowable bearing pressure exceeds maximum applied bearing pressure

RETAINING WALL DESIGN

In accordance with EN1992-1-1:2004 incorporating Corrigendum dated January 2008 and the UK National Annex incorporating National Amendment No.1

Tedds calculation version 2.9.14

Concrete details - Table 3.1 - Strength and deformation characteristics for concrete

Concrete strength class	C30/37
Characteristic compressive cylinder strength	$f_{ck} = \mathbf{30}$ N/mm^2
Characteristic compressive cube strength	$f_{ck,cube} = \mathbf{37}$ N/mm^2
Mean value of compressive cylinder strength	$f_{cm} = f_{ck} + 8$ N/mm^2 $= \mathbf{38}$ N/mm^2
Mean value of axial tensile strength	$f_{ctm} = 0.3$ N/mm$^2 \times (f_{ck} / 1$ N/mm$^2)^{2/3} = \mathbf{2.9}$ N/mm^2
5% fractile of axial tensile strength	$f_{ctk,0.05} = 0.7 \times f_{ctm} = \mathbf{2.0}$ N/mm^2
Secant modulus of elasticity of concrete	$E_{cm} = 22$ kN/mm$^2 \times (f_{cm} / 10$ N/mm$^2)^{0.3} = \mathbf{32837}$ N/mm^2
Partial factor for concrete - Table 2.1N	$\gamma_C = \mathbf{1.50}$
Compressive strength coefficient - cl.3.1.6(1)	$\alpha_{cc} = \mathbf{0.85}$
Design compressive concrete strength - exp.3.15	$f_{cd} = \alpha_{cc} \times f_{ck} / \gamma_C = \mathbf{17.0}$ N/mm^2
Maximum aggregate size	$h_{agg} = \mathbf{20}$ mm

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Ultimate strain - Table 3.1 ε_{cu2} = **0.0035**

Shortening strain - Table 3.1 ε_{cu3} = **0.0035**

Effective compression zone height factor λ = **0.80**

Effective strength factor η = **1.00**

Bending coefficient k_1 K_1 = **0.40**

Bending coefficient k_2 $K_2 = 1.00 \times (0.6 + 0.0014/\varepsilon_{cu2})$ = **1.00**

Bending coefficient k_3 K_3 =**0.40**

Bending coefficient k_4 $K_4 = 1.00 \times (0.6 + 0.0014/\varepsilon_{cu2})$ =**1.00**

Reinforcement details

Characteristic yield strength of reinforcement f_{yk} = **500** N/mm^2

Modulus of elasticity of reinforcement E_s = **200000** N/mm^2

Partial factor for reinforcing steel - Table 2.1N γ_S = **1.15**

Design yield strength of reinforcement $f_{yd} = f_{yk} / \gamma_S$ = **435** N/mm^2

Cover to reinforcement

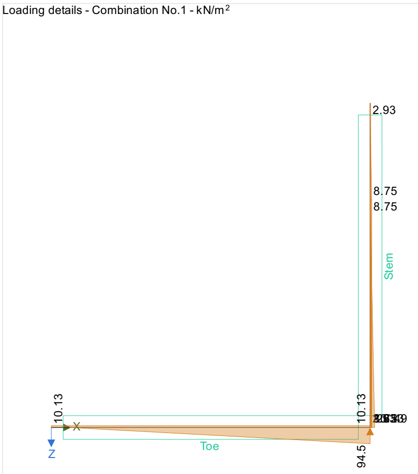
Front face of stem c_{sf} = **40** mm

Rear face of stem c_{sr} = **50** mm

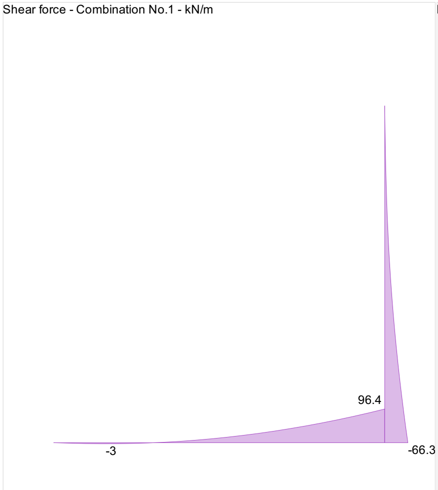
Top face of base c_{bt} = **50** mm

Bottom face of base c_{bb} = **75** mm

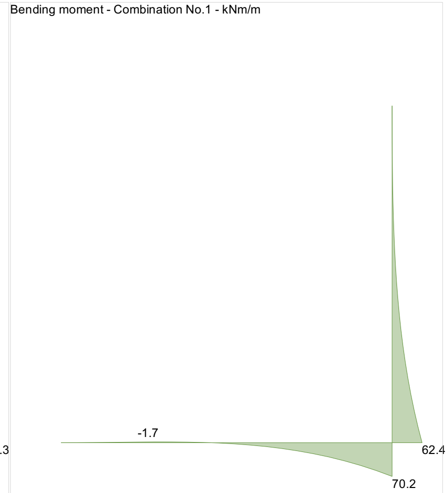
Loading details - Combination No.1 - kN/m^2



Shear force - Combination No.1 - kN/m



Bending moment - Combination No.1 - kNm/m



SYMMETRYS STRUCTURAL / CIVIL ENGINEERS	Project				Job no.	
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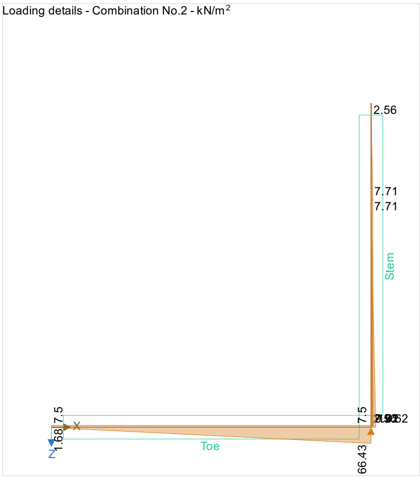
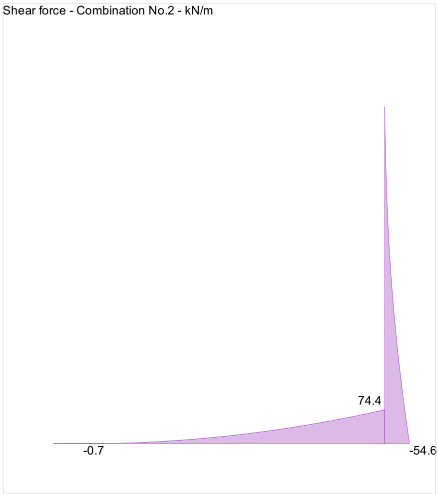
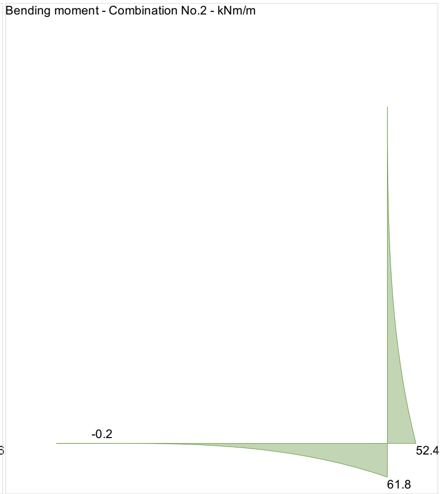
	Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved date
	KL	19/09/2023	EB	13/03/2023		







Check stem design at base of stem

Depth of section — $h = \mathbf{300}$ mm

Rectangular section in flexure - Section 6.1

Design bending moment combination 1 — $M = \mathbf{62.4}$ kNm/m

Depth to tension reinforcement — $d = h - c_{sr} - \phi_{sr} / 2 = \mathbf{242}$ mm

$K = M / (d^2 \times f_{ck}) = \mathbf{0.036}$

$K' = (2 \times \eta \times \alpha_{cc}/\gamma_C)\times(1 - \lambda \times (\delta - K_1)/(2 \times K_2))\times(\lambda \times (\delta - K_1)/(2 \times K_2))$

$K' = \mathbf{0.207}$

K' > K - No compression reinforcement is required

Lever arm — $z = \min(0.5 + 0.5 \times (1 - 2 \times K / (\eta \times \alpha_{cc} / \gamma_C))^{0.5}, 0.95) \times d = \mathbf{230}$ mm

Depth of neutral axis — $x = 2.5 \times (d - z) = \mathbf{30}$ mm

Area of tension reinforcement required — $A_{sr.req} = M / (f_{yd} \times z) = \mathbf{624}$ mm^2/m

Tension reinforcement provided — 16 dia.bars @ 200 c/c

Area of tension reinforcement provided — $A_{sr.prov} = \pi \times \phi_{sr}^2 / (4 \times s_{sr}) = \mathbf{1005}$ mm^2/m

Minimum area of reinforcement - exp.9.1N — $A_{sr.min} = \max(0.26 \times f_{ctm} / f_{yk}, 0.0013) \times d = \mathbf{364}$ mm^2/m

Maximum area of reinforcement - cl.9.2.1.1(3) — $A_{sr.max} = 0.04 \times h = \mathbf{12000}$ mm^2/m

$\max(A_{sr.req}, A_{sr.min}) / A_{sr.prov} = \mathbf{0.621}$

PASS - Area of reinforcement provided is greater than area of reinforcement required

Library item: Rectangular single output

Deflection control - Section 7.4

Reference reinforcement ratio — $\rho_0 = \sqrt{(f_{ck} / 1\ \text{N/mm}^2)} / 1000 = \mathbf{0.005}$

Required tension reinforcement ratio — $\rho = A_{sr.req} / d = \mathbf{0.003}$

Required compression reinforcement ratio — $\rho' = A_{sr.2.req} / d_2 = \mathbf{0.000}$

Structural system factor - Table 7.4N — $K_b = \mathbf{0.4}$

Reinforcement factor - exp.7.17 — $K_s = \min(500\ \text{N/mm}^2 / (f_{yk} \times A_{sr.req} / A_{sr.prov}), 1.5) = \mathbf{1.5}$

Limiting span to depth ratio - exp.7.16.a — $\min(K_s \times K_b \times [11 + 1.5 \times \sqrt{(f_{ck} / 1\ \text{N/mm}^2)} \times \rho_0 / \rho + 3.2 \times \sqrt{(f_{ck} / 1\ \text{N/mm}^2)} \times (\rho_0 / \rho - 1)^{3/2}], 40 \times K_b) = \mathbf{16}$

Actual span to depth ratio — $h_{stem} / d = \mathbf{11.8}$

PASS - Span to depth ratio is less than deflection control limit

Crack control - Section 7.3

Limiting crack width — $w_{max} = \mathbf{0.3}$ mm

Variable load factor - EN1990 – Table A1.1 ψ_2 = **0.6**

Serviceability bending moment M_{sls} = **42.2** kNm/m

Tensile stress in reinforcement $\sigma_s = M_{sls} / (A_{sr.prov} \times z)$ = **182.4** N/mm^2

Load duration Long term

Load duration factor k_t = **0.4**

Effective area of concrete in tension $A_{c.eff} = \min(2.5 \times (h - d), (h - x) / 3, h / 2)$

$A_{c.eff}$ = **89917** mm^2/m

Mean value of concrete tensile strength $f_{ct.eff} = f_{ctm}$ = **2.9** N/mm^2

Reinforcement ratio $\rho_{p.eff} = A_{sr.prov} / A_{c.eff}$ = **0.011**

Modular ratio $\alpha_e = E_s / E_{cm}$ = **6.091**

Bond property coefficient k_1 = **0.8**

Strain distribution coefficient k_2 = **0.5**

k_3 = **3.4**

k_4 = **0.425**

Maximum crack spacing - exp.7.11 $s_{r.max} = k_3 \times c_{sr} + k_1 \times k_2 \times k_4 \times \phi_{sr} / \rho_{p.eff}$ = **413** mm

Maximum crack width - exp.7.8 $w_k = s_{r.max} \times \max(\sigma_s – k_t \times (f_{ct.eff} / \rho_{p.eff}) \times (1 + \alpha_e \times \rho_{p.eff}), 0.6 \times \sigma_s) / E_s$

w_k = **0.226** mm

w_k / w_{max} = **0.754**

PASS - Maximum crack width is less than limiting crack width

Rectangular section in shear - Section 6.2

Design shear force V = **66.3** kN/m

$C_{Rd,c} = 0.18 / \gamma_C$ = **0.120**

$k = \min(1 + \sqrt{(200 \text{ mm} / d)}, 2)$ = **1.909**

Longitudinal reinforcement ratio $\rho_l = \min(A_{sr.prov} / d, 0.02)$ = **0.004**

$v_{min} = 0.035 \text{ N}^{1/2}\text{/mm} \times k^{3/2} \times f_{ck}^{0.5}$ = **0.506** N/mm^2

Design shear resistance - exp.6.2a & 6.2b $V_{Rd.c} = \max(C_{Rd.c} \times k \times (100 \text{ N}^2\text{/mm}^4 \times \rho_l \times f_{ck})^{1/3}, v_{min}) \times d$

$V_{Rd.c}$ = **128.5** kN/m

$V / V_{Rd.c}$ = **0.516**

PASS - Design shear resistance exceeds design shear force

Horizontal reinforcement parallel to face of stem - Section 9.6

Minimum area of reinforcement – cl.9.6.3(1) $A_{sx.req} = \max(0.25 \times A_{sr.prov}, 0.001 \times t_{stem})$ = **300** mm^2/m

Maximum spacing of reinforcement – cl.9.6.3(2) s_{sx_max} = **400** mm

Transverse reinforcement provided 10 dia.bars @ 200 c/c

Area of transverse reinforcement provided $A_{sx.prov} = \pi \times \phi_{sx}^2 / (4 \times s_{sx})$ = **393** mm^2/m

PASS - Area of reinforcement provided is greater than area of reinforcement required

Check base design at toe

Depth of section h = **300** mm

Rectangular section in flexure - Section 6.1

Design bending moment combination 1 M = **70.2** kNm/m

Depth to tension reinforcement $d = h - c_{bb} - \phi_{bb} / 2$ = **215** mm

$K = M / (d^2 \times f_{ck})$ = **0.051**

$K' = (2 \times \eta \times \alpha_{cc}/\gamma_C)\times(1 - \lambda \times (\delta - K_1)/(2 \times K_2))\times(\lambda \times (\delta - K_1)/(2 \times K_2))$

K' = **0.207**

K' > K - No compression reinforcement is required

Lever arm $z = \min(0.5 + 0.5 \times (1 - 2 \times K / (\eta \times \alpha_{cc} / \gamma_C))^{0.5}, 0.95) \times d$ = **204** mm

Depth of neutral axis $x = 2.5 \times (d – z)$ = **27** mm

Area of tension reinforcement required — $A_{bb.req} = M / (f_{yd} \times z) =$ **790** mm^2/m

Tension reinforcement provided — 20 dia.bars @ 150 c/c

Area of tension reinforcement provided — $A_{bb.prov} = \pi \times \phi_{bb}^2 / (4 \times s_{bb}) =$ **2094** mm^2/m

Minimum area of reinforcement - exp.9.1N — $A_{bb.min} = \max(0.26 \times f_{ctm} / f_{yk}, 0.0013) \times d =$ **324** mm^2/m

Maximum area of reinforcement - cl.9.2.1.1(3) — $A_{bb.max} = 0.04 \times h =$ **12000** mm^2/m

$\max(A_{bb.req}, A_{bb.min}) / A_{bb.prov} =$ **0.377**

PASS - Area of reinforcement provided is greater than area of reinforcement required

Library item: Rectangular single output

Crack control - Section 7.3

Limiting crack width — $w_{max} =$ **0.3** mm

Variable load factor - EN1990 – Table A1.1 — $\psi_2 =$ **0.6**

Serviceability bending moment — $M_{sls} =$ **51** kNm/m

Tensile stress in reinforcement — $\sigma_s = M_{sls} / (A_{bb.prov} \times z) =$ **119.3** N/mm^2

Load duration — Long term

Load duration factor — $k_t =$ **0.4**

Effective area of concrete in tension — $A_{c.eff} = \min(2.5 \times (h - d), (h - x) / 3, h / 2)$

$A_{c.eff} =$ **91042** mm^2/m

Mean value of concrete tensile strength — $f_{ct.eff} = f_{ctm} =$ **2.9** N/mm^2

Reinforcement ratio — $\rho_{p.eff} = A_{bb.prov} / A_{c.eff} =$ **0.023**

Modular ratio — $\alpha_e = E_s / E_{cm} =$ **6.091**

Bond property coefficient — $k_1 =$ **0.8**

Strain distribution coefficient — $k_2 =$ **0.5**

$k_3 =$ **3.4**

$k_4 =$ **0.425**

Maximum crack spacing - exp.7.11 — $s_{r.max} = k_3 \times c_{bb} + k_1 \times k_2 \times k_4 \times \phi_{bb} / \rho_{p.eff} =$ **403** mm

Maximum crack width - exp.7.8 — $w_k = s_{r.max} \times \max(\sigma_s – k_t \times (f_{ct.eff} / \rho_{p.eff}) \times (1 + \alpha_e \times \rho_{p.eff}), 0.6 \times \sigma_s) / E_s$

$w_k =$ **0.144** mm

$w_k / w_{max} =$ **0.48**

PASS - Maximum crack width is less than limiting crack width

Rectangular section in shear - Section 6.2

Design shear force — $V =$ **96.4** kN/m

$C_{Rd,c} = 0.18 / \gamma_C =$ **0.120**

$k = \min(1 + \sqrt{(200 mm / d)}, 2) =$ **1.964**

Longitudinal reinforcement ratio — $\rho_l = \min(A_{bb.prov} / d, 0.02) =$ **0.010**

$v_{min} = 0.035 N^{1/2}/mm \times k^{3/2} \times f_{ck}^{0.5} =$ **0.528** N/mm^2

Design shear resistance - exp.6.2a & 6.2b — $V_{Rd.c} = \max(C_{Rd.c} \times k \times (100 N^2/mm^4 \times \rho_l \times f_{ck})^{1/3}, v_{min}) \times d$

$V_{Rd.c} =$ **156.1** kN/m

$V / V_{Rd.c} =$ **0.618**

PASS - Design shear resistance exceeds design shear force

Check base design at toe

Depth of section — $h =$ **300** mm

Rectangular section in flexure - Section 6.1

Design bending moment combination 1 — $M =$ **1.7** kNm/m

Depth to tension reinforcement — $d = h - c_{bt} - \phi_{bt} / 2 =$ **245** mm

$K = M / (d^2 \times f_{ck}) =$ **0.001**

$K' = (2 \times \eta \times \alpha_{cc}/\gamma_C)\times(1 - \lambda \times (\delta - K_1)/(2 \times K_2))\times(\lambda \times (\delta - K_1)/(2 \times K_2))$

$K' = \mathbf{0.207}$

K' > K - No compression reinforcement is required

Lever arm	$z = \min(0.5 + 0.5 \times (1 - 2 \times K / (\eta \times \alpha_{cc} / \gamma_C))^{0.5}, 0.95) \times d = \mathbf{233}$ mm
Depth of neutral axis	$x = 2.5 \times (d - z) = \mathbf{31}$ mm
Area of tension reinforcement required	$A_{bt.req} = M / (f_{yd} \times z) = \mathbf{17}$ mm^2/m
Tension reinforcement provided	10 dia.bars @ 150 c/c
Area of tension reinforcement provided	$A_{bt.prov} = \pi \times \phi_{bt}^2 / (4 \times s_{bt}) = \mathbf{524}$ mm^2/m
Minimum area of reinforcement - exp.9.1N	$A_{bt.min} = \max(0.26 \times f_{ctm} / f_{yk}, 0.0013) \times d = \mathbf{369}$ mm^2/m
Maximum area of reinforcement - cl.9.2.1.1(3)	$A_{bt.max} = 0.04 \times h = \mathbf{12000}$ mm^2/m
	$\max(A_{bt.req}, A_{bt.min}) / A_{bt.prov} = \mathbf{0.705}$

PASS - Area of reinforcement provided is greater than area of reinforcement required

Library item: Rectangular single output

Crack control - Section 7.3

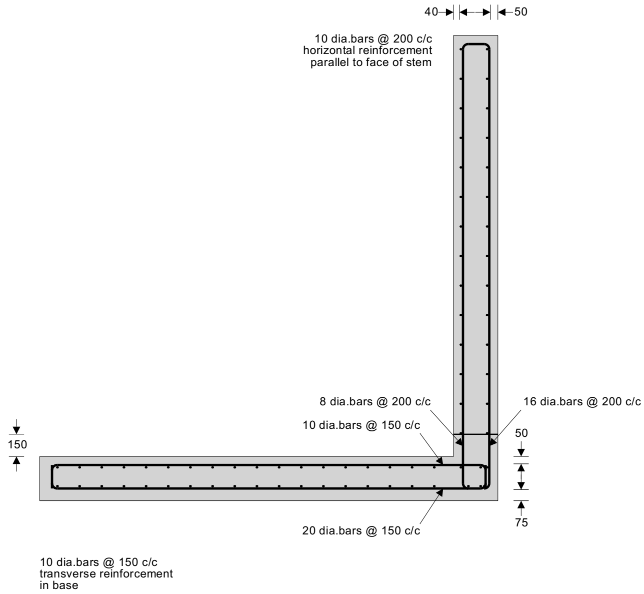
Limiting crack width	$w_{max} = \mathbf{0.3}$ mm
Variable load factor - EN1990 – Table A1.1	$\psi_2 = \mathbf{0.6}$
Serviceability bending moment	$M_{sls} = \mathbf{0}$ kNm/m
Tensile stress in reinforcement	$\sigma_s = M_{sls} / (A_{bt.prov} \times z) = \mathbf{0}$ N/mm^2
Load duration	Long term
Load duration factor	$k_t = \mathbf{0.4}$
Effective area of concrete in tension	$A_{c.eff} = \min(2.5 \times (h - d), (h - x) / 3, h / 2)$
	$A_{c.eff} = \mathbf{89792}$ mm^2/m
Mean value of concrete tensile strength	$f_{ct.eff} = f_{ctm} = \mathbf{2.9}$ N/mm^2
Reinforcement ratio	$\rho_{p.eff} = A_{bt.prov} / A_{c.eff} = \mathbf{0.006}$
Modular ratio	$\alpha_e = E_s / E_{cm} = \mathbf{6.091}$
Bond property coefficient	$k_1 = \mathbf{0.8}$
Strain distribution coefficient	$k_2 = \mathbf{0.5}$
	$k_3 = \mathbf{3.4}$
	$k_4 = \mathbf{0.425}$
Maximum crack spacing - exp.7.11	$s_{r.max} = k_3 \times c_{bt} + k_1 \times k_2 \times k_4 \times \phi_{bt} / \rho_{p.eff} = \mathbf{462}$ mm
Maximum crack width - exp.7.8	$w_k = s_{r.max} \times \max(\sigma_s - k_t \times (f_{ct.eff} / \rho_{p.eff}) \times (1 + \alpha_e \times \rho_{p.eff}), 0.6 \times \sigma_s) / E_s$
	$w_k = \mathbf{0}$ mm
	$w_k / w_{max} = \mathbf{0}$

PASS - Maximum crack width is less than limiting crack width

Secondary transverse reinforcement to base - Section 9.3

Minimum area of reinforcement – cl.9.3.1.1(2)	$A_{bx.req} = 0.2 \times A_{bb.prov} = \mathbf{419}$ mm^2/m
Maximum spacing of reinforcement – cl.9.3.1.1(3)	$s_{bx\_max} = \mathbf{450}$ mm
Transverse reinforcement provided	10 dia.bars @ 150 c/c
Area of transverse reinforcement provided	$A_{bx.prov} = \pi \times \phi_{bx}^2 / (4 \times s_{bx}) = \mathbf{524}$ mm^2/m

PASS - Area of reinforcement provided is greater than area of reinforcement required



Reinforcement details

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APPENDIX C
SITE INVESTIGATION AND GROUND MOVEMENT ASSESSMENT

70 Lady Margaret Road
London
NW5 2NP

Desk Study, Ground Investigation & Basement Impact Assessment

Philip Allard

October 2023

J23059
Rev 2

Ground investigation | Geotechnical consultancy | Contaminated land assessment

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Rev No	Status	Revision Details	Date	Approved for Issue
0	Final		3 May 2023	
1	Final	Requested amendments	24 May 2023	
2	Final	Response to CR comments	6 October 2023	SH

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

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Contents

GEA

Executive summary

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

Brief

This report describes the findings of a site investigation carried out by Geotechnical and Environmental Associates Limited (GEA) on the instructions of Symmetrys, on behalf of Philip Allard, with respect to partial demolition of the existing rear extension and subsequent construction of a new extension with a single level basement. The purpose of the investigation has been to determine the ground conditions and hydrogeology, to provide a preliminary assessment of the presence of contamination and to provide information to assist with the design of the basement structure and suitable foundations. The report also includes information required to comply with London Borough of Camden Planning Guidance (CPG) Basements, relating to the requirement for a Basement Impact Assessment (BIA), including a ground movement analysis (GMA).

Previous desk study findings

The earliest map studied, dated 1850, shows the site to be vacant, with Maiden Lane present in the location of present-day Brecknock Road, located approximately 35 m to the north of the site. This road had been renamed to Brecknock Road by 1871. The map dated 1895 shows that the existing house had been constructed and significant development had taken place in the surrounding area. A post office was present approximately 10 m to the north of the site. With the exception of some houses removed in the 1930s and 1940s, some of which were presumably following WWII bomb damage in the surrounding area, very few changes are noted on subsequent maps. Planning permission was granted for the site in February 1970 for the erection of an extension to the existing building to provide an additional kitchen. The site and surrounding area have since remained largely unchanged.

Ground conditions

The expected ground conditions were encountered in that, below a moderate thickness of made ground, the London Clay Formation was proved to the maximum depth investigated of 9.50 m. The made ground was underlain by patio slabs or decorative gravel and was found to comprise very soft orange brown and reddish brown sandy slightly gravelly clay with variable amounts of brick and concrete fragments, flint gravel, tile, metal, carbonaceous material, slate and roots and rootlets, present to a maximum depth of 0.80 m. Below this, the London Clay was present which comprised an initial layer of firm becoming stiff brown mottled light grey slightly sandy clay with occasional decayed rootlets and fine to coarse selenite to a depth of 5.00 m. This initial layer contained several lenses of fine orange brown sand. Decayed rootlets were present to a depth of 3.80 m but no visual evidence of desiccation was identified. Below this, the London Clay comprised stiff becoming very stiff brown mottled orange brown clay with occasional selenite to the full depth investigated of 9.50 m.

Groundwater was not encountered in the borehole and the standpipe installed was found to be dry during a subsequent monitoring visit. Groundwater seepages were present at the base of Trial Pit No 2 and at a depth of 0.50 m in Trial Pit No 3. Both of these trial pits were excavated to identify the shallow foundation configuration of the single-storey extension and the seepages are thought to be due to the water building up against the foundations of this building.

Contamination testing has indicated two of the samples to contain marginally elevated concentrations of lead. Additionally, fibres of chrysotile asbestos were encountered in three of the four samples, at concentrations of less than 0.001%.

Recommendations

Formation level for the proposed basement should be within the firm to stiff London Clay. Excavations for the proposed basement structure will require temporary support to maintain stability and to prevent any excessive ground movements. Significant groundwater flows are not expected to be encountered within the basement excavation. The use of concrete underpinning to form the basement retaining walls is considered a suitable solution in view of the ground conditions at this site. New spread foundations bearing in the London Clay below basement level may be designed to apply a net allowable bearing pressure of 150 kN/m^2.

Site workers should adopt suitable precautions when handling soil but a requirement for any permanent remedial works is not envisaged.

Basement Impact Assessment

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

The ground movement analysis and building damage assessment has indicated that the basement is not expected to cause unacceptable movements or levels of damage to surrounding sensitive structures.

Part 1: Investigation Report

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

1.0 Introduction

Geotechnical and Environmental Associates Limited (GEA) has been commissioned by Symmetrys on behalf of Philip Allard to carry out a desk study, ground investigation and ground movement assessment at 70 Lady Margaret Road, London NW5 2NP.

This report also forms part of a Basement Impact Assessment (BIA), which has been carried out in accordance with guidelines from the London Borough of Camden (LBC) in support of a planning application.

1.1 Proposed Development

The proposed development involves the demolition of the existing three-storey rear extending structure and the construction of a ground plus two-storey extension attached to the existing retained structure and a single-storey basement underneath the proposed extension.

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

1.2 Purpose of Work

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

- to check the history of the site with respect to previous contaminative uses;
- to provide an assessment of the risk of encountering unexploded ordnance (UXO);
- to determine the ground conditions and their engineering properties;
- to use the above information to provide recommendations with respect to the design of suitable foundations and retaining walls;
-
- to assess the impact of the proposed basement on the local hydrogeology, hydrology and stability of the surrounding natural and build environment;
- to provide an indication of the degree of soil contamination present; and
- to assess the risk that any such contamination may pose to the proposed development, its users or the wider environment.

1.3 Scope of Work

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

- a review of historical Ordnance Survey (OS) maps and environmental searches sourced from the Envirocheck database;
- a review of readily available geological maps;
- a preliminary unexploded ordnance (UXO) risk assessment carried out by 1st Line Defence; and
- a walkover survey of the site carried out in conjunction with the fieldwork.

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

- a single borehole advanced to a depth of 9.50 m below ground level using a cut-down opendrive sampling rig;
- standard penetration tests (SPTs) carried out at regular intervals within the borehole to provide quantitative data on the strength of the soils;
- three manually excavated trial pits to determine the configuration of existing foundations;
- the installation of a single groundwater monitoring standpipe in the borehole and a single subsequent monitoring visit;

- testing of selected soil samples for contamination and geotechnical purposes; and
- provision of a report presenting and interpreting the above data, together with our advice and recommendations with respect to the proposed development.

This report includes a contaminated land assessment which has been undertaken by a suitably qualified and competent professional in accordance with the methodology presented by the Environment Agency in their Land contamination risk assessment (LCRM)[1] published 19 April 2021. This involves identifying, making decisions on, and taking appropriate action to deal with, land contamination in a way that is consistent with government policies and legislation within the United Kingdom. Risk management is divided into three stages; Risk Assessment, Options Appraisal and Remediation, and each stage comprises three tiers. The Risk Assessment stage includes preliminary risk assessment (PRA), generic quantitative risk assessment (GQRA) and detailed quantitative risk assessment (DQRA)and this report includes the PRA and GQRA.

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

1.3.1 Basement Impact Assessment

The work carried out includes a Hydrological and Hydrogeological Assessment and Land Stability Assessment (also referred to as Slope Stability Assessment). These assessments form part of the BIA procedure specified in the London Borough of Camden Planning Guidance CPG[2] and their Guidance for Subterranean Development[3] prepared by Arup (the "Arup report") in accordance with Policy A5 of the Camden Local Plan 2017. The aim of the work is to provide information on surface water, groundwater and land stability and in particular to assess whether the development will affect neighbouring properties or groundwater movements and whether any identified impacts can be appropriately mitigated by the design of the development.

1.3.2 Qualifications

The land stability element of the Basement Impact Assessment (BIA) has been carried out by Martin Cooper, a BEng in Civil Engineering, a chartered engineer (CEng), member of the Institution of Civil Engineers (MICE), and Fellow of the Geological Society (FGS) who has over 20 years' specialist experience in ground engineering. The subterranean (groundwater) flow assessment has been carried out by Nick Mannix, MSc in Hydrogeology, Chartered Geologist (CGeol) and Fellow of the Geological Society of London (FGS). The surface water and flooding assessment has been carried out by Rupert Evans, a hydrologist with more than ten years consultancy experience in flood risk assessment, surface water drainage schemes and hydrology / hydraulic modelling. Rupert Evans is a Chartered Environmentalist, Chartered Water and Environmental Manager and a Member of CIWEM.

The assessments have been made in conjunction with Steve Branch, a BSc in Engineering Geology and Geotechnics, MSc in Geotechnical Engineering, a Chartered Geologist (CGeol) and Fellow of the Geological Society (FGS) with some 30 years' experience in geotechnical engineering and engineering geology.

All assessors meet the qualification requirements of the Council guidance.

1.4 Limitations

The conclusions and recommendations made in this report are limited to those that can be made on the basis of the investigation. The results of the work should be viewed in the context of the range of data sources consulted, the number of locations where the ground was sampled and the number of soil, gas or ground water samples tested. No liability can be accepted for information in other data sources or conditions not revealed by the sampling or testing. Any comments made on the basis of information obtained from the client or third parties are given in good faith on the assumption that the information is accurate; no independent validation of such information has been made by GEA.

1 https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm
2 London Borough of Camden Planning Guidance CPG (January 2021) *Basements*
3 Ove Arup & Partners (2010) *Camden geological, hydrogeological and hydrological study. Guidance for Subterranean Development.* For London Borough of Camden November 2010

2.0 The Site

2.1 Site Description

The site is located in London Borough of Camden, approximately 250 m to the south of Tufnell Park London Underground station. It fronts onto and is accessed from Lady Margaret Road to the northwest and is bordered to the northeast by 70A Lady Margaret Road, to the southwest by 68 Lady Margaret Road and to the southeast by the rear garden of Nos 149-151 Brecknock Road. The site may be additionally located by National Grid Reference 529310, 185600 and is shown on the map extract below.

A walkover of the site was carried out by a geotechnical engineer from GEA at the time of the fieldwork. The site is roughly rectangular in shape and measures approximately 60 m northwest to southeast by 10 m northeast to southwest. It is occupied by a three-storey to four-storey residential property with associated front and rear gardens and a passageway running along the northern boundary. A small, low-headroom basement is present below the front of the site, likely to have been used as a coal cellar or similar. A single storey extension was constructed at the rear of the site in the 1970s. The house is located in the northwest of the site with a small patio and low garden wall in the centre of the site. A long and narrow grassed garden with planters surrounding is present in the southeast of the site. A semi-mature deciduous tree is present in the garden close to the single-storey extension and several mature and semi mature shrubs, bushes and trees are located in the planters and along the northern, southern and eastern boundaries both on and just off site in neighbouring gardens.

The site is sensibly level. At the front of the site is a paved pedestrian walkway and Lady Margaret Road slopes gently towards the northeast.

2.1.1 Adjoining Structures

No 68 Lady Margaret Road to the southeast is formed of three-storeys and also probably includes a single level part-basement similar to the subject site. No 70A Lady Margaret Road appears to be a small, single storey building. It is not known if this has a basement but it is considered unlikely. However, the building is constructed on a level considerably lower than that of No 70 Lady Margaret Road.

2.2 Site History

The earliest map studied, dated 1850, shows the site to be vacant, with Maiden Lane in the location of present-day Brecknock Road, located approximately 35 m to the north of the site. This road had been renamed Brecknock Road by 1871.

The map dated 1895 shows the existing house had been constructed on site and significant development had taken place in the surrounding area. A post office was present approximately 10 m to the north of the site.

With the exception of some houses removed in the 1930s and 1940s, presumably due to WWII damage in the surrounding area, very few changes are noted on subsequent maps. Planning permission was granted for the site in February 1970 for the erection of an extension to the existing building to provide an additional kitchen.

2.3 Other Information

Environmental searches revealed no records of any existing and historical landfill sites, waste management, treatment or disposal sites within 700 m of the site. Additionally, no areas of potentially infilled land are recorded within 600 m of the site.

No pollution incidents to controlled waters have been recorded within 900 m of the site. Furthermore, no fuel stations are recorded within 450 m of the site.

The search indicated that the site is located in an area where less than 1% of homes are affected by radon emissions; according to records held by the Health Protection Agency, and as such radon protection measures will not be required.

2.4 Preliminary UXO Risk Assessment

A Preliminary UXO Risk Assessment has been undertaken by 1st Line Defence, and a copy of their report (ref PRA-17472, dated February 2023) is included within the appendix. The risk assessment has been carried out in accordance with the guidelines provided by CIRIA[4], which state that the likelihood of encountering and detonating UXO below a site should be assessed along with establishing the consequences that may arise. The first phase comprises a preliminary risk assessment, which should be undertaken at an early stage of the development planning. If such an assessment identifies a high level of risk then a detailed risk assessment should be carried out by a UXO specialist, which will identify an appropriate course of action with regard to risk mitigation.

The report indicates that during WWII (world war II) the site was located within the Metropolitan Borough of St Pancras which sustained an overall very high density of bombing. Reference to London Bomb Census mapping has indicated the nearest bomb strike to the site to be at the junction of Lady Margaret Road and Brecknock Road. The lack of bombing on the site is corroborated by the LLC bomb damage map, which does not record any damage to structures on or immediately surrounding the site. The closest damage is recorded approximately 25 m north and 45 m south and west. Available aerial photography does not indicate any damage to the site during the war, or on the neighbouring sites. As a result, it was concluded that the risk level at the site is not considered to be significantly elevated above the 'background level' for the wider area and it was therefore recommended that no further research or mitigation was required.

2.5 Geology

The British Geological Survey (BGS) map of the area (Sheet 256) indicates the site is directly underlain by the London Clay. However, the site is shown within an area of previously worked ground. According to the BGS memoir, the London Clay is homogenous, slightly calcareous silty clay to very silty clay, with some beds of clayey silt grading to silty fine-grained sand. The London Clay overlies a downwards sequence of Lambeth Group (sandy clays) overlying Thanet Sand (fine grained sands), which in turn overlies the Cretaceous Chalk.

A search of the BGS borehole archive revealed the records of a borehole drilled approximately 80 m to the east of the site, which extended to a depth of about 12 m. The borehole initially encountered made ground described as rubble which extended to a depth of 0.30 m. Below this depth the London Clay was encountered and is described as an initial layer of firm to stiff brown and mottled brown fissured silty clay, extending to a depth of 11.00 m, below which the London Clay was described as stiff blue/grey fissured silty clay which extended to the full depth of the borehole.

2.6 Hydrology and Hydrogeology

The London Clay Formation is classified as Unproductive Strata, referring to rock layers or drift deposits with low permeability and that have negligible significance for water supply or river base flow.

As the London Clay is likely to comprise predominantly clay soils, it cannot support groundwater flow over any significant distance, nor can it be considered to support a "water table" or continuous piezometric surface. Boreholes constructed within clays can fill with water, due to the often high water content of shallow clays draining into the standpipe or by the collection of surface water drainage, which is unable to drain through the clay; however, this is not reflective of the type of groundwater flow that would occur in a porous and permeable saturated stratum.

The permeability of the weathered London Clay will be predominantly secondary, through fissures in the clay. Published data indicates the horizontal permeability of the London Clay to generally range between 1×10^{-11} m/s and 1×10^{-9} m/s.

Groundwater was not encountered during the advancement of the BGS borehole described in the previous section. There are no surface water features within 450 m of the site and the site lies outside the catchment of the Hampstead Heath chain of ponds but is shown to be within an area of worked ground on Figure 16 of the Arup report.

The site is not located within a groundwater Source Protection Zone (SPZ) and there are no groundwater abstraction zones located within 1 km of the site.

4 CIRIA C681 (2009) *Unexploded ordnance (UXO) A guide for the construction industry*

Lady Margaret Road is listed within the London Borough of Camden report[5] as having suffered from surface water flooding in the 2002 flooding event. However, the report indicates that the Road did not suffer surface water flooding at the site during the 1975 event.

Spring lines are present at the interface of the Bagshot Beds and the Claygate Member in the area of Hampstead Heath and, to a lesser extent, near the boundary between the Claygate Member and the underlying lowly permeable London Clay. These springs have been the source of a number of London's lost rivers, including the Tyburn and Westbourne.

Figure 11 of the Arup report and reference to the Lost Rivers of London[6] indicates that the site does not lie in close proximity to the path of any former watercourses.

The site is largely covered by the existing building and hardstanding and therefore infiltration of rainwater into the ground beneath the site is limited to the front and rear gardens, and the majority of surface runoff is likely to drain into combined sewers in the road.

2.7 Preliminary Risk Assessment

Part IIA of the Environmental Protection Act 1990, which was inserted into that Act by Section 57 of the Environment Act 1995, provides the main regulatory regime for the identification and remediation of contaminated land. The determination of contaminated sites is based on a "suitable for use" approach which involves managing the risks posed by contaminated land by making risk-based decisions. This risk assessment is carried out on the basis of a source-pathway-receptor approach.

Source

The desk study findings indicate that the site has not had a potentially contaminative history as it has been occupied by the existing buildings since the early 20th Century.

The buildings on site may have asbestos included in their construction, such that fragments or fibres of asbestos, as well as heavy metals or polyaromatic hydrocarbons (PAHs) may have entered the shallow soils during construction, and there is a risk of these contaminants being released during demolition. As with any developed site, there is the potential for localised spillages and leakages, but this is not considered to represent a significant source of contamination.

There are no historical or existing landfill sites within 1 km of the site and no areas of potentially infilled land within 600 m of the site, therefore there is not a risk to the site from landfill gas.

Receptor

The continued use of the site as for residential purposes means that end users represent high sensitivity receptors.

Buried services are likely to come into contact with any contaminants present within the soils through which they pass, and site workers are likely to come into contact with any contaminants present during construction works.

Groundwater and adjacent sites are also considered relatively sensitive receptors.

Pathway

Within the site, end users will be isolated from direct contact with any contaminants present within the made ground by the house and surrounding hard surfacing, thus potential contaminant exposure pathways will exist with respect to end users only in areas of proposed soft landscaping.

There will be a potential for contaminants to move onto or off the site horizontally within the made ground via any perched groundwater flows, although these pathways are already in existence. A pathway for ground workers to come into contact with any contamination will exist during construction work and services will come into contact with any contamination within the soils in which they are laid.

There is thus considered to be a low potential for a contaminant pathway to be present between any potential contaminant source and a target for the particular contaminant.

Preliminary Risk Appraisal

On the basis of the above it is considered that there is a LOW risk of there being a significant contaminant linkage at this site which would result in a requirement for major remediation work. Furthermore, as there is no evidence of filled ground within the vicinity of the site and no landfill sites, there is not considered to be a significant potential for hazardous soil gas to be present on or migrating towards the site.

5 London Borough of Camden (2003) *Floods in Camden, Report of the Floods Scrutiny Panel*

6 Barton, N, & Meyers, S (2016) *The Lost Rivers of London (revised and extended edition with colour maps).* Historical Publications Ltd.

3.0 Screening

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

3.1 Screening Assessment

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

3.1.1 Subterranean (groundwater) Screening Assessment

Question	Response for 70 Lady Margaret Road
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 water in sufficient quantities to support groundwater abstractions or watercourses.
1b. Will the proposed basement extend beneath the water table surface?	No. The London Clay and clay dominated Head Deposits, if present, cannot support groundwater flow and cannot therefore support a water table consistent with a permeable water bearing strata.
2. Is the site within 100 m of a watercourse, well (used/ disused) or potential spring line?	No. There are no surface water features within 450 m of the site and the site does not lie in close proximity to any of the lost rivers of London.
3. Is the site within the catchment of the pond chains on Hampstead Heath?	No. Topographical maps acquired as part of the desk study and Figures 12 and 14 of the Arup report confirms that the site is not located within this catchment area
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	*Yes, there will be a decrease in impermeable area as a result of the development from the existing 109.3 m2 to 59 m2 due to the use of a green roof and permeable paving to replace existing. However, the low permeability of the underlying London Clay would result in a low recharge in any case and consequently there would be little or no effect on groundwater.*
5. As part of the site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or SUDS)?	No. Given that the site is underlain by clay soils and is unlikely to be suitable for a soakaway or similar SUDS based system, the site drainage will therefore be directed to public sewer. Site drainage will therefore be designed to generally maintain the existing situation. Green roofs to replace existing impermeable roofs will provide some limited water attenuation and it is proposed to utilise water buts to save water.
6. Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to or lower than, the mean water level in any local pond or spring line?	No. There are no groundwater dependent ponds or spring lines present within 500 m of the site. The flow of the former Tyburn watercourse was perched on the London Clay.

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

Q4 There will be a decrease in hardstanding at the rear of the site.

3.1.2 Stability Screening Assessment

Question	Response for 70 Lady Margaret Road
1. Does the existing site include slopes, natural or manmade, greater than 7°?	No, as indicated on the Slope Angle Map Fig 16 of the Arup report. However, the slope does gradually slope falling to the northwest.
2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to > 7°?	No. The site is not to be significantly re-profiled as part of the development.
3. Does the development neighbour land, including railway cuttings and the like, with a slope > 7°?	No. As indicated on the Slope Angle Map Fig 16 of the Arup report. The adjacent land has a slope similar to that of the site.
4. Is the site within a wider hillside setting in which the general slope is greater than 7°?	No. As indicated on the Slope Angle Map Fig 16 of the Arup report.
5. Is the London Clay the shallowest strata at the site?	*Yes. As indicated on the geological map and Figures 3, 5 and 8 of the Arup report.*
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. A single tree will be removed, although this work is unrelated to the development, due to previous subsidence issues.*

Question	Response for 70 Lady Margaret Road
7. Is there a history of seasonal shrink-swell subsidence in the local area and / or evidence of such effects at the site?	*Yes. The area is prone to these effects as a result of the presence of shrinkable London Clay.*
8. Is the site within 100 m of a watercourse or potential spring line?	No. There are no surface water features or Lost Rivers of London located within 100 m of the site.
9. Is the site within an area of previously worked ground?	*Yes. The geological map of the area and Figures 3, 4 and 8 of the LB Camden, Camden Geological, Hydrogeological and Hydrological Study – Guidance for Subterranean Development produced by Arup, 2010, do indicate the site to be underlain by worked ground.*
10a. Is the site within 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.
10b. Will the proposed basement extend beneath the water table such that dewatering may be required during construction?	No. The London Clay cannot support a continuous water table.
11. Is the site within 50 m of Hampstead Heath ponds?	No. Figure 14 of the LB Camden, Camden Geological, Hydrogeological and Hydrological Study – Guidance for Subterranean Development produced by Arup, 2010, report confirms that the site is not located within 50 m of the Hampstead Heath ponds.
12. Is the site within 5 m of a highway or pedestrian right of way?	The site fronts onto Lady Margaret Road, however, the basement development is proposed towards the rear of the building and does not extend within 5 m of the roadway.
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	*Yes. Although No 68 Lady Margaret Road is known to have a basement similar to that of the existing basement on the site, some of the walls will be founded close to ground level. Additionally, it is assumed that the foundations of No 70A are formed close to ground level, with no basement present. The maximum dig will be 2.90 m. The foundations of No 68 Lady Margaret Road will be underpinned adjacent to the excavation.*
14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	No. The site is not located on any railway or tube line.

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

Q5 The London Clay is the shallowest strata beneath the site.
Q6 A tree will be felled as part of the development
Q7 The site is in an area likely to be affected by seasonal shrink-swell.
Q9 The site is located within an area of previously worked ground.
Q13 The proposed basement will significantly increase the differential depth of foundations relative to neighbouring properties.

3.1.3 Surface Flow and Flooding Screening Assessment

Question	Response for 70 Lady Margaret Road
1. Is the site within the catchment of the pond chains on Hampstead Heath?	No. Figure 14 of the LB Camden, Camden Geological, Hydrogeological and Hydrological Study – Guidance for Subterranean Development produced by Arup, 2010, confirms that the site is not located within this catchment area.
2. As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route?	No. Any additional surface water from the marginal increase in hardstanding area will be attenuated and discharged into the sewers to ensure the surface water flow regime will be unchanged. The basement will mainly be beneath the footprint of the building and existing hardstanding areas, and the 1m distance between the roof of the basement and ground surface as recommended by section 3.2 of the CPG Basements 2021 does not apply across these areas.
3. Will the proposed basement result in a change in the proportion of hard surfaced / paved areas?	*Yes, there will be a decrease in impermeable area as a result of the development from the existing 109.3 m2 to 59 m2 due to the use of a green roof and permeable paving to replace existing.*
4. Will the proposed basement development result in changes to the profile of the inflows (instantaneous and long term) of surface water being received by adjacent properties or downstream watercourses?	No. Any additional surface water from the marginal increase in hardstanding area will be attenuated and discharged into the sewers to ensure the surface water flow regime will be unchanged. The basement will be beneath the footprint of the building, and the 1 m distance between the roof of the basement and ground surface as recommended by section 3.2 of the CPG Basements 2021 does not apply across these areas.
5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	No. The proposal is very unlikely to result in any changes to the quality of surface water being received by adjacent properties or downstream watercourses as the surface water drainage regime will be unchanged and the land uses will remain the same.

Question	Response for 70 Lady Margaret Road
6. Is the site in an area identified to have surface water flood risk according to either the Local Flood Risk Management Strategy or the Strategic Flood Risk Assessment or is it at risk of flooding, for example because the proposed basement is below the static water level of nearby surface water feature?	*Yes. The Camden Flood Risk Management Strategy dated 2013, together with Figures 3v, 4e, 5a and 5b of the SFRA dated 2014, and Environment Agency online flood maps show that the site has a very low flooding risk from sewers, reservoirs (and other artificial sources), groundwater and fluvial/tidal watercourses.* *The Environment Agency online flood maps and Figure 3v of the SFRA show that the site has a very low to low flooding risk from surface water. The flood depth is shown to be <0.3 m during the low risk event.* *It is possible that the basement will be constructed within pockets of perched water and the recommendations outlined in the BIA with regards to water-proofing and tanking of the basement will reduce the risk to acceptable levels.* *In accordance with paragraph 5.11 of the CPG, a positive pumped device will be installed in the basement in order to further protect the site from sewer flooding.*

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

Q3 There will be a decrease in hardstanding at the rear of the site.

Q6 The site is at a low risk of surface water flooding. Whilst it is shown to be in an area at risk of surface water flooding, it is classified as a very low to low risk and as such it is not considered necessary to take it forward to the scoping stage.

4.0 Scoping and Site Investigation

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

4.1 Potential Impacts

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

Potential Impact	Consequence
London Clay is the shallowest stratum at the site.	The London Clay is prone to seasonal shrink-swell (subsidence and heave).
Seasonal shrink-swell can result in foundation movements.	Multiple potential impacts depending on the specific setting of the basement development. For example, the implications of a deepened basement/foundation system on neighbouring properties should be considered.
Increase in the proportion of hard standing.	Less soft covering for surface water infiltration. However, the extent of the change will be minimal, and the London Clay is of very low permeability so will not make much difference.
The site is located within an area of previously worked ground.	Previously worked ground may be less homogeneous that natural strata which could result in differential settlement.
The development will significantly increase the differential depth of foundations relative to neighbouring properties.	The basement excavation may result in structural damage to neighbouring properties.
A tree will be felled during the development	The removal of the tree will likely lead to a gradual swelling of the ground which could affect soil strength and therefore slope stability. Additionally the binding effect of the tree roots may have been beneficial to slope stability.

These potential impacts have been investigated through the site investigation, as detailed in Section 13.0.

4.2 Exploratory Work

Access to the site was limited by the presence of the existing buildings, which remained occupied and in use at the time of the investigation. Therefore, in order to meet the objectives described in Section 1.2, as far as was possible within the access constraints of the existing building, a single borehole was advanced, to a depth of 9.50 m using demountable opendrive percussive sampling equipment. Additionally three trial pits were hand excavated to a maximum depth of 1.45 m to determine the configuration of the existing foundations.

During boring, undisturbed samples were obtained from the borehole for subsequent laboratory examination and testing. A single groundwater monitoring standpipe was installed in the borehole to a depth of 5.00 m and a single monitoring visit has been undertaken to date.

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

All of the above work was carried out under the supervision of a geotechnical engineer from GEA. The borehole records are appended, together with a site plan indicating the exploratory positions.

4.3 Sampling Strategy

The boreholes were positioned on site by a geotechnical engineer from GEA in accessible areas, with due regard to the proposed development and the locations of known buried services. The trial pit positions were specified by the consulting engineers.

Four samples of the made ground have been tested for the presence of contamination. The analytical suite of testing was selected to identify a range of typical industrial contaminants for the purposes of general coverage. For this investigation the analytical suite for the soil included a range of metals, total petroleum hydrocarbons (TPH), polycyclic aromatic hydrocarbons (PAH), total cyanide and monohydric phenols. The samples were also screened for the presence of asbestos. The contamination analyses were carried out at an MCERTs accredited laboratory with the majority of the testing suite accredited to MCERTS standards. A summary of the MCERTs accreditation and test methods are included with the attached results and further details are available upon request.

5.0 Ground Conditions

The investigation encountered the anticipated ground conditions in that below a moderate thickness of made ground, the London Clay Formation was encountered and was proved to the maximum depth investigated of 9.50 m.

5.1 Made Ground

The made ground was underlain by patio slabs or decorative gravel and was found to comprise very soft orange brown and reddish brown sandy slightly gravelly clay with variable amounts of brick and concrete fragments, flint gravel, tile, metal, carbonaceous material, slate and roots and rootlets, present to a maximum depth of 0.80 m.

Apart from the presence of fragments of extraneous material noted above, no visual or olfactory evidence of contamination was observed during the fieldwork. Four samples of the made ground have however been analysed for a range of contaminants as a precautionary measure and the results are detailed within Section 5.4.

5.2 London Clay

The London Clay comprised an initial layer of firm becoming stiff brown mottled light grey slightly sandy clay with occasional decayed rootlets and fine to coarse selenite to a depth of 5.00 m. This initial layer contained several sand lenses comprising fine orange brown sand. Decayed rootlets were present to a depth of 3.80 m but no visual evidence of desiccation was identified. Below this depth, the London Clay comprised stiff becoming very stiff brown mottled orange brown clay with occasional selenite to the full depth investigated of 9.50 m.

The results of plasticity index tests indicate the clay to be of high volume change potential, and the results of quick undrained triaxial tests undertaken on undisturbed samples of the clay from the adjacent site indicate the clay to be of medium becoming very high strength.

5.3 Groundwater

Groundwater was not encountered in the borehole. Groundwater seepages were present at the base of Trial Pit No 2 and at a depth of 0.50 m in Trial Pit No 3. Both of these trial pits were excavated to identify the shallow foundation configuration of the single-storey extension and the seepages are thought to be due to the water building up against the foundations of this building. A groundwater standpipe was installed to a depth of 5.00 m within Borehole No 1 which was found to be dry during a single subsequent monitoring visit.

5.4 Soil Contamination

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

Determinant	BH1 0.40 m	TP1 0.80 m	TP2 0.50 m	TP3 0.30 m
pH	8.0	7.9	7.8	9.5
Asbestos	Chrysotile	Not Detected	Chrysotile	Chrysotile
Asbestos Quantification	<0.001	NA	<0.001	<0.001
Arsenic	10	11	22	15
Cadmium	<0.2	<0.2	<0.2	<0.2
Chromium	33	36	34	35
Lead	65	88	**380**	**200**
Mercury	<0.3	0.4	0.7	<0.3
Copper	26	33	91	28
Nickel	21	23	26	23
Selenium	<1.0	<1.0	<1.0	<1.0
Zinc	53	60	200	160
Total PAH	<0.80	<0.80	12.4	2.42
Sulphide	22	8.7	40	4.4
Total Cyanide	<1.0	<1.0	<1.0	<1.0
Total Organic Carbon	0.8	1.2	1.6	0.8
Benzo(a)pyrene	<0.05	<0.05	1.1	0.23
Naphthalene	<0.05	<0.05	0.11	<0.05
TPH	<10	<10	<10	<10
Total Phenols	<1.0	<1.0	<1.0	<1.0
Note: Figures in bold indicate values in excess of the generic guideline screening values.				

5.4.1 Generic Quantitative Risk Assessment

The use of a risk-based approach has been adopted to provide an initial screening of the test results to assess the need for subsequent site-specific risk assessments. Contaminants of concern are those that have values in excess of generic human health risk-based guideline values, which are either the CLEA[7] Soil Guideline Values where available, the Suitable 4 Use Values[8] (S4UL) produced by LQM/CIEH calculated using the CLEA UK Version 1.07[9] software, or the DEFRA Category 4 Screening values[10], assuming a residential end use. The key generic assumptions for this end use are as follows:

- that groundwater will not be a critical risk receptor;
- that the critical receptor for human health will be a young female aged 0 to 6 years old;
- that the exposure duration will be 6 years;
- that the critical exposure pathways will be direct soil and indoor dust ingestion, consumption of home grown produce, consumption of soil adhering to home grown produce, skin contact with soils and dust, and inhalation of dust and vapours; and
- that the building type equates to a terraced house.

It is considered that these assumptions are acceptable for this generic assessment of this site. The tables of generic screening values derived by GEA and an explanation of how each value has been derived are included in the Appendix.

7 *Updated Technical Background to the CLEA Model (Science Report SC050021/SR3) Jan 2009* and Soil Guideline Value reports for specific contaminants; all DEFRA and Environment Agency.

8 *The LQM/CIEH S4Uls for Human Health Risk Assessment* S4UL3065 November 2014

9 Contaminated Land Exposure Assessment (CL|EA) Software Version 1.071 Environment Agency 2015

10 CL:AIRE (2013) *Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination* Final Project Report SP1010 and DEFRA (2014) *Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination* Policy Companion Document SP1010

Where contaminant concentrations are measured at concentrations below the generic screening value it is considered that they pose an acceptable level of risk and thus further consideration of these contaminant concentrations is not required. However, where concentrations are measured in excess of these generic screening values there is considered to be a potential that they could pose an unacceptable risk and thus further action will be required which could include;

- additional testing to zone the extent of the contaminated material and thus reduce the uncertainty with regard to its potential risk;
- site specific risk assessment to refine the assessment criteria and allow an assessment to be made as to whether the concentration present would pose an unacceptable risk at this site; or
- soil remediation or risk management to mitigate the risk posed by the contaminant to a degree that it poses an acceptable risk.

When comparing the results from the contamination testing to those in the Soil Guideline Values and Generic Guideline Values for a residential end use with plant uptake, two of the samples (TP2 0.50 m and TP3 0.30 m) were found to contain marginally elevated concentrations of lead (380 mg/kg and 200 mg/kg). Additionally, fibres of Chrysotile asbestos were encountered in three of the four samples at concentrations of less than 0.001%.

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

5.5 Existing Foundations

The findings of the trial pits are summarised in the table below. Sketches and photographs of each pit are included in the Appendix.

Trial Pit No	Section	Structure	Foundation detail	Bearing Stratum
1	A-A'	Main House	Not Determined Top NA Base <1.45 m Lateral projection NA	Not Proved
	B-B'	Low Brick Wall	Brick Footing Top 0.00 m Base 0.17 m Lateral projection 0 mm	Made Ground (brown and reddish brown slightly sandy slightly gravelly clay with brick and concrete fragments, roots and rootlets, tile, rare metal and carbonaceous material)
2	A-A'	1970's Extension	Mass concrete strip / trenchfill Top 0.68 m Base 0.81 m Lateral projection 290 mm	Firm orange brown silty CLAY
3	A-A'	1970's Extension	Mass concrete strip / trenchfill Top 0.55 m Base 0.68 m Lateral projection 330 mm	Firm orange brown silty CLAY

Part 2: Design Basis Report

This section of the report provides an interpretation of the findings detailed in Part 1, in the form of a ground model, and then provides advice and recommendations with respect to the proposed development.

6.0 Introduction

The proposed development involves the demolition of the existing three-storey rear extending structure and the construction of a ground plus two-storey extension attached to the existing retained structure and a single-storey basement underneath the proposed extension. The basement is expected to be extend to about 3.00 m below the current floor level and the loads are to supported by shallow spread foundations constructed just below basement level.

7.0 Ground Model

The desk study has revealed that the site does not have a potentially contaminative history, as it has only been developed with the existing buildings, and on the basis of the fieldwork, the ground conditions at this site can be characterised as follows:

- beneath a moderate thickness of made ground, London Clay extends to the full depth of the investigation, of 9.50 m;
- the made ground comprises orange-brown and reddish brown sandy slightly gravelly clay with brick and concrete fragments, flint gravel, tile, metal, carbonaceous material, slate and roots and rootlets, and extends to a maximum depth of 0.80 m;
- the London Clay comprises an initial horizon of firm becoming stiff brown mottled light grey slightly sandy clay with occasional decayed rootlets and fine to coarse selenite, extending to a depth of 5.00 m, below which stiff becoming very stiff brown mottled orange brown clay with occasional selenite is present and extends to the full depth investigated of 9.50 m.
- perched groundwater is present within the made ground around the existing foundations but no consistent water table is present beneath the site; and
- contamination testing has revealed the presence of very low levels of asbestos contamination and localised marginally elevated concentrations of lead within the made ground.

8.0 Advice & Recommendations

Excavations for the proposed basement structure will require temporary support to maintain stability and to prevent any excessive ground movements. Formation level for the basement will be within the London Clay at a depth of about 3.00 m below street level. On the basis of the investigation observations and the underlying ground conditions, significant groundwater inflows are not expected to be encountered within the basement excavation.

On the basis of the proposals and the contamination testing undertaken to date, there is not considered to be a requirement for remedial works.

8.1 Basement Construction

Formation level for the basement is likely to be within the stiff clay of the London Clay at a depth of about 3.00 m below ground level, which is similar to that of the existing basement section on the site.

Inflows of groundwater were not encountered in the borehole during drilling and the standpipe installed to a depth of 5.00 m was found to be dry during a subsequent monitoring visit. However, localised inflows were encountered within the trial pits. Whilst groundwater monitoring should continued, it is considered that significant groundwater inflows are not expected to be encountered in the basement excavation. Any relatively minor perched water inflows or seepages should be adequately dealt with through sump pumping, although it would be prudent for the chosen contractor to have a contingency plan in place to deal with more significant or prolonged inflows as a precautionary measure.

The design of basement support in the temporary and permanent conditions needs to take account of the need to maintain the stability of the excavation and surrounding structures, and to protect against potential shallow groundwater inflows. There are a number of methods by which the sides of the basement excavation could be supported in the temporary and permanent conditions. The choice of wall may be governed to a large extent by whether it is to be incorporated into the permanent works and have a load bearing function.

The final choice will depend to a large extent on the need to protect nearby structures from movements, the required overall stiffness of the support system, and the need to control groundwater movement through the wall in the temporary condition. In this respect the stability of the existing and adjacent buildings, will be paramount.

In the absence of significant groundwater inflows and the presence of clay soils, where the basement is to be constructed below the proposed extension footprint the use of underpinning in a traditional hit and miss approach is to be utilised along with the construction of cast in-situ reinforced concrete retaining walls constructed using a similar methodology. Careful workmanship will be required to ensure that movement of the surrounding structures does not occur and the contractor should be required to provide details of how they intend to control groundwater and instability of excavations, should it arise.

An assessment of the potential movements as a result of the proposed basement construction has been carried out as part of the Ground Movement Analysis, which is reported in Part 3.

8.1.1 Basement Retaining Walls

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

Stratum	Bulk Density (kg/m^3)	Effective Cohesion (c' – kN/m^2)	Effective Friction Angle (ϕ' – degrees)
Made ground	1700	Zero	27
London Clay	1950	Zero	23

Significant groundwater inflows are not anticipated within the basement excavation.

Provided that a fully effective drainage system can be ensured in order to prevent the build-up of groundwater behind the retaining walls, it should be possible to design the basement on the basis that water will not collect behind the walls. If an effective drainage system cannot be ensured, then a water level of two-thirds of the basement depth, subject to a minimum depth of 1.0 m, should be assumed. The advice in BS8102:2009[11] should be followed in this respect and with regard to the provision of suitable waterproofing.

8.1.2 Basement Heave

The 3.00 m deep excavation of the basement will result in an unloading of around 55 kN/m^2 which will result in the heave of the underlying London Clay. This will comprise immediate elastic movement, which will account for approximately 40 % of the total movement and be expected to be complete during the construction period, and long-term movements, which will theoretically take many years to complete. These movements will, to some extent, be mitigated by the loads applied by the proposed development, however the ground movements associated with the proposed basement excavation and construction have been considered in more detail in Part 3 of this report.

8.2 Spread Foundations

Spread foundations bearing beneath the proposed basement extension in the stiff clay of the London Clay may be designed to apply a net allowable bearing pressure of 150 kN/m^2.

The above value incorporates an adequate factor of safety against bearing capacity failure and should ensure that settlements remain within normal tolerable limits.

8.3 Shallow Excavations

On the basis of the borehole findings, it is considered that it will be generally feasible to form relatively shallow excavations terminating within the London Clay without the requirement for lateral support, although localised instabilities may occur where more granular material or groundwater is encountered.

Significant inflows of groundwater into shallow excavations are not generally anticipated, although seepages may be encountered from perched water tables within the made ground, particularly within the vicinity of existing foundations, although such inflows should be suitably controlled by sump pumping.

If deeper excavations are considered or if excavations are to remain open for prolonged periods it is recommended that provision be made for battered side slopes or lateral support. Where personnel are required to enter excavations, a risk assessment should be carried out and temporary lateral support or battering of the excavation sides considered in order to comply with normal safety requirements.

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

8.4 Basement Floor Slab

Following excavation of the basement, the floor slab will need to be suspended over a void or a layer of compressible material to accommodate the anticipated heave unless the slab can be suitably reinforced to cope with these movements.

Further information on the detailed movements is provided in the ground movement assessment in Part 3.

8.5 Effect of Sulphates

Chemical analyses have revealed moderate concentrations of soluble sulphate and near-neutral pH in accordance with Class DS-3 conditions of Table C2 of BRE Special Digest 1:SD Third Edition (2005). The measured pH values of the samples show that an ACEC class of AC-3s would be appropriate for the site. This assumes a static water condition at the site. The guidelines contained in the digest should be followed in the design of foundation concrete.

8.6 Contamination Risk Assessment

The desk study findings indicate that the site does not have a potentially contaminative history as it has been developed with the existing buildings for its entire developed history. Furthermore, no there are no potential offsite sources of contamination that are considered to pose a risk to the site.

The contamination testing revealed two of the samples (TP2 0.50 m and TP3 0.30 m) to contain marginally elevated concentrations of lead (380 mg/kg and 200 mg/kg). Additionally, fibres of chrysotile asbestos were encountered in three of the four samples at concentrations of less than 0.001%.

As asbestos is insoluble it is not considered to pose any meaningful risk to groundwater, the development or to neighbouring sites through migration in the ground. It is however potentially hazardous to human health as airborne fibres and could thus pose a risk through inhalation during construction works and to end users through direct contact pathways. The asbestos was found to be present at concentrations of less than 0.001% and was encountered in damp soil and as a result there is a negligible risk of fibres dusting into the air with respect to end users[12]. However, it would be prudent to provide suitable protection to site workers during the groundworks.

All work being carried out within asbestos containing soils should be carried out in accordance with the Control of Asbestos Regulations, including toolbox talks for all workers and having the correct PPE in place. During the excavation and movement of any soils, an asbestos specialist should be appointed and will need to hand pick and suitably bag any asbestos containing material and also monitor dust levels using air monitoring equipment. Any asbestos containing soil will need to be covered, either by a cover system, or by hardstanding in order to protect end users from exposure to fibres dusting from the shallow soil during activities on site. The local authority and / or HSE should be consulted prior to commencement of any excavations.

A basement is proposed beneath the affected part of the site, such that all of the made ground in this area will be removed and will therefore not represent an ongoing source of contamination. A moderate thickness of made ground is present beneath the site, and it would be prudent to keep the made ground separate from the natural soils and carry out additional asbestos screening of samples of made ground to be removed from the site to determine if any asbestos is present.

As the site is underlain by the London Clay Formation, classified as Unproductive Strata, groundwater is a not a sensitive receptor. In any case, given that the observed contamination is relatively immobile and unlikely to be in a soluble form and is considered to be non-volatile or of a low volatility, the contamination does not present a significant risk to groundwater through leaching, migration to adjacent sites or vapour risk.

The site lies within an area known to have background concentrations of lead of between 600 mg/kg and >900 mg/kg. Therefore the measured contamination is well below the background levels of the area and as such the presence of these concentrations will not result in an elevated risk to any sensitive receptors. Therefore a requirement for remedial measures is no envisaged.

8.7 Waste Disposal

Under the European Waste Directive, waste is classified as being either Hazardous or Non-Hazardous and landfills receiving waste are classified as accepting hazardous or non-

12 *The Release of Dispersed Asbestos Fibres from* Soils, Addison et. al., 1988 http://www.iom-world.org/pubs/IOM_TM8814.pdf

hazardous wastes or the non-hazardous sub-category of inert waste in accordance with the Waste Directive. Waste classification is a staged process and this investigation represents the preliminary sampling exercise of that process. Once the extent and location of the waste that is to be removed has been defined, further sampling and testing may be necessary. The results from this ground investigation should be used to help define the sampling plan for such further testing, which could include WAC leaching tests where the totals analysis indicates the soil to be a hazardous waste or inert waste from a contaminated site. It should however be noted that the Environment Agency guidance WM3[13] states that landfill WAC analysis, specifically leaching test results, must not be used for waste classification purposes.

Any spoil arising from excavations or landscaping works, which is not to be re-used in accordance with the CL:AIRE[14] guidance, will need to be disposed of to a licensed tip. Waste going to landfill is subject to landfill tax at either the standard rate of £102.10 per tonne (about £190 per m^3) or at the lower rate of £3.25 per tonne (roughly £6.00 per m^3). However, the classifications for tax purposes and disposal purposes differ and currently all made ground and topsoil is taxable at the 'standard' rate and only naturally occurring soil and stones, which are accurately described as such in terms of the 2011 Order, would qualify for the 'lower rate' of landfill tax.

Based on the technical guidance provided by the EA it is considered likely that the soils encountered during this ground investigation, as represented by the chemical analyses carried out, would be generally classified as follows.

Soil Type	Waste Classification (Waste Code)	WAC Testing Required Prior to Landfill Disposal?	Current applicable rate of Landfill Tax
Made ground	Non-hazardous (17 05 04)	No	£102.10 / tonne (Standard rate)
Natural Soils	Inert non-hazardous (17 05 04)	Should not be required but confirm with receiving landfill	£3.125 / tonne (Reduced rate for uncontaminated naturally occurring rocks and soils)

Any soils containing asbestos may be classified as hazardous waste if the concentration is over 0.1 %. It would be prudent to screen the made ground for asbestos before exporting off-site, with the hand picking out any asbestos material but a suitably qualified contractor.

Under the requirements of the European Waste Directive all waste needs to be pre-treated prior to disposal. The pre-treatment process must be physical, thermal, chemical or biological, including sorting. It must change the characteristics of the waste in order to reduce its volume, hazardous nature, facilitate handling or enhance recovery. The waste producer can carry out the treatment but they will need to provide documentation to prove that this has been carried out. Alternatively, the treatment can be carried out by an approved contractor. The Environment Agency has issued a position paper[15] which states that in certain circumstances, segregation at source may be considered as pre-treatment and thus excavated material may not have to be treated prior to landfilling if the soils can be segregated onsite prior to excavation by sufficiently characterising the soils insitu prior to excavation.

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

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

13 Environment Agency 2015. *Guidance on the classification and assessment of waste.* Technical Guidance WM3 First Edition

14 CL:AIRE March 2011. *The Definition of Waste: Development Industry Code of Practice* Version 2

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

Part 3: Ground Movement Analysis

This section of the report comprises an analysis of the ground movements arising from the proposed basement and foundation scheme discussed in Part 2 and the information obtained from the investigation, presented in Part 1 of the report.

9.0 Introduction

The sides of an excavation will move to some extent regardless of how they are supported. The movement will typically be both horizontal and vertical and will be influenced by the engineering properties of the ground, groundwater level and flow, the efficiency of the various support systems employed and the efficiency or stiffness of any support structures used.

An analysis has been carried out of the likely movements arising from the proposed excavation and the results of this analysis have been used to predict the effect of these movements on surrounding structures.

10.0 Basis of Ground Movement Assessment

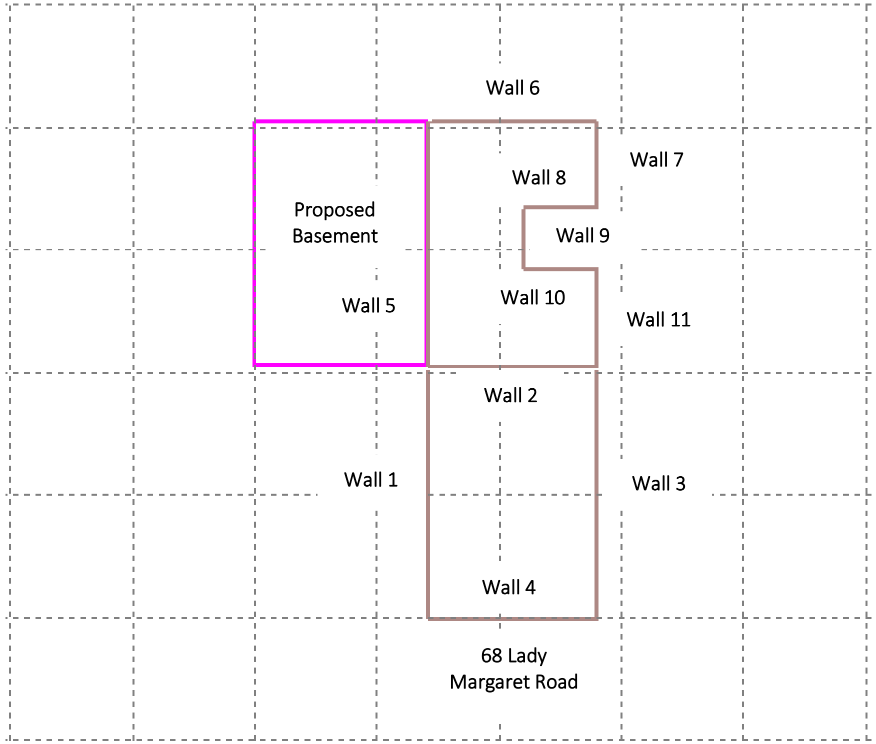
10.1 Nearby Sensitive Structures

Sensitive structures relevant to this assessment include the neighbouring properties of Nos 68 and 70A Lady Margaret Road.

Information with respect to the construction of No 70A Lady Margaret Road has been provided by the consulting engineers for the project, which includes drawings detailing the presence of a contiguous piled wall being installed along the boundary between the two properties to facilitate the construction. The excavation depth of the site of No 70A Lady Margaret Road is detailed on the drawings as being at a depth of 3.75 m below the ground level of No 70 Lady Margaret Road. The proposed basement will extend to a depth of 3.00 m below existing ground level and will therefore remain above the level of the foundations of No 70A Lady Margaret Road. Therefore this structures will not be affected and has been excluded from the analysis.

Information was also provided with respect to No 68 Lady Margaret Road. The plans do not indicate the structure to include a basement, although it is considered likely that the structure has a similar basement to that of No 70 Lady Margaret Road. The structure is clearly formed at the same level as No 70 Lady Margaret Road and the structure is four-storeys in height, including the dormer loft. The building height was estimated from on-site observations.

A plan indicating the locations of each of the sensitive structures and the positions of the individual elevations are shown on the plan below.



10.2 Construction Sequence

In general, the sequence of works for excavation and construction are assumed to comprise the following stages.

1. Demolish existing extension;
2. build temporary structure to support existing building;
3. underpin rear elevation of existing and party wall with adjacent building;
4. excavations for the forming of cast in-situ reinforced concrete retaining walls along other elevations of proposed basement;
5. build basement retaining walls and construct ground floor slab;
6. excavate basement and cast basement floor slab; and,
7. build super structure over basement.

The underpins and cast in-situ concrete retaining walls will be adequately laterally propped and sufficiently dowelled together, and the concrete will be cast and adequately cured prior to excavation of the basement and removal of the formwork and supports. It is assumed that the corners of the excavation will be locally stiffened by cross-bracing or similar and that the new retaining walls will not be cantilevered at any stage during the construction process. It is assumed that adequate temporary propping of the new retaining walls, particularly at the top level, will occur at all times prior to the construction of permanent concrete floor slabs.

11.0 Ground Movements

An assessment of ground movements within and surrounding the excavation has been undertaken using the P-Disp and X-Disp computer programs licensed from the OASYS suite of geotechnical modelling software from Arup. These programs are commonly used within the ground engineering industry and are considered to be appropriate tools for this analysis.

The X-Disp and P-Disp programs have been used to predict ground movements likely to arise from the excavation and construction of the proposed basement. This includes the heave / settlement of the ground (vertical movement) and the lateral movement of soil behind the proposed retaining walls (horizontal movement). Both the P-Disp and X-Disp programs are commonly used within the ground engineering industry and are considered to be appropriate tools for the purpose of this analysis.

For the purpose of these analyses, the corners have been defined by x and y coordinates, with the x-direction approximately parallel with the orientation of Lady Margaret Road, whilst the y-direction is approximately perpendicular. Vertical movement is in the z-direction. Wall lengths of less than 10 m have been modelled as 1 m long structural elements, while walls greater than 10 m in length have been modelled as 2 m elements to reflect their greater stiffness.

The basement structure has been modelled as a polygon, which will be formed through the combination of the underpinning of existing foundations and the construction of new cast in situ reinforced retaining walls formed using similar methods to underpinning. Below the existing building footprint, underpinning depths of around 2.50 m will be required.

It is assumed that suitable propping will be provided during the construction of the basement and in the permanent condition, such that the walls can be considered to be stiff for the purpose of the ground movement modelling.

The full outputs of all the analyses can be provided on request but samples of the output movement contour plots are included within the appendix.

11.1 Ground Movements – Surrounding the Basement Excavation

11.1.1 Model Used

For the X-Disp analysis, the soil movement relationships used for the embedded retaining walls are the default values within CIRIA report C760[16], which were derived from a number of historic case studies.

Published data for ground movements associated with underpinned retaining walls and the subsequent excavation of a new basement is limited compared to other types of retaining wall. It is widely accepted that movements associated with underpinning are generally influenced by the quality of the workmanship. It is also generally accepted that horizontal movements would be expected to fall within the order of 5 mm to 10 mm. A movement curve that produces a minimum of 5 mm of both vertical and horizontal movement for a maximum of 3 m retained height has therefore been produced and adopted for modelling the movements associated with the construction of the underpins and the subsequent mass excavation.

11.1.2 Results

Phase of Works	Wall Movement (mm)	
	Vertical Settlement	Horizontal Movement
Combined Installation and Excavation Movements	5.0	5.0

The movements set out in the table and discussed above are the maximum movements and the analysis has indicated that they occur immediately or just outside the line of the retaining walls, and also account for the likely overprediction of movements within re-entrant corners included within the model.

11.2 Ground Movements within the Excavation

11.2.1 Model Used

Unloading of the London Clay will take place as a result of the excavation of the proposed basements and the reduction in vertical stress will cause heave to take place. Undrained soil parameters have been used to estimate the potential short-term movements, which include the "immediate" or elastic movements as a result of the basement excavation. Drained parameters have been used to provide an estimate of the total long-term movement.

The elastic analysis requires values of soil stiffness at various levels to calculate displacements. Values of stiffness for the soils at this site are readily available from published data[17] and a well-established method has been used to provide estimated values. Relationships of E_u = 500 C_u and E' = 300 C_u for the cohesive soils have been used to obtain values of Young's modulus.

The 3.00 m deep excavation of the basement will result in a net unloading of around 55 kN/m^2, which will result in heave of the underlying London Clay.

Loading information provided by the consulting engineers has indicated a uniform distributed load of 32 kN/m^2 will apply at basement level following the completed construction.

The soil parameters used in this analysis and tabulated below have been primarily derived from the data from the GEA investigation on the site. The results have been extrapolated from the existing data set where the soil profile extends beyond the maximum depth of the investigation.

A rigid boundary for the analysis has been set at the base of the London Clay at a depth of 40 m below ground level, which has been determined on the basis of a BGS archive borehole record located about 700 m (530020, 185630) to the east of the site (TQ38NW/5). The Lambeth Group below this depth is not considered to be impacted by the proposed development and comprise essentially incompressible soils.

Stratum	Depth Range (m)	Eu (MPa)	E'(Mpa)
London Clay	GL to 40.0	10 to 187	6 to 112

16 Gaba, A, Hardy, S, Powrie, W, Doughty, L and Selemetas, D (2017) *Embedded retaining walls – guidance for economic design* CIRIA Report C760

17 Burland JB, Standing, JR, and Jardine, FM (2001) *Building response to tunnelling, case studies from construction of the Jubilee Line Extension.* CIRIA Special Publication 200

11.2.2 Results

The predicted movements are summarised in the table below; the results are presented below and in subsequent tables to the degree of accuracy required to allow predicted variations in ground movements around the structure(s) to be illustrated, but may not reflect the anticipated accuracy of the predictions.

The assessment has been carried out as three separate analyses representing three phases of the development, the excavation of the basement in the short term, the excavation of the basement and application of the loads of the new structure in the short term and the complete construction in the overall term.

Phase	Heave Movement (mm)	
	Centre of Excavation	Perimeter of Excavation
Excavation (Short Term)	-9	-3 to -5
Complete Construction (Short Term)	-4	-2
Complete Construction (Overall Term)	-7	-3 to -5

If a compressible material is used beneath the slab, it will need to be designed to be able to resist the potential uplift forces generated by the ground movements. In this respect, potential heave pressures are typically taken to equate to around 40% of the total unloading pressure.

12.0 Damage Assessment

In addition to the above assessment of the likely movements that will result from the proposed development, any neighbouring buildings within the zone of influence of the excavations are considered to be sensitive structures, requiring Building Damage Assessments, on the basis of the classification given in Table 6.4 of CIRIA report C760.

The sensitive structures outlined previously have been modelled as displacement lines in the analysis along which the damage assessment has been undertaken.

12.1 Damage to Neighbouring Structures

The ground movements resulting from the piling, underpinning and basement excavation phases have been calculated using X-Disp modelling software to carry out an assessment of the likely damage to adjacent properties and the results are discussed below.

The building damage reports for sensitive structures previously discussed are included in the appendix and indicate that damage to the adjoining and nearby structures due to basement construction are expected to fall within Category 0 'Negligible. A summary of the predicted building damage categories for the individual structures is shown in the table below.

Structure	Elevation	Category*
68 Lady Margaret Road	All Elevations	Negligible (0)

The results discussed above are based on individual building lines, or walls, that in some instances, have been further divided up within the analysis into a series of segments that are assumed to be able to move independently of one another, with the most critical segment determining the result for the entire wall. In reality, this is unlikely to be the case as the walls will behave as single stiff elements that are also joined continuously with the rest of the structure.

The results therefore provide a conservative estimate of the behaviour of each of the sensitive structures and overestimate the degree of damage, although they provide a useful indication of the most critical structures within the adjoining properties that may require further assessment, as detailed below.

The proposed basement will not impact existing services, as the proposed basement is located towards the rear of the property, some 14 m from the nearest roadway and therefore at least 14 m from the nearest service. The both the horizontal and vertical movements resulting from the development reduce to below 1 mm approximately 10 m from the edges of the basement. As a result, the development does not pose a risk to nearby services.

12.2 Monitoring of Ground Movements

The predictions of ground movement based on the ground movement analysis should be checked by monitoring of the adjacent properties and structures. The structures to be monitored during the construction stages should include the existing property and the neighbouring structure assessed above. Condition surveys of the above existing structures should be carried out before and after the proposed works.

The precise monitoring strategy will be developed at a later stage, and it will be subject to discussions and agreements with the owners of the adjacent properties and structures. Contingency measures will be implemented if movements of the adjacent structures exceed predefined trigger levels. Both contingency measures and trigger levels will need to be developed within a future monitoring specification for the works.

13.0 GMA Conclusions

The analysis has concluded that the predicted damage to the neighbouring properties from the construction of the proposed basements would be 'Negligible'.

On this basis, the damage that has been predicted to occur as a result of the construction the proposed basement falls within the limits acceptable to the London Borough of Camden assuming that the careful control is taken during construction of the proposed excavations, and monitoring will be required to ensure that no excessive movements occur that would lead to damage in excess of these limits.

The separate phases of work, including piling and subsequent excavation of the proposed basement, will in practice be separated by a number of weeks. This will provide an opportunity for the ground movements during and immediately after installation of the retaining walls to be measured and the data acquired can be fed back into the design and compared with the predicted values. Such a comparison will allow the ground model to be reviewed and the predicted wall movements to be reassessed prior to the main excavation taking place so that propping arrangements can be adjusted if required.

Part 4: Basement Impact Assessment

This section of the report evaluates the direct and indirect implications of the proposed project, based on the findings of the previous screening and scoping, site investigation and ground movement assessment.

14.0 Introduction

The screening identified a number of potential impacts. The desk study and ground investigation information has been used below to review the potential impacts, to assess the likelihood of them occurring and the scope for reasonable engineering mitigation.

14.1 Potential Impacts

The table below summarises the previously identified potential impacts and the additional information that is now available from the ground investigation in consideration of each impact.

Potential Impact	Consequence
London Clay is the shallowest stratum at the site.	The London Clay is prone to seasonal shrink-swell (subsidence and heave).
Seasonal shrink-swell can result in foundation movements.	Multiple potential impacts depending on the specific setting of the basement development. For example, the implications of a deepened basement/foundation system on neighbouring properties should be considered.
Decrease in the proportion of hard standing.	Less soft covering for surface water infiltration. However, the extent of the change will be minimal, and the London Clay is of very low permeability so will not make much difference.
The site is located within an area of previously worked ground.	Previously worked ground may be less homogeneous that natural strata which could result in differential settlement.
The development will significantly increase the differential depth of foundations relative to neighbouring properties.	The basement excavation may result in structural damage to neighbouring properties.
A tree will be felled during the development	The removal of the tree will likely lead to a gradual swelling of the ground which could affect soil strength and therefore slope stability. Additionally the binding effect of the tree roots may have been beneficial to slope stability.

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.

London Clay is the shallowest stratum / Seasonal Shrink-Swell

The investigation indicated that beneath a moderate thickness of made ground, the London Clay is present. The London Clay has been classified as being of high volume change potential, which are prone to seasonal shrink-swell (settlement and heave).

Shrinkable clay is present within a depth that can be affected by tree roots. No trees are present on site, but three semi mature deciduous trees are present on neighbouring land. In any case, the proposed basement is likely to extend below the potential depth of root action.

Decrease in hardstanding and paved areas

The proposed development for the site will result in a decrease in impermeable area from about 109.3 m^2 to 59 m^2. However this will have little effect as the ground is of low permeability. The ground conditions will not be suitable for a soakaway or similar SUDS based system. Attenuation systems could be adopted to mitigate any potential impact on surface water inflows and run-off.

Differential founding depths / Neighbouring structures

The stability of neighbouring properties and structures will be ensured at all times, through a suitable retention system. 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.

An analysis of the potential ground movements resulting from construction of the proposed basement is included in Part 3 of this report and has concluded that the predicted damage to the neighbouring properties would be Category 0 (Negligible). On this basis, the damage that would inevitably occur as a result of such an excavation would fall well within the acceptable limits although monitoring and mitigation measures will be required to ensure that no excessive movements occur that would lead to damage in excess of these limits.

The site is located within an area of previously worked ground

The investigation has indicated that the London Clay is consistent with natural soil at the depth of the proposed basement level such that lateral variations in the ground are considered unlikely. Therefore no detrimental effects should be experienced.

Trees will be felled during the development

A single tree will be felled during the development, although this will be the case regardless as it is associated with previous subsidence issues. However, the site does not slope significantly and does not neighbour land which slopes significantly. Additionally, it is GEA's understanding that nether the line of the tree's canopy or the anticipated root network, extending 1.5 x the diameter of the canopy, extend within the vicinity of neighbouring structures. Therefore the removal of the tree should not result in stability issues.

14.2 BIA Conclusions

A Basement Impact Assessment has been carried out following the information and guidance published by the London Borough of Camden. It is concluded that the proposed development is unlikely to result in any specific land or slope stability issues.

14.3 Non-Technical Summary of Evidence

This section provides a short summary of the evidence acquired and used to form the conclusions made within the BIA.

14.3.1 Screening

The following table provides the evidence used to answer the subterranean (groundwater flow) screening questions.

Question	Evidence
1a. Is the site located directly above an aquifer?	Aquifer designation maps acquired from the Environment Agency as part of the desk study and Figures 3, 5 and 8 of the Arup report.
1b. Will the proposed basement extend beneath the water table surface?	Previous nearby GEA investigations and BGS archive borehole records.
2. Is the site within 100 m of a watercourse, well (used/ disused) or potential spring line?	Topographical and historical maps acquired as part of the desk study, reference to Lost Rivers of London and Figures 11 and 12 of the Arup report.
3. Is the site within the catchment of the pond chains on Hampstead Heath?	Figures 12 and 14 of the Arup report
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	A site walkover and existing plans of the site have confirmed the proportions of hardstanding and soft landscaping, which have been compared to the proposed drawings to determine the changes.
5. As part of the site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or SUDS)?	The details of the proposed development do not indicate the use of soakaway drainage.
6. Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to or lower than, the mean water level in any local pond or spring line?	Topographical maps acquired as part of the desk study and Figures 11 and 12 of the Arup report.

The following table provides the evidence used to answer the slope stability screening questions.

Question	Evidence
1. Does the existing site include slopes, natural or manmade, greater than 7°?	Topographical maps and Figures 16 and 17 of the Arup report and confirmed during a site walkover
2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7°?	The details of the proposed development provided do not include the re-profiling of the site to create new slopes
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	Topographical maps and Figures 16 and 17 of the Arup report
4. Is the site within a wider hillside setting in which the general slope is greater than 7°?	

Question	Evidence
5. Is the London Clay the shallowest strata at the site?	Geological maps and Figures 3, 5 and 8 of the Arup report
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?	The details of the proposed development.
7. Is there a history of seasonal shrink-swell subsidence in the local area and / or evidence of such effects at the site?	Knowledge on the ground conditions of the area and reference to NHBC guidelines were used to make an assessment of this, in addition to a visual inspection of the buildings carried out during the site walkover.
8. Is the site within 100 m of a watercourse or potential spring line?	Topographical maps acquired as part of the desk study and Figures 11 and 12 of the Arup report
9. Is the site within an area of previously worked ground?	Geological maps and Figures 3, 5 and 8 of the Arup report
10. Is the site within an aquifer?	Aquifer designation maps acquired from the Environment Agency as part of the desk study and Figures 3, 5 and 8 of the Arup report.
11. Is the site within 50 m of Hampstead Heath ponds?	Topographical maps acquired as part of the desk study and Figures 12 and 14 of the Arup report
12. Is the site within 5 m of a highway or pedestrian right of way?	Site plans and the site walkover.
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Camden planning portal and the site walkover confirmed the position of the proposed basement relative the neighbouring properties.
14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	Maps and plans of infrastructure tunnels were reviewed.

The following table provides the evidence used to answer the surface water flow and flooding screening questions.

Question	Evidence
1. Is the site within the catchment of the pond chains on Hampstead Heath?	Topographical maps acquired as part of the desk study and Figures 12 and 14 of the Arup report
2. As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route?	A site walkover confirmed the current site conditions and the details provided on the proposed

Question	Evidence
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	development, including reference to the FRA for the site.
4. Will the proposed basement development result in changes to the profile of the inflows (instantaneous and long term) of surface water being received by adjacent properties or downstream watercourses?	
5. Will the proposed basement result in changes to the quantity of surface water being received by adjacent properties or downstream watercourses?	
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 Kings Cross, or is it at risk of flooding because the proposed basement is below the static water level of a nearby surface water feature?	Flood risk maps acquired from the Environment Agency as part of the desk study, Figure 15 of the Arup report, the Camden Flood Risk Management Strategy dated 2013 and the North London Strategic Flood Risk Assessment dated 2008, and reference to the site specific FRA.

14.3.2 Scoping and Site Investigation

The questions in the screening stage that there were answered 'yes', were taken forward to a scoping stage and the potential impacts discussed in Section 4.0 of this report, with reference to the possible impacts outlined in the Arup report.

A ground investigation has been carried out, which has allowed an assessment of the potential impacts of the basement development on the various receptors identified from the screening and scoping stages. Principally the investigation aimed to establish the ground conditions, including the groundwater level, the engineering properties of the underlying soils to enable suitable design of the basement development and the configuration of existing party wall foundations. The findings of the investigation are discussed in Section 5.0 of this report and summarised in both Section 7.0 and the Executive Summary.

14.3.3 Impact Assessment

Section 14.0 of this report summarises whether, on the basis of the findings of the investigation, the potential impacts still need to be given consideration and identifies ongoing risks that will require suitable engineering mitigation. Section 9.0 of this report also provides recommendations for the design of the proposed development.

A ground movement analysis and building damage assessment has been carried out and its findings are presented in Part 3.

15.0 Outstanding Risks & Issues

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

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

As discussed throughout the report, perched water is likely to be encountered during the basement excavation, although the finding of the investigation indicate that potential inflows are unlikely to be significant and should be adequately dealt with through sump pumping. However, groundwater monitoring should be carried out, and trial excavations should be considered to assess the extent of inflows to be expected within the proposed basement excavations.

Once the existing building has been demolished and sufficient space is available on site, it is recommended that further investigation is carried out in order to provide site specific parameters for the design of both spread and piled foundations, and the basement retaining walls.

The investigation has not identified the presence of any significant contamination and as the vast majority of the made ground will be removed from this site through the excavation of the proposed basement and large areas are covered by hardstanding, remedial measures should not be required. However, as with any site there is a potential for further areas of contamination to be present within the made ground beneath parts of the site not covered by the investigation it is recommended that a watching brief is maintained during any groundworks for the proposed new foundations and that if any suspicious soils are encountered that they are inspected by a geoenvironmental engineer and further assessment may be required. Additionally, site workers should be made aware of the presence of asbestos and elevated concentrations of lead and total PAH within the made ground, with appropriate measures put in place to protect site workers from unacceptable exposure of asbestos fibres and asbestos containing materials.

If during ground works any visual or olfactory evidence of contamination is identified it is recommended that further investigation be carried out and that the risk assessment is reviewed.

These areas of doubt should be drawn to the attention of prospective contractors and further investigation will be required or sufficient contingency should be provided to cover the outstanding risk.

Appendix

a. Field Work

Site Plan
Borehole Records
Trial Pit Records

b. Lab Testing

Geotechnical Test Results
Chemical Test Results
Generic Risk Based Screening Values

c. Desk Study

Site Sensitivity Extracts
Historic Maps
Preliminary UXO Assessment

d. Ground Movement Analysis

PDisp Analysis – Short Term Movements (excavation only)
PDisp Analysis – Short Term Movements (complete construction)
PDisp Analysis – Total Movements

XDisp Analysis – Installation Movements
XDisp Analysis – Installation & Excavation Movements
XDisp Analysis – All Input and Output Data

appendix a

Field Work

Site Plan
Borehole Records

appendix b

Lab Testing

Geotechnical Test Results
Chemical Test Results
Generic Risk Based Screening Values

appendix c

c. Desk Study

Site Sensitivity Extracts
Historic Maps
Preliminary UXO Assessment

appendix d

Ground Movement Analysis

GMA Reference Plan
XDisp Analysis – All Input Data
XDisp Analysis – Installation Movements
XDisp Analysis – Installation & Excavation Movements
XDisp Analysis – Building Damage Assessment Results

PDisp Analysis – All Input Data
PDisp Analysis – Short Term Movements
PDisp Analysis – Total Movements

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APPENDIX D
SUDS STRATEGY LAYOUT AND CALCS

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	20.700	Add Flow / Climate Change (%)	0
Ratio R	0.440	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	550	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	**Area (ha)**	**Time (mins)**	**Area (ha)**
0-4	0.013	4-8	0.000

Total Area Contributing (ha) = 0.013

Total Pipe Volume (m³) = 0.161

Network Design Table for Storm

PN	**Length (m)**	**Fall (m)**	**Slope (1:X)**	**I.Area (ha)**	**T.E. (mins)**	**Base Flow (l/s)**	**k (mm)**	**HYD SECT**	**DIA (mm)**	**Section Type**	**Auto Design**
S1.000	5.000	0.050	100.0	0.000	5.00	0.0	0.600	o	100	Pipe/Conduit	
S1.001	5.000	0.295	16.9	0.006	0.00	0.0	0.600	o	100	Pipe/Conduit	
S1.002	2.500	0.075	33.3	0.007	0.00	0.0	0.600	o	100	Pipe/Conduit	
S2.000	2.349	0.062	37.9	0.000	5.00	0.0	0.600	o	100	Pipe/Conduit	
S1.003	2.500	0.025	100.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	**Rain (mm/hr)**	**T.C. (mins)**	**US/IL (m)**	**Σ I.Area (ha)**	**Σ Base Flow (l/s)**	**Foul (l/s)**	**Add Flow (l/s)**	**Vel (m/s)**	**Cap (l/s)**	**Flow (l/s)**
S1.000	178.39	5.11	9.700	0.000	0.0	0.0	0.0	0.77	6.0	0.0
S1.001	177.82	5.15	9.650	0.006	0.0	0.0	0.0	1.89	14.8	2.9
S1.002	177.41	5.18	9.355	0.013	0.0	0.0	0.0	1.34	10.5	6.2
S2.000	179.41	5.03	9.600	0.000	0.0	0.0	0.0	1.26	9.9	0.0
S1.003	176.88	5.23	9.230	0.013	0.0	0.0	0.0	1.00	17.8	6.2

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.000	0.000	0.000
1.001	-	-	100	0.006	0.006	0.006
1.002	-	-	100	0.007	0.007	0.007
2.000	-	-	100	0.000	0.000	0.000
1.003	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.013	0.013	0.013

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	1
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.700	Storm Duration (mins)	30
Ratio R	0.440		

Online Controls for Storm

Orifice Manhole: S5, DS/PN: S1.003, Volume (m^3): 0.2

Diameter (m) 0.030 Discharge Coefficient 0.600 Invert Level (m) 9.230

Storage Structures for Storm

Porous Car Park Manhole: S2, DS/PN: S1.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	7.0
Membrane Percolation (mm/hr)	1000	Length (m)	10.0
Max Percolation (l/s)	19.4	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	9.650	Cap Volume Depth (m)	0.150

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	1
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.438
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	20.800	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
S1.000	S1	60 minute 1 year Winter I+0%	10.000	9.711	-0.089	0.000	0.03
S1.001	S2	120 minute 1 year Winter I+0%	10.000	9.659	-0.091	0.000	0.02
S1.002	S3	15 minute 1 year Winter I+0%	10.000	9.409	-0.046	0.000	0.10
S2.000	S4	15 minute 1 year Summer I+0%	10.000	9.600	-0.100	0.000	0.00
S1.003	S5	15 minute 1 year Winter I+0%	10.000	9.407	0.027	0.000	0.07

PN	US/MH Name	Overflow (l/s)	Infil. Flow (l/s)	Infil. Vol (m³)	Maximum Vol (m³)	Discharge Vol (m³)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S1.000	S1				0.001	0.231		0.2	FLOOD RISK
S1.001	S2		0.0	0.000	0.200	0.796	35	0.3	OK
S1.002	S3				0.011	0.626		0.8	OK
S2.000	S4				0.000	0.000		0.0	OK
S1.003	S5				0.039	0.626		0.8	SURCHARGED

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	1
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.438
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	20.800	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
S1.000	S1	30 minute 30 year Winter I+0%	10.000	9.719	-0.081	0.000	0.08
S1.001	S2	60 minute 30 year Winter I+0%	10.000	9.693	-0.057	0.000	0.08
S1.002	S3	15 minute 30 year Winter I+0%	10.000	9.769	0.314	0.000	0.24
S2.000	S4	15 minute 30 year Winter I+0%	10.000	9.765	0.065	0.000	0.01
S1.003	S5	15 minute 30 year Winter I+0%	10.000	9.766	0.386	0.000	0.12

PN	US/MH Name	Overflow (l/s)	Infil. Flow (l/s)	Infil. Vol (m³)	Maximum Vol (m³)	Discharge Vol (m³)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S1.000	S1				0.002	0.652		0.4	FLOOD RISK
S1.001	S2		0.0	0.000	0.917	2.108	18	1.1	OK
S1.002	S3				0.101	2.345		1.8	FLOOD RISK
S2.000	S4				0.025	0.000		0.1	FLOOD RISK
S1.003	S5				0.115	2.345		1.3	FLOOD RISK

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	1
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.438
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	20.800	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
S1.000	S1	60 minute 100 year Winter I+40%	10.000	9.845	0.045	0.000	0.13
S1.001	S2	60 minute 100 year Winter I+40%	10.000	9.841	0.091	0.000	0.10
S1.002	S3	60 minute 100 year Winter I+40%	10.000	9.836	0.381	0.000	0.21
S2.000	S4	60 minute 100 year Winter I+40%	10.000	9.832	0.132	0.000	0.01
S1.003	S5	60 minute 100 year Winter I+40%	10.000	9.832	0.452	0.000	0.13

PN	US/MH Name	Overflow (l/s)	Infil. Flow (l/s)	Infil. Vol (m³)	Maximum Vol (m³)	Discharge Vol (m³)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S1.000	S1				0.022	1.726		0.7	FLOOD RISK
S1.001	S2		0.0	0.000	3.214	4.351	37	1.3	FLOOD RISK
S1.002	S3				0.111	7.822		1.6	FLOOD RISK
S2.000	S4				0.036	0.000		0.1	FLOOD RISK
S1.003	S5				0.126	7.822		1.4	FLOOD RISK

KEY

- 100mm dia Surface Water Drain @ 1:100 UNO
- 100mm dia Foul Water Drain @ 1:40 UNO
- Existing Combined Water Sewer
- Proposed 450mm dia Surface Water PPIC
- Proposed 450mm dia Foul Water PPIC
- RE — Rodding Eye
- Permeable paving with 150mm Type 3 lined sub base 30% porosity.
- RM VP CD — Foul pump by specialist
- SVP/SS — Soil Vent Pipe/ Stub Stack
- RWP — Rainwater pipe
- CH — Linear Channel
- Existing Combined Manhole
- Flow control chamber
- Surface Water Gully
- Floor Gully

Existing areas

Impermeable	Permeable
Roof 48 sqm	Grass 59.3 sqm
External paving 61.3 sqm	

Existing runoff 3.22 l/s

Rational Method
Q=2.78 x 106.3 x 0.0109= 3.22 l/s
intensity calculated for 1 in 100 15 min storm

Proposed areas

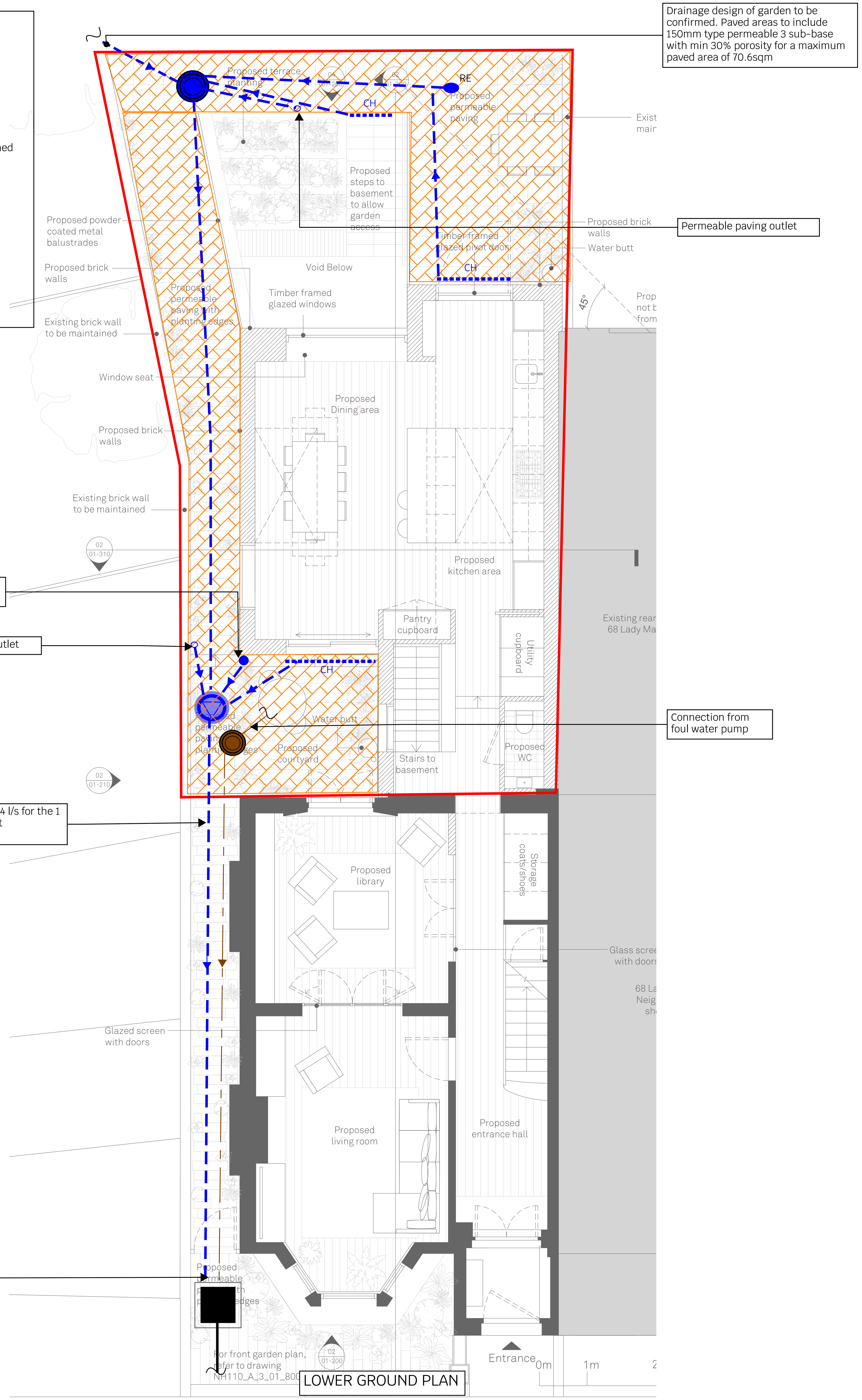
Impermeable	Permeable
Roof 59 sqm	Greenroof 39 sqm
	Permeable Paving 70.6 sqm

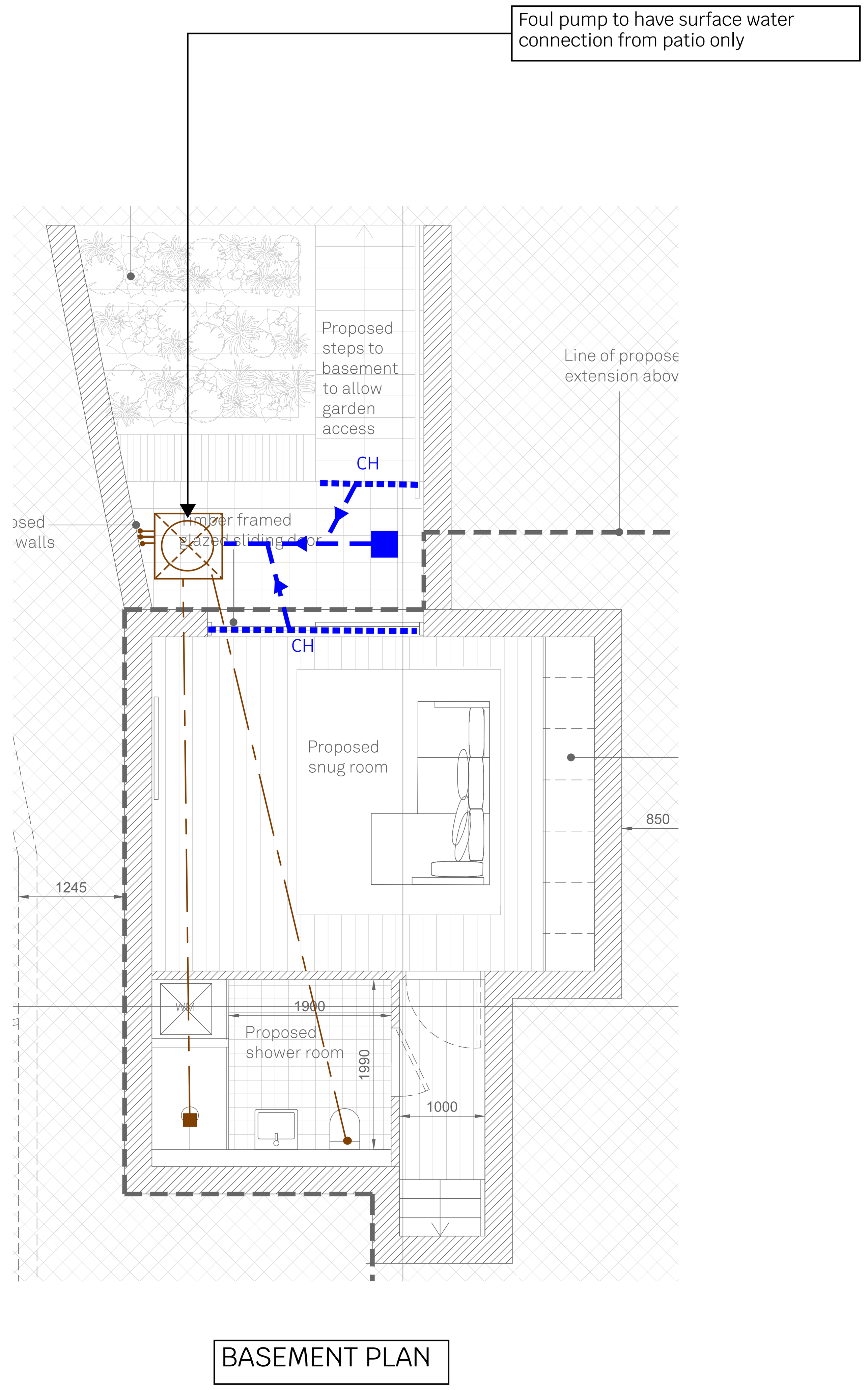
Proposed runoff 1.4 l/s for 1 in 100 +40%
56% reduction of existing rates

Impermeable areas are reduced by 35%

NOTES

1. Drainage Strategy subject to CCTV Drainage Survey and detailed design
2. Drainage Strategy for planning stage only, to be developed
3. Foul water drainage to be developed at next design stage





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