BASEMENT IMPACT ASSESSMENT

49 BELSIZE LANE, HAMPSTEAD

FOR

MR NIKOS PANIGIRTZOGLOU

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APPROVAL & DISTRIBUTION SHEET

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FOREWORD

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1. SUMMARY

The site location is at 49 Belsize Lane, Hampstead NW3 5AU.

The site is occupied by a two-storey house (about 9m wide, 11.6m long) that is located to the front of property's curtilage with a garden to the rear. The house contains an existing partial single basement inset from the front façade and Party Wall to no. 47a Belsize Lane.

The proposed development comprises deepening the existing basement and extending it into the rear garden by about 4.5m. The roof of the basement extension will be at ground floor level and will therefore extend significantly above the rear garden ground level. The area of the proposed basement extension will be about 31m^2 and will occupy the current garden space. The roof of the basement will comprise a tiled terrace. The excavation for the basement will be about 2.5m below existing ground level and be constructed using reinforced concrete retaining walls and a raft foundation. The existing basement will be deepened using conventional concrete underpins. Proposed works plans are included in Appendix B.

The following assessments are presented in this report:

- Desk Study;
- Screening;
- Scoping;
- Site investigation;
- Ground movement/Damage category assessment; and
- Summary and impact assessment.

A conceptual ground model for the site is summarised as follows:

- **Excavation Depth** – Approximately 2.5m below ground level;
- **Site Topography** – Relatively flat at 70mOD;
- **Surface Water Bodies** – None within 500m;
- **Flood Risk** – Low from flooding and very low from surface water;
- **Ground Conditions**
    - Made Ground from 0 to 1.1m below ground level;
    - Firm Weathered London Clay Formation from 1.1m to 5.8m below ground level; and

  - Stiff Unweathered London Clay Formation below 5.8m depth.

- **Aquifer** – None 'Unproductive' stratum (London Clay Formation); and
- **Groundwater** – Groundwater level of 0.99mbgl.

The main conclusions from the screening and scoping assessment are as follows:

- Slope stability issues within the London Clay Formation will be highly unlikely to impact the site or surrounding area due to the relatively level ground profile;

- Some trees are due to be felled, and the roots of another tree will be affected as part of construction. In the rear garden the proposed works include: 1 x False Acacia (T1) - Fell to ground level, 1 x Sycamore (T3) - Prune encroaching roots to allow repair / deepening of foundations of garden wall, and 1 x Portuguese laurel (T4) - Fell to ground level. Approval for this work has been granted by the London Borough of Camden. The affect of tree root removal on ground heave will need to be considered if tree removal is carried out close to construction;

- The site is on the London Clay Formation that has a high-volume change potential and will be prone to shrinkage/swelling. The proposed basement will extend to below the recorded groundwater table, although the long-term groundwater profile at the site has not been assessed. Therefore, heave as a result of tree roots will need to be considered. Heave as a result of net unloading from the basement excavation is expected to occur in the order of -15kN/m^2 that could result in heave of around 3mm;

- The site is not located above an aquifer however a measured groundwater level of 0.99m below ground level in a monitoring standpipe indicates the proposed basement will extend below the groundwater table. The strata above and immediately below founding level (London Clay Formation) are expected to have a low permeability and this combined with the low topographic profile would likely create minimal groundwater flow at the level of the proposed basement. Therefore, it is considered unlikely that the basement would cause any significant adverse impact on groundwater flows. Groundwater level monitoring readings should be taken during the detailed design period and prior to construction;

- Construction of the new basement will reduce the proportion of the existing soft landscaped garden area and increase the proportion of hardstanding resulting in the generation of surface water run-off. The control of surface water will be via new drainage. There is an existing terrace which drains into the ground that will be improved with a soakaway for the top of the terrace;

- Construction of the basement will result in lowering of the foundations compared to adjacent sites by a net value of about 2m and excavation of the basement will result in some ground movements. The effect of this has been reviewed in ground movement and damage category assessments. Contour plots of displacement in response to the changes in vertical pressure caused by the excavation and construction of the proposed basement are included. Based upon the maximum displacements predicted by PDISP analyses, Damage Category Assessments were undertaken for the worst-case scenarios in the adjoining properties and these combined with the ground movements alongside the basement in response to the lateral stress release are as predicted by Figure 6.15b of the CIRIA publication C760;

- In the assessed cases, the nearest walls of 47a Belsize Lane are classified as Category 1 'slight' and the nearest walls on 51 Belsize Lane is Category 0 'Negligible' (as given in CIRIA SP200). The damage category results have been plotted graphically in Figure 4. No further Damage Category Assessments have been carried out as other structures in the vicinity are further away and/or have a similar founding depth to the proposed basement and therefore considered lower risk. Therefore, all other walls are considered to be classified as Category 0 'negligible'. The above assessment assumes the use of best practice construction methods to ensure that the ground movements are kept in line with the above predictions. If the appropriate mitigation measures and monitoring strategies are applied, and transitional underpinning adopted, then the damage category rating of all assessed walls would reasonably be considered to fall within Burland Category 1 or less. Pre-construction condition surveys of neighbouring properties are also recommended, and a system of monitoring adjoining and adjacent structures should be established before the works start.

2. INTRODUCTION

2.1 General introduction

This report presents a Basement Impact Assessment (BIA), Ground Movement Assessment (GMA) and Damage Category Assessment (DCA) for a proposed basement development at 49 Belsize Lane, Hampstead ('the site'). The site is located at post code NW3 5AU within the London Borough of Camden as shown on Figure A1.

This report has been carried at the request of Ensoul Ltd acting on behalf of the house owner, Mr Nikos Panigirtzoglou.

This BIA has been produced specifically to meet the requirements of London Borough of Camden (LBC), including Planning Guidance - Basements (Camden Planning Guidance CPG, March 2018) - and the Local Plan (A5 Basements, July 2017). The report structure follows guidance for BIAs set out in the Camden Borough CPG4 (2015). The CPG4 requires desk study, screening and scoping stages, a site investigation and interpretation and ground movement assessment, and impact assessment.

The BIA evaluates the geological, hydrogeological and hydrological conditions and assess the potential detrimental ground stability, groundwater and surface water impacts the proposed development may have on the surrounding area and neighbouring properties.

Attention is drawn to the fact that whilst every effort has been made to ensure the accuracy of the data supplied and any analysis derived from it, there is a potential for variations in ground and groundwater conditions between and beyond the specific locations investigated. No liability can be accepted for any such variations. Furthermore, any recommendations are specific to the client's requirements as detailed herein and no liability will be accepted should these be used by third parties without prior consultation with CET Structures Limited.

2.2 Authors

The BIA has been written by:
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The BIA has been reviewed by:
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Principal Geotechnical Engineer

2.3 Sources of Information

The following baseline data have been referenced to complete the BIA in relation to the proposed development:

- Site walkover conducted during a ground investigation in December 2018;
- Current/historical mapping contained in an Envirocheck report;
- The site's geological setting is based on the British Geological Survey (BGS) Geological Map Sheet 256 (North London 1: 50,000 scale solid and drift, 2006), the BGS digital geology maps that utilises most up to date names of geological units (www.bgs.ac.uk/data) and the Geology of London Memoir (Ellison et al., 2004);
- Online flood risk mapping by the Environment Agency;
- LB Camden, Strategic Flood Risk Assessment (produced by URS, 2014);
- LB Camden, Planning Guidance (CPG) – Basements (March 2018);
- LB Camden, Camden Geological, Hydrogeological and Hydrological Study – Guidance for Subterranean Development GHHS (produced by Arup, 2010); and
- LB Camden, Local Plan Policy A5 Basements (2017).

2.4 Existing site location and layout

The subject site is located at 49 Belsize Lane (NW3 5AU) at approximate Ordnance Survey grid reference TQ268848 (see Figure A1).

The property comprises an existing two-storey house that is about 9m wide by 12m long. It is of brick construction with a plaster finish and shares party walls with 47a Belsize Lane to the northeast and 51 Belsize Lane to the southwest. The neighbouring properties comprise similar sized brick built houses.

The house is located on the northeast (front) half of the property's curtilage and the rear southwest half of the property comprises a garden with shrubs and trees. According to sketches provided by Ensoul the house contains an existing partial single basement inset from the front façade and Party Wall to no. 47a Belsize Lane.

2.5 Topography

The topographic map contained in the GHHS and an online topographic map source (http://en-gb.topographic-map.com) shows that the general area of the site is located on at about 70mAOD. The general area slopes downwards from northwest to southeast away from Hampstead Heath. However, the site is essentially level with no significant slopes noted as shown on Figure A3.

2.6 Proposed development

The proposed development comprises deepening the existing basement and extending it into the rear garden by about 4.5m. The roof of the basement extension will be at ground floor level and will therefore extend above the rear garden ground level.

The size of the proposed basement extension is about 4.5m deep by 6.8m wide (31m^2). The garden area is 8.8m deep by 11.5m (101m^2) so the new basement will take up about 30% of the existing garden space.

The depth of the existing house is 9m and the basement (4.5m) will be roughly 50% of the depth of the house.

The depth of the existing garden is about 9m so the basement will extend about 50% into the depth of the garden.

The existing house floor area is 105m^2 so the proposed basement will be less than 1.5 times the area of the house.

The top of the basement will comprise a hard-tiled surface with rainwater run-off so there will be reduction in surface area of the existing garden by about 31m^2. New drainage is proposed to accommodate the increase in run-off generated by the terrace. In addition, there is an existing terrace adjoining the rear of the dwelling beside the proposed basement and drainage from this existing terrace will also be improved.

There is a sycamore tree in the garden of the house to the northeast. There is also a small tree next to the house on the boundary, which will need to be removed. An arboricultural report has been carried out to assess the impact of the proposed works on the trees.

The proposed finished floor level of the basement will be set at about 2.3m below existing ground level of the garden and an excavation depth of 2.5m, including an allowance for construction of the floor slab has been assumed. The perimeter walls will comprise reinforced concrete (RC) retaining walls and the basement structure will have a raft foundation.

In preparing this report the existing and proposed drawings provided by Elite Designers are included in Appendix B.

2.7 Neighbouring properties and structures

The subject property is located on the southeast side of Belsize Lane and is attached to 47a Belsize Lane to the northeast and 51 Belsize Lane to the southwest. The boundaries between the subject site and the neighbouring properties comprise party walls and the front and rear walls are in line with that of 49 Belsize Lane. Both neighbouring properties comprise similar two-storied houses of brick construction that are located on the front half of the properties. The rear of these properties also contains gardens. It is not known if the neighbouring properties also contain basements.

The nearest underground rail tunnel to the site is the Network Rail Belsize rail tunnel that is located about 140m north of the site as shown on Figure A2.

3. DESK STUDY

Information in this section has been obtained from the sources outlined in Section 2.3. The background information has been used to undertake a screening and assessment of potential basement impacts.

3.1 Site History

Historical maps have been obtained for the area and are presented in the Envirocheck Report in Appendix C. Notable developments are detailed below:

- 1871 to 1880: The earliest map available displayed the property footprint and dwelling in place. The neighbouring property to the southeast was also present. On the opposite side of Belsize Lane to the northwest was undeveloped land labelled as Belsize Farm. A rail tunnel was shown about 200m north of the site and a ventilation shaft was shown within Belsize Farm;
- 1896: There was no change to the site. The area to the northwest (formerly Belsize Farm) was heavily developed with housing; and
- 1920 to Present: There was little obvious change to the property and surroundings.

3.2 Geology

Publications of the British Geological Survey (BGS) indicate that the site is underlain by the London Clay Formation without any superficial deposits. The Claygate Member is shown on the BGS geological map about 200m to the northwest of the site. The online BGS geological map extract displaying the geology is presented in Figure A4.

Two deep BGS boreholes located approximately 400m to the southwest of the site were available for review. The locations of the boreholes are presented on Figure A4, and depths of geology and groundwater levels are summarised in Table 3-1.

Table 3-1: BGS borehole data

Borehole Reference	Drill Date (Depth)	Geology	Geological Unit	Depth From (m bgl)	Depth To (m bgl)	Groundwater Level
TQ28SE2335	March 2007 (30m)	Grey mottled orange brown slightly gravelly slightly sandy CLAY	Made Ground	0	3.0	Not Encountered
		Stiff brown slightly sandy clay	London Clay Formation (weathered)	3.0	10.1	
		Stiff to very stiff dark grey clay	London Clay Formation	10.1	30.0+	

Borehole Reference	Drill Date (Depth)	Geology	Geological Unit	Depth From (m bgl)	Depth To (m bgl)	Groundwater Level
TQ28SE2336	March 2007 (30m)	Grey mottled orange brown slightly gravelly slightly sandy CLAY	Made Ground	0	1.2	Seepage 12.1mbgl
		Stiff brown slightly sandy clay	London Clay Formation (weathered)	1.2	7.6	
		Stiff to very stiff dark grey clay	London Clay Formation	7.6	30.0+	

The borehole records in Table 3-1 show a typical sequence of Made Ground overlying the Weathered London Clay Formation before encountering unweathered London Clay Formation. These boreholes are located about 400m to the south west of the site but the geology at the site is not expected to vary signficantly. The actual ground conditions have been assessed by a site specific ground investigation and are discussed later in this report.

3.3 Hydrogeology

Groundwater information obtained from the BGS boreholes in Table 3-1 recorded either dry conditions or a deep seepage.

Hydrogeological information provided by the GHHS and Envirocheck report is summarised below:-

- **Aquifer Category (as defined by the Environment Agency)** – No Superficial Deposits aquifer present. The bedrock aquifer designation is Unproductive (non-aquifer); rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow;
- **Nearest groundwater abstraction licence** – None within 500m;
- **Source Protection Zone (SPZ)** – None present at the site. Zone II Outer source protection zone about 241m south of the site;
- **Groundwater vulnerability and soil leaching potential** – None (non-aquifer); and
- **Groundwater flooding susceptibility** – None within 200m of the site.

3.4 Hydrology

Hydrological information provided by the Envirocheck report and GHHS is summarised below:-

- **Surface water features** – None within 600m (nearest is 578m to the south);
- **Surface water abstraction licences** – None within 500m;

- **River and coastal Zone 2 or 3 flooding** – Site is not on a Zone 2 or 3 floodplain and none are identified within 500m;
- **Risk of flooding from rivers or seas** – Very low;
- **Risk of flooding from surface water** – No risk from 1:30 and 1:100 year event. Some risk on the site from 1:1000 year event;
- **Flood defences** – None identified within 250m; and
- **Flood storage areas** – None within 250m.

The book 'The Lost Rivers of London' (Barton, 1992) does not identify any former tributaries on the site, but tributaries are shown roughly 300m west and 400m east of the site (Figure A5).

3.5 Flooding

The flood risk from rivers and seas from the Environment Agency flood map for planning service is shown on Figure A6 that shows a low risk.

The URS 2014 LBC strategic flood risk assessment report identified the following risk ratings:-

- Very low risk for surface water (<1: 1000 years) and low flood hazard for 1: 1000 year event;
- No surface water bodies (open of culverted) near the site;
- No risk from internal sewer flooding (on the margin of Zone NW 3 4 that is 1 property affected); and
- Risk of 1 property affected from external sewer flooding (Zone NW 3 5).

3.6 Site conditions summary

A conceptual site model for the site has been developed using the information obtained from the desk study and site investigation for use during the Scoping and Impact Assessment stages.

The conceptual site model can be summarised as follows:-

- **Excavation Depth** – Approximately 2.5m below ground level;
- **Site Topography** – Relatively flat at 70mOD;
- **Surface Water Bodies** – None within 500m;

- **Flood Risk** – Low from flooding and very low from surface water;
- **Ground Conditions**
    - Made Ground from 0 to 1.1m below ground level; and
    - London Clay Formation below 1.1m below ground level.
- **Aquifer** – None 'Unproductive' stratum (London Clay Formation); and
- **Groundwater** – Groundwater flow expected to be shallow slow seepage.

4. SCREENING

Screening has been carried out using the criteria outlined in CPG4 to identify any matters of concern relating to slope stability, groundwater flow and surface water flow/flooding that should be carried forward to the Scoping stage. The screening process uses the background site information provided in Section 2 and Section 3 of this report to complete flow charts provided in CPG4. The flow charts are reproduced in the tables below. Items requiring scoping, investigation and impact assessment are highlighted in yellow and are addressed in subsequent sections of this report.

4.1 Slope Stability

The slope stability screening flowchart from CPG4 is displayed in Table 4-1.

Table 4-1: Screening – Slope Stability

Slope stability screening chart	
1. Does the existing site include slopes, natural or manmade, greater than 7 degrees? (approx. 1 in 8)	No. The site is relatively flat at approximately 70mOD with no sloping land above 7 degrees to the horizontal.
2. Will the proposed re-profiling of landscaping at site change slopes at the property boundary to more than 7 degrees? (approx. 1 in 8)	No. No re-profiling is planned.
3. Does the development neighbouring land, including railway cuttings and the like, with a slope greater than 7 degrees? (approx. 1 in 8)	No. The surrounding area slopes at less than 7 degrees.
4. Is the site within a wider hillside setting in which the general slope is greater than 7 degrees? (approx. 1 in 8)	No. The surrounding area slopes at less than 7 degrees.
5. Is the London Clay the shallowest strata at the site?	Yes. The geological maps do not show any superficial deposits at the site. This should be assessed by a site investigation.
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. In the rear garden the proposed works include: 1 x False Acacia (T1) - Fell to ground level, 1 x Sycamore (T3) - Prune encroaching roots to allow repair / deepening of foundations of garden wall, and 1 x Portuguese laurel (T4) - Fell to ground level. Approval for this work has been granted by the London Borough of Camden.
7. Is there a history of seasonal shrink-swell subsidence in the local area, and/or evidence of such effects at site?	The Envirocheck Report indicates a 'moderate' shrink-swell hazard rating. No evidence of shrink-swell subsidence has been provided.
8. Is the site within 100m of a watercourse or a potential spring line?	No. There are no watercourses or spring lines have been identified within 100m of the site.

Slope stability screening chart	
9. Is the site within an area of previously worked ground?	No. There is no evidence of any previously worked ground on the site.
10. Is the site within an aquifer? If so, will the proposed basement extend beneath the water table such that dewatering may be required during construction?	No. The Envirocheck report and GHHS indicates the site is not located on an aquifer.
11. Is the site within 50m of the Hampstead Heath Ponds	No.
12. Is the site within 5m of a highway or pedestrian right of way?	No. The proposed excavation is beyond 5m from the pedestrian right of way.
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Yes. Following review of available information, the neighbouring properties are likely to be set on shallow foundations at ground floor level and the proposed basement will extend to 2.5m below the current ground level.
14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	No. The nearest railway tunnel is 140m to the north of the site.

4.2 Subterranean (Groundwater) Flow

The subterranean (groundwater) flow screening flowchart from CPG4 is displayed in Table 4-2.

Table 4-2: Screening – Subterranean (groundwater) Flow

Subterranean (groundwater) flow screening chart	
1. a) Is the site located directly above an aquifer?	No. The Envirocheck report and GHHS indicates the site is not located on an aquifer. This is due to the site being underlain by the London Clay Formation that is Unproductive strata.
b) Will the proposed basement extend beneath the water table surface?	Unknown. The data available from the historical boreholes is insufficient to make an accurate estimate of groundwater level. A site investigation is required to assess groundwater levels.
2. Is the site within 100m of a watercourse, well (used/disused) or potential spring line?	No.
3. Is the site within the catchment of the pond chains on Hampstead Heath?	No.
4. Will the proposed basement development result in a change in the proportion of hard surfaced/paved external areas?	Yes. The proposed basement will extend 4.5m into the rear garden and an area of about 31m^2 will become a hard-surfaced terrace above the basement.
5. As part of the site drainage, will more surface water (e.g. rainfall and runoff) than at present be discharged	Yes. The proposed basement will extend 4.5m into the rear garden and an area of about 31m^2 will become a hard-surfaced terrace above the basement that will generate surface water.

to the ground (e.g. via soakaways and/or SUDS)?	
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 ponds or spring lines identified in the vicinity of the site.

4.3 Surface Flow and Flooding

The surface flow and flooding screening flowchart from CPG4 is displayed in Table 4-3.

Table 4-3: Screening – Surface Flow and Flooding

Surface flow and flooding screening chart	
1. Is the site within the catchment of the pond chains on Hampstead Heath?	No.
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?	Yes. The proposed basement will extend 4.5m into the rear garden and an area of about 31m^2 will become a hard-surfaced terrace above the basement that will generate surface water.
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?	Yes. The proposed basement will extend 4.5m into the rear garden and an area of about 31m^2 will become a hard-surfaced terrace above the basement.
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. There are no nearby watercourses.
5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	No. There are no nearby water courses.
6. Is the site in an area identified to have surface water flood risk or is it at risk from flooding, for example because the proposed basement is below the static water level of nearby surface water feature?	No. The site is in an area of low flood risk and there are no nearby water courses.

4.4 Screening Non-Technical summary

The following items have been identified from the screening stage as requiring assessment:

Slope stability:

CPG 4 Query	Explanation
5. Is the London Clay the shallowest strata at the site?	Yes. The geological maps do not show any superficial deposits at the site. This should be assessed by a site investigation.
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. In the rear garden the proposed works include: 1 x False Acacia (T1) - Fell to ground level, 1 x Sycamore (T3) - Prune encroaching roots to allow repair / deepening of foundations of garden wall, and 1 x Portuguese laurel (T4) - Fell to ground level. Approval for this work has been granted by the London Borough of Camden.
7. Is there a history of seasonal shrink-swell subsidence in the local area, and/or evidence of such effects at site?	The Envirocheck Report indicates a 'moderate' shrink-swell hazard rating. No evidence of shrink-swell subsidence has been provided.
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Yes. Following review of available information, the neighbouring properties are likely to be set on shallow foundations at ground floor level and the proposed basement will extend to 2.5m current ground level.

Sub surface groundwater flow

CPG 4 Query	Explanation
1b) Will the proposed basement extend beneath the water table surface?	Unknown. The data available from the historical boreholes is insufficient to make an accurate estimate of groundwater level. A site investigation is required to assess groundwater levels.
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?	Yes. The proposed basement will extend 4.5m into the rear garden and an area of about 31m^2 will become a hard-surfaced terrace above the basement.
5. As part of the site drainage, will more surface water (e.g. rainfall and runoff) than at present be discharged to the ground (e.g. via soakaways and/or SUDS)?	Yes. The proposed basement will extend 4.5m into the rear garden and an area of about 31m^2 will become a hard-surfaced terrace above the basement that will generate surface water.

Surface flow and flooding

CPG 4 Query	Explanation
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?	Yes. The proposed basement will extend 4.5m into the rear garden and an area of about $31m^2$ will become a hard-surfaced terrace above the basement that will generate surface water.
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?	Yes. The proposed basement will extend 4.5m into the rear garden and an area of about $31m^2$ will become a hard-surfaced terrace above the basement.

5. SCOPING

The Scoping stage identifies the potential impacts of the proposed scheme that are shown by the Screening stage. Items that have been identified as having a potential impact have been taken forward into the Impact Assessment stage.

The following impact assessments are based on concerns identified previously and the CPG4 screening assessments in Section 4.0.

5.1 Slope Stability

The potential impacts identified in the slope stability CPG4 Stage 1 Screening Assessment, Table 4-1, have been addressed in Table 5-1.

Table 5-1: Scoping – Slope Stability Impact Assessment

Slope stability scoping chart		
Screening Question	**Scoping**	**Impact Assessment**
5. Is the London Clay the shallowest strata at the site?	The ground investigation shows that the London Clay Formation is the shallowest strata on the site. The London Clay Formation is not expected to cause a slope stability hazard as the house is located on relatively flat land with no significant with no significant slopes noted.	No further impact assessment required.
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. In the rear garden the proposed works include: 1 x False Acacia (T1) - Fell to ground level, 1 x Sycamore (T3) - Prune encroaching roots to allow repair / deepening of foundations of garden wall, and 1 x Portuguese laurel (T4) - Fell to ground level.	Approval for this work has been granted by the London Borough of Camden. If the root zone of the trees to be felled encroach into the construction zone then heave as a result of root loss will need to be considered if this is undertaken close to construction and the soil moisture content has not re-equilibrated.
7. Is there a history of seasonal shrink-swell subsidence in the local area, and/or evidence of such effects at site?	The Envirocheck Report indicates a 'moderate' shrink-swell hazard rating. No evidence of shrink-swell subsidence has been provided. The site review has shown bedrock at the site is the London Clay Formation, which has a high-volume change potential. This has the potential to be affected by moisture changes causing shrink/swell. Roots were observed to 4.7m depth in a borehole.	The shrink-swell potential of the London Clay Formation has been assessed during a site investigation and is considered to have a high volume change potential. The basement will extend below the groundwater table so the founding stratum should remain saturated, although long tern groundwater level have not been measured. It has been recommended that the basement slab design should account for ground heave from unloading and heave of around 3mm could occur. Heave protection from trees is also recommended.

13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Yes, the neighbouring properties are likely to be set on shallow foundations at ground level. Excavation and formation of the basement could cause ground movement affecting these properties.	The basement design and construction will need to consider the neighbouring properties. The impacts and potential mitigation are discussed in more detail below. A Damage Category Assessment has been carried to assess the potential damage to neighbouring properties (see Section 7.0).

Ground movement associated with forming the basement excavation is a potential hazard. A Damage Category Assessment (DCA) (Sections 7 and 8) has been completed to assess the effects of the excavation and construction of the proposed basement on neighbouring properties.

The excavation and construction of the proposed basement will inevitably cause some ground movement. The magnitude of movements when using underpinning techniques will primarily depend on the geology, the adequacy of temporary support to both the underpinning excavations and the partially complete underpinning prior to installation of full permanent support as well as the quality of workmanship when construction the permanent structure.

It is crucial therefore that the use of best practice methods of temporary support and a high-quality workmanship are used to control ground movements alongside the basement excavations. Prior to excavations for the underpinning works begin all cracks in load-bearing walls that have weakened structural integrity should be fully repaired in accordance with recommendations from the appointed structural engineer.

Under UK standard practice, the design and implementation of temporary works is the Contractor's responsibility, so it is considered essential that the Contractor employed for these works has successfully completed similar schemes. Therefore, it is recommended to carefully pre-select the Contractors invited to tender for the works. The Contractor's temporary works should be fully detailed in the works method statements.

5.2 Subterranean Groundwater Flow

The potential impacts identified in the subterranean flow CPG4 Stage 1 Screening Assessment, Table 4-2, have been addressed in Table 5-2.

Table 5-2: Scoping and Impact Assessment – Subterranean (Groundwater) Flow Impact Assessment

Subterranean (groundwater) flow scoping chart		
Screening Question	**Scoping**	**Impact Assessment**
1b) Will the proposed basement extend beneath the water table surface?	Yes, a groundwater level of 0.99mbgl has been recorded in a monitoring standpipe installed in a borehole at the site.	See text below table.
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?	Yes. The proposed basement will extend 4.5m into the rear garden and an area of about $31m^2$ will become a hard-surfaced terrace above the basement.	Control of surface water will be via new drainage. There is an existing terrace that drains into the ground that will be improved with a soakaway for the top of the terrace.
5. As part of the site drainage, will more surface water (e.g. rainfall and runoff) than at present be discharged to the ground (e.g. via soakaways and/or SUDS)?	Yes. The proposed basement will extend 4.5m into the rear garden and an area of about $31m^2$ will become a hard-surfaced terrace above the basement that will generate surface water.	Control of surface water will be via new drainage. There is an existing terrace which drains into the ground that will be improved with a soakaway for the top of the terrace.

The groundwater table was encountered near the surface of the London Clay Formation at 0.99mbgl. This stratum has a relatively low permeability with groundwater flow expected to be slow. In light of this, the proposed basement is not anticipated to have any significant impact on groundwater flows/levels and therefore no significant impact on neighbouring properties would be expected.

There are no identified directly adjoining basements and therefore due to the anticipated minimal groundwater flow, 'coffering', which is the extensive damming of groundwater by adjoining or closely spaced basements, is not considered to be an issue even if groundwater levels are above the basement level. Accordingly, no mitigation measures are considered necessary in relation to groundwater flow.

This hydrogeological regime (i.e. groundwater levels and pressures) will be affected by long-term climatic variations as well as seasonal fluctuations and other man-induced influences, all of which must be considered by the designers when selecting a design water level for the permanent works. No long term, multi-seasonal groundwater monitoring data is available, so a conservative approach will be needed, as required by current geotechnical design standards.

5.3 Surface Water

The potential impacts identified in the subterranean flow CPG4 Stage 1 Screening Assessment, Table 4-3, have been addressed in Table 5-3.

Table 5-3: Scoping and Impact Assessment – Surface Water Flow Impact Assessment

Subterranean (groundwater) flow scoping chart		
Screening Question	**Scoping**	**Impact Assessment**
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?	Yes. The proposed basement will extend 4.5m into the rear garden and an area of about 31m2 will become a hard-surfaced terrace above the basement that will generate surface water for drainage.	Control of surface water will be via new drainage. There is an existing terrace which drains into the ground that will be improved with a soakaway for the top of the terrace.
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?	Yes. The proposed basement will extend 4.5m into the rear garden and an area of about 31m^2 will become a hard-surfaced terrace above the basement.	New drainage will be installed to collect surface water run off generated by the terrace. The designers will need to assess the impact of this on the existing stormwater system.

6. SITE INVESTIGATION

A site investigation stage has been undertaken to develop an understanding of the site and its immediate surroundings and for use in assessing matters of concerns identified during the Screening stage. The results have been used to address the matters of concern in the Scoping and Impact Assessment stages.

6.1 Intrusive Ground Investigation

A ground investigation (GI) was completed by CET in December 2018 and comprised one windowless sampler borehole (WLS01) and a foundation trial pit. Details of the GI are outlined in Table 6-1. The borehole was undertaken in the rear garden of the property.

Table 6-1: Ground Investigation Details

Type	Reference	Depth mbgl (termination)	In situ Testing	Installation Details
Trial pit	TP01 (House wall)	1.8 (target depth)	-	-
Windowless sampler	WS01	8.0m (target depth)	Hand vane. Pocket penetrometer (PP).	4m deep with 1m plain pipe and 3m slotted pipe.

6.2 Ground and Groundwater Conditions

A summary of the ground conditions encountered in the GI is presented in the table below. The borehole log is presented in Appendix D.

Table 6-2: Summary of Ground Conditions

Strata name	Depth to top of strata (mbgl)	Thickness (m)	Description
Made Ground	0	1.10	Soft, dark brown, slightly fine to coarse sandy, gravelly CLAY. Gravel is angular and sub-angular, fine to coarse brick and mortar. Low cobble content of angular brick.
London Clay Formation	1.10	Proven to 8m depth. Base not reached.	Firm, brown mottled orange brown and grey CLAY with rare fine to coarse sand and fine and medium gravel size

		Expected to be over 60m thick.	selenite. (Weathered London Clay Formation). Below 5.8m: Stiff, grey, very closely fissured CLAY with rare fine and medium sand size selenite.

A water strike was recorded in WS01 at 6.5m below ground level with no rise after 20 minutes on 6th March 2019. A subsequent reading of a piezometer installed in WS01, made during a post site work monitoring visit, found groundwater at a depth of 0.99m below ground level on the 13th of March 2019. It should also be appreciated that the groundwater table may vary both seasonally and in the long-term. Groundwater flow in the London Clay Formation is expected to be slow due to it having a low permeability.

7. GROUND MOVEMENT ASSESSMENT

7.1 Introduction

Oasys PDISP software has been used to undertake the analyses of heave and settlement ground movements arising from changes in vertical stresses caused by excavation of the basement. The analysis is based on Boussinesq's theory of analysis for calculating stresses and strains in soils due to vertically applied loads with the predicted ground movements being derived by integration of vertical strains derived from Boussinesq's equations. These preliminary analyses have not modelled the horizontal forces on the retaining walls and so have simplified the stress regime significantly. In addition, consistent with Boussinesq theory, the soils are assumed to comprise a semi-infinite isotropically homogeneous elastic medium.

7.2 Proposed Basement Layout

The basement layout has been based on drawings provided by Elite (Figure 1). The proposed basement extension is up to approximately 4.5m long by 6.8m wide with the excavation extending to a depth of about 2.5m below garden ground level, including the floor slab. The proposed basement construction is estimated therefore to have an overall soil pressure unloading of about 50kN/m^2, although the part of the basement under the house that is to be deepened will have a much lower unloading compared to the basement extension as this area has already been unloaded.

Gross pressure changes across the development have been estimated based on information provided by the structural engineer. The load zones, positive and negative, used to model the proposed basement in PDISP are displayed in Figure 1. These include the excavation and loads on the retaining walls, excavation of central area from existing ground level and construction of the basement raft/slab.

The retaining walls will be cast in 1m wide bays and the base width will be 1250mm. In the permanent condition, all bases will be integral with the main slab itself. Since these 'retaining wall' bays will need to be laterally propped in the temporary condition, there would only be a nominal pressure below the bases. There will be no internals columns or pads and the basement will be a reinforced concrete box. The basement slab will be ground bearing, acting as a raft. The average bearing pressure in the completed condition will be of the order of 35kN/m^2 (un-factored), including Imposed loads.

Table 7-1 presents the net changes in vertical pressure for each load zone for the four major stages in the sequence of stress changes which will result from excavation and construction of the basement as outlined below:

- Stage 1: Construction of retaining walls – Short-term (undrained) condition;

- Stage 2: Bulk excavation to basement formation level – Short-term (undrained) conditions;
- Stage 3: Construction of the basement – Short-term (undrained) conditions; and
- Stage 4: Construction of the basement – Long-term (drained) conditions.

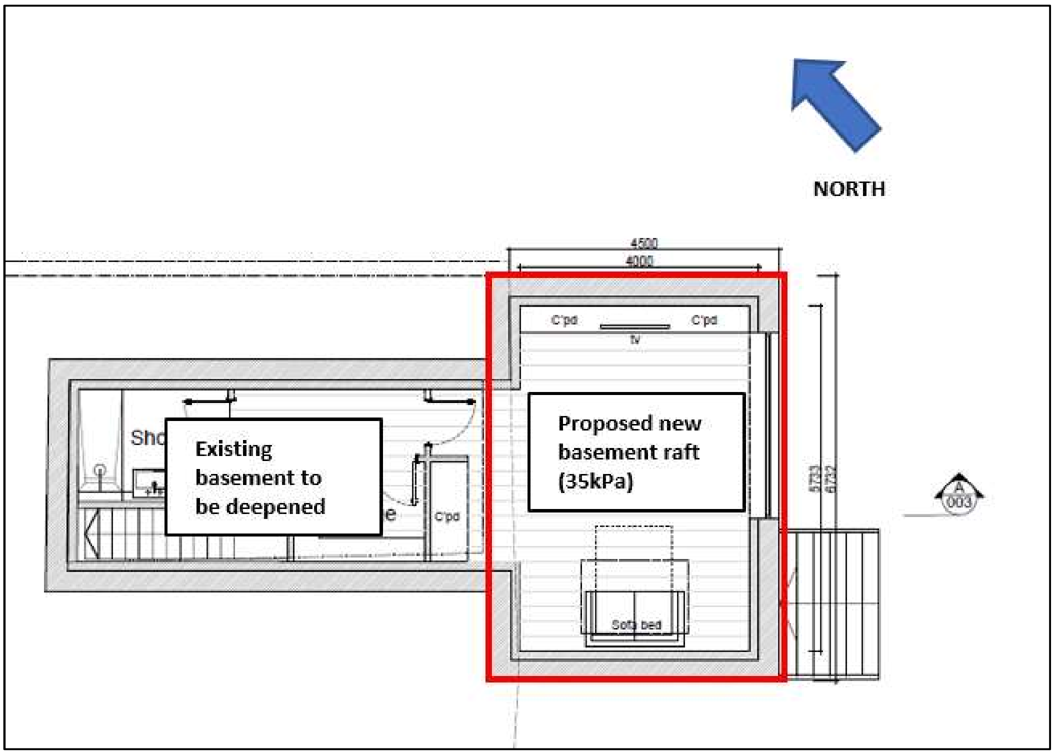


Figure 1: Load zones introduced to PDISP.

Table 7-1: Net bearing pressures for PDISP

Zone	Net change in vertical pressure (kN/m^2)		
	Stage 1 Retaining wall	Stage 2 Bulk Excavation	Stages 3 & 4 Basement raft construction short and long term
Basement walls and raft	Negligible	-50	-50 + 35 = -15

7.3 Ground Conditions

The ground conditions are based on the CET ground investigation are shown in Table 6-2 and the logs are contained in Appendix D. The proposed basement will be constructed within the London Clay Formation at 2.5m below ground level.

The short-term and long-term geotechnical properties used in the analysis are summarised in Table 7-3. These were based on the results of the ground investigation. The London Clay Formation Young's modulus properties were calculated assuming undrained Young's modulus, $E_u = 500 \times c_u$, and drained Young's modulus, $E' = 0.75 \times E_u$.

All Made Ground will be excavated and therefore only the change in vertical pressure, due to its excavation, is required for the PDISP analyses. Geotechnical parameters for the Made Ground are not used in the analysis.

A global Poisson's ratio of 0.5 has been adopted for the London Clay Formation over the modelled thickness.

Table 7-2: Soil Parameters for PDISP Analyses

Strata	**Depth (m bgl)**	**Bulk Density (kN/m³)**	**Cu (kPa)**	**Short-term, undrained Young's Modulus, Eu (MPa)**	**Long-term, drained Young's Modulus, E' (MPa)**
Made Ground	0 to 1.1	20	Not used	Not used	Not used
London Clay Formation	Below 1.1	20	70 to 80	35	26

7.4 PDISP Analysis

Three dimensional analyses of vertical displacements have been undertaken using PDISP software and the basement geometry, loads/stresses and ground conditions outlined above to assess the potential magnitudes of ground movements (heave or settlement) which may result from the vertical stress changes caused by excavation of the basement. PDISP analyses have been carried out as follows:

- Stage 1: Construction of the retaining walls – Short-term (undrained) condition;
- Stage 2: Bulk excavation of central area to basement formation level – Short-term (undrained) conditions;
- Stage 3: Construction of the basement raft – Short-term (undrained) conditions; and
- Stage 4: Construction of the basement raft – Long-term (drained) conditions.

The results of the analyses for Stages 1, 2, 3 and 4 are presented as contour plots in Appendix E.

7.5 Heave and Settlement Analysis

Excavation of the basement and construction of the raft cause immediate elastic heave/settlements in response to the stress changes, followed by long term plastic swelling/settlement as the underlying clay takes up groundwater or consolidation occurs. The rate of plastic swelling/consolidation will be determined largely by the availability of water and as a result, given the low permeability of the London Clay Formation, can take many years to reach equilibrium. The basement slab will need to be designed to enable it to accommodate the swelling displacements/pressures developed underneath it.

The ranges of predicted short-term and long-term movements for each of the main sections of the proposed basement are presented in Table 7-4. All values are approximate owing to the simplification of the stress regime and include only displacements caused by stress changes in the ground beneath the basement.

All the short-term elastic displacements would have occurred before the basement slab is cast, so only the post-construction incremental heave/settlements, the difference from Stages 3, short-term, to 4, long-term, are relevant to the slab design.

Table 7-3: Summary of Predicted Ground Movements from PDISP

Location / Building Element	Stage 1 (short term) Retaining walls	Stage 2 (short term) Bulk Excavation	Stage 3 (short term) Basement raft construction	Stage 4 (long term) Basement raft construction
Basement perimeter along northeast side	Negligible	2mm to 4mm heave	1mm to 2mm heave	1mm to 2mm heave
Basement perimeter along southeast side	Negligible	2mm to 5mm heave	1mm to 2mm heave	1mm to 2mm heave
Basement perimeter along southwest side boundary	Negligible	2mm to 5mm heave	1mm to 2mm heave	1mm to 2mm heave
Basement perimeter along northwest boundary	Negligible	2mm to 5mm heave	1mm to 2mm heave	1mm to 2mm heave
Basement raft slab area	N/A	2mm to 8mm heave	1mm to 3mm heave	1mm to 3mm heave

8. DAMAGE CATEGORY ASSESSMENT

8.1 Introduction

Behaviour of the ground will depend on the quality and methods of construction, so rigorous calculations of predicted ground movements are not practical. However, provided that the temporary support follows best practice, then industry experience has shown that the bulk movements of the ground alongside retaining walls for a single storey basement at a nominal depth 2.5m below ground level should not exceed 5mm horizontally. This figure should be adjusted pro-rata for shallower or deeper basements.

To relate these predicted ground movements to possible damage to adjacent properties, it is necessary to consider the strains and the angular distortion (as a deflection ratio) that may be generated using the method proposed by Burland (2001, in CIRIA Special Publication 200, which developed earlier work by Burland and others).

8.2 Critical Damage Category Locations

As detailed earlier, no evidence has been provided that the neighbouring properties have basements. Due to the uniform founding level beneath the proposed basement the potentially critical locations will be determined by the displacements predicted by the PDISP analyses, and the geometries and distances of the neighbouring properties.

As ground movements reduce with distance away from the proposed basement and the relative founding depths, the worst-case scenarios will be the southeast and party walls of 47a and 51 Belsize Lane that are located either side of the proposed basement, the latter being the farthest away. The locations of the assessed walls are displayed in Figure 2.

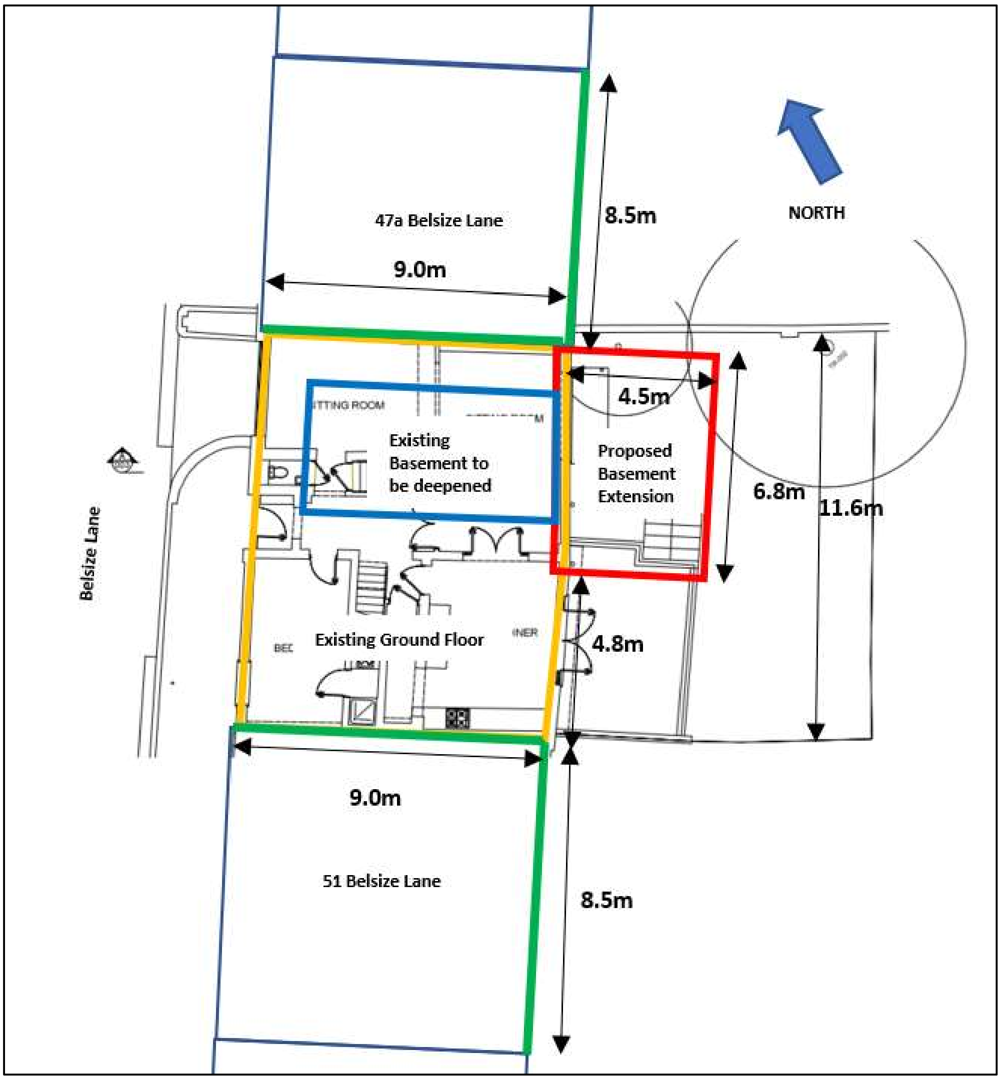


Figure 2: Critical Damage Category Assessment (DCA) Locations (green lines)

8.3 Affected Widths of Critical Locations

The damage category assessments will consider the PDISP analyses of ground movements from vertical stress changes and ground movements alongside the proposed underpinning retaining walls caused by relaxation of the ground in response to the excavations.

CIRIA C760 (Gaba et al., 2017) details that ground movements related to the construction of retaining walls in clay extend up to four times the depth of excavation. A settlement of up to 0.35% of the maximum excavation depth is predicted by CIRIA C760 for worst case 'low support stiffness' walls in stiff clay, which is considered appropriate for the development. The relevant geometries of the assessed locations have been obtained from the available drawings or approximated using maps and aerial images. The relevant geometries and affected widths and predicted settlements of the critical locations are detailed in Table 8-1.

Table 8-1: Geometries, Affected Widths and Predicted Settlements of Critical Locations

	47a Belsize Lane SE and party wall	51 Belsize Lane SE and party wall
Relative depth of foundations beneath ground floor	0.5m (assumed)	0.5m (assumed)
Depth of excavation (below lower ground floor level)	2.5 – 0.5 = 2.0m	2.5 – 0.5 = 2.0m
Zone of influence behind basement wall	2.5 x 4 = 10m	2.5 x 4 = 10m
Distance from proposed basement	0m	4.8m
Ground surface movement due to excavation in front of basement wall (CIRIA 760 Figure 6.15b)	0.35% of max excavation depth (@0m from basement wall)	0.1% of max excavation depth (@4.8m from basement wall)
Approximate width of assessed wall	8.5m	8.5m
Assessed width, L	8.5m	8.5m
Height of affected building, H	6m (approximate average height)	6m (approximate average height)
L / H	c.1	c.1
CIRIA predicted settlement	7mm	2mm

8.4 Displacements Along Assessed Walls

The predicted 5mm horizontal displacement decreases pro-rata when the relative depth of excavation is taken into account. The predicted horizontal displacements and the relative theoretical horizontal strains beneath each wall as well as the maximum settlements produced by PDISP beneath the location of the assessed walls are displayed in Table 8-2.

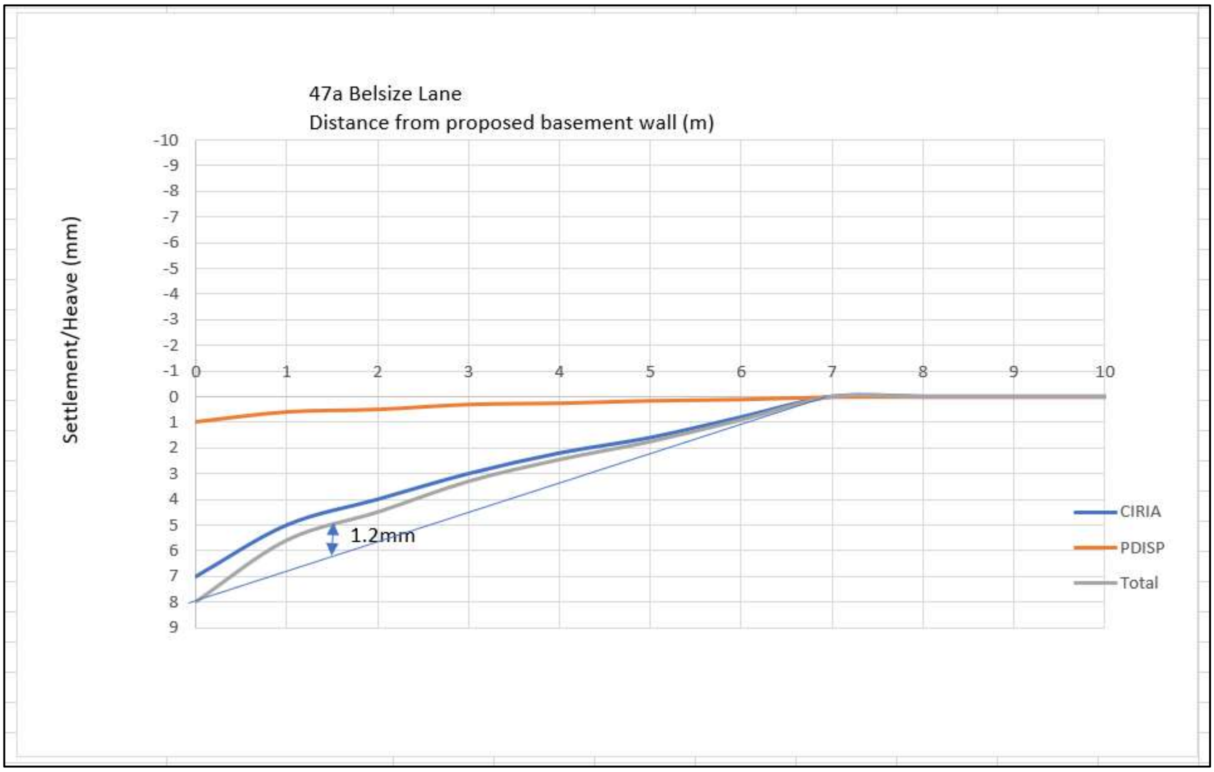
Table 8-2: Displacements of Assessed Walls at Closest Point

	47a Belsize Lane SE and party wall	51 Belsize Lane SE and party wall
Horizontal displacement	5mm	2.6mm
Horizontal strain, ε_h	0.059%	0.031%
Maximum PDISP settlement	1.2mm	0.2mm
CIRIA settlement	7mm	2mm
Combined CIRIA and PDISP settlement	8.2mm	2.2mm

The settlement profile produced by PDISP along the assessed wall locations must be added to the settlement profile presented in Figure 6.15b of CIRIA Report C760, which is appropriate for the underpinned retaining wall construction method. The combined maximum settlements, at the closest point of the assessed walls are displayed in Table 8-2. The CIRIA settlement profiles from the basement wall to the maximum distance of affected ground are predicted to be the same for both walls and this is displayed in Figure 3.

The horizontal strain is the horizontal displacement divided by the affected wall length.

The deflection along the walls is calculated as the difference between the tangent of the relevant width of the affected walls and the total combined predicted ground surface movements curves from the CIRIA C760 and the PDISP analyses.



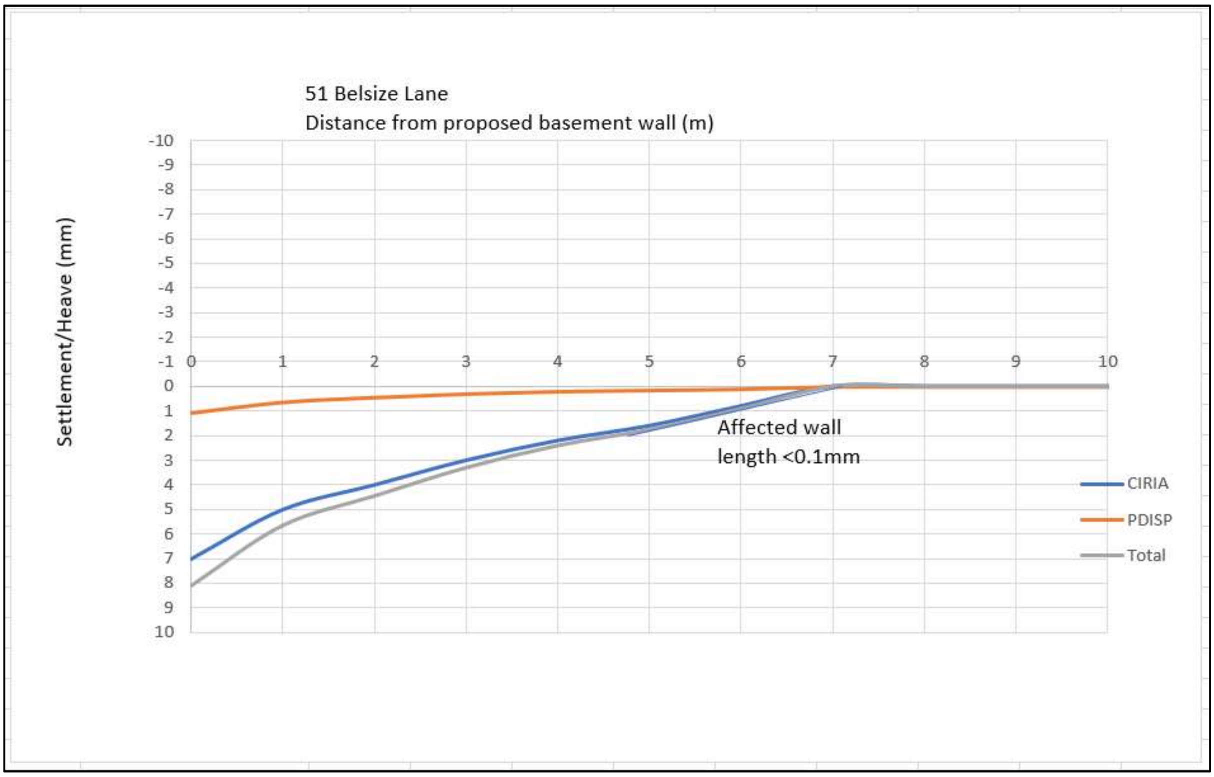


Figure 3: Predicted displacements for the nearest walls to 47a and 51 Belsize Lane to excavation of proposed basement

The maximum vertical deflections, from the convex settlement curves for the low stiffness ground support case and the relevant deflection ratios are displayed in Table 8-3.

The vertical deflection of the facing walls for 47a and 51 Belsize Lane will be the difference in settlement along the affected wall length determined from PDSIP analysis. The deflection ratio is the vertical deflection divided by the wall height, which is estimated to be about 6m.

Table 8-3: Vertical Deflections of Assessed Walls

	47a Belsize Lane SE and party wall	51 Belsize Lane SE and party wall
Vertical deflection, Δ	1.2mm	0.2mm
Deflection ratio, Δ/L	2.0×10^{-4} 0.020%	3.3×10^{-5} 0.0033%

8.5 Damage Category Rating

The damage category the assessed walls are illustrated in Figure 4, using the damage category ratings and graphs given in CIRIA SP200. Figure 5 explains the damage categories.

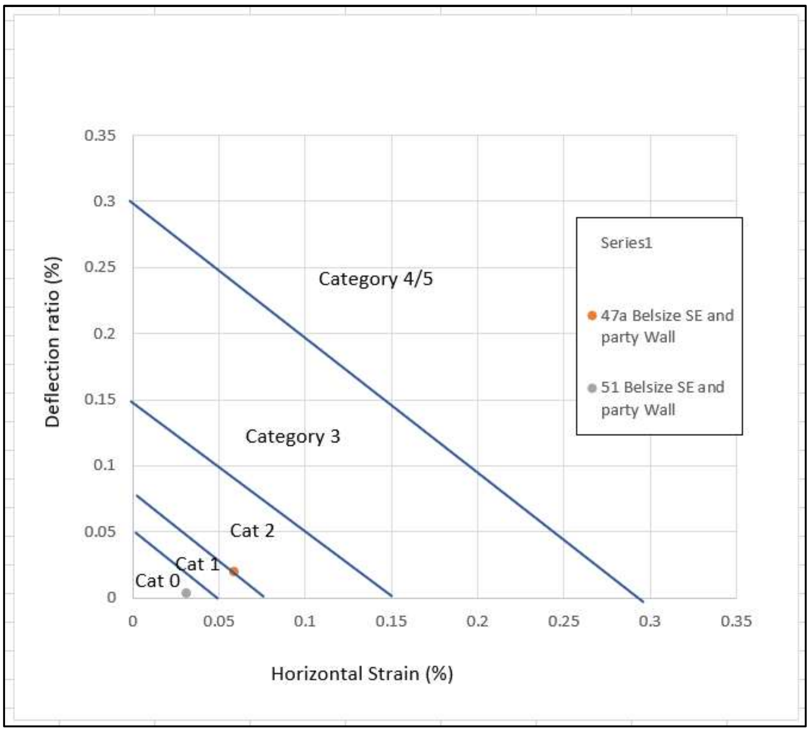


Figure 4: Damage Category ratings

The results show the affected walls are:

- 47a Belsize Lane SE and party wall: On the boundary of Category 1 (Very Slight) and Category 2 (Slight). The CIRIA data relates to retaining walls significantly longer and deeper than those proposed in this assessment and, assuming the use of best practice construction techniques, the movements associated with the construction of the proposed basement are likely to be smaller than those predicted by the CIRIA data. An observational approach is recommended to be applied so that all displacements remain within Category 1 or less. To keep any damage within Category 1, a monitoring strategy with appropriate trigger levels is required. The vertical deflection must not exceed say 4.5 mm and a horizontal strain not exceeding 0.053% will be required. The use of transitional underpinning would be an additional mitigation measure to further limit displacements.

- 51 Belsize Lane SE and party wall (Category 0 (Negligible).

Use of best practice construction methods will be essential to ensure that the ground movements are kept in line with the above predictions. If the appropriate mitigation measures and monitoring strategies are applied, and transitional underpinning adopted, then the damage category rating of all assessed walls would reasonably be considered to fall within Burland Category 1 or less. Pre-construction condition surveys of neighbouring properties are also recommended and a system of monitoring adjoining/adjacent structures should be established before the works start.

Category of damage	Description of typical damage (ease of repair is underlined)	Approximate crack width (mm)	Limiting tensile strain, ε_{lim} (%)
0 Negligible	Hairline cracks of less than about 0.1 mm are classed as negligible	<0.1	0.0 to 0.05
1 Very slight	**Fine cracks that can easily be treated during normal decoration.** Perhaps isolated slight fracture in building. Cracks in external brickwork visible on inspection	<1	0.05 to 0.075
2 Slight	**Cracks easily filled. Redecoration probably required.** Several slight fractures showing inside of building. Cracks are visible externally and **some repointing may be required externally** to ensure weathertightness. Doors and windows may stick slightly.	<5	0.075 to 0.15
3 Moderate	**The cracks require some opening up and can be patched by a mason. Recurrent cracks can be masked by suitable lining. Repointing of external brickwork and possibly a small amount of brickwork to be replaced.** Doors and windows sticking. Service pipes may fracture. Weathertightness often impaired.	5 to 15 or a number of cracks >3	0.15 to 0.3
4 Severe	**Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows.** Windows and frames distorted, floor sloping noticeably. Walls leaning or bulging noticeably, some loss of bearing in beams. Services pipes disrupted.	15 to 25, but also depends on number of cracks	>0.3
5 Very severe	**This requires a major repair, involving partial or complete rebuilding.** Beams lose bearings, walls lean badly and require shoring. Windows broken with distortion. Danger of instability.	Usually >25, but depends on numbers of cracks	

Notes

1 In assessing the degree of damage, account must be taken of its location in the building or structure.

2 Crack width is only one aspect of damage and should not be used on its own as a direct measure of it.

Figure 5: Classification of visual damage to wall

(after Burland et al, 1977; and Boscardin and Cording, 1989; and Burland, 2001).

9. BASEMENT IMPACT ASSESSMENT CONCLUSIONS AND SUMMARY

This Summary includes the principal aspects and primary findings of this assessment. The whole report should be read to obtain a full understanding of the matters considered.

Location: 49 Belsize Lane, Hampstead NW3 5AU in the London Borough of Camden.

9.1 Stage 1: Screening

Slope stability:

CPG 4 Query	Explanation
5. Is the London Clay the shallowest strata at the site?	Yes. The geological maps do not show any Superficial Deposits at the site. This should be assessed by a site investigation.
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. In the rear garden the proposed works include: 1 x False Acacia (T1) - Fell to ground level, 1 x Sycamore (T3) - Prune encroaching roots to allow repair / deepening of foundations of garden wall, and 1 x Portuguese laurel (T4) - Fell to ground level. Approval for this work has been granted by the London Borough of Camden.
7. Is there a history of seasonal shrink-swell subsidence in the local area, and/or evidence of such effects at site?	The Envirocheck Report indicates a 'moderate' shrink-swell hazard rating. No evidence of shrink-swell subsidence has been provided.
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Yes. Following review of available information, the neighbouring properties are likely to be set on shallow foundations at ground floor level and the proposed basement will extend to 2.5m current ground level.

Sub surface groundwater flow

CPG 4 Query	Explanation
1b) Will the proposed basement extend beneath the water table surface?	Unknown. The data available from the historical boreholes is insufficient to make an accurate estimate of groundwater level. A site investigation is required to assess groundwater levels.
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?	Yes. The proposed basement will extend 4.5m into the rear garden and an area of about 31m^2 will become a hard-surfaced terrace above the basement.
5. As part of the site drainage, will more surface water (e.g. rainfall and runoff) than at present be discharged to the ground (e.g. via soakaways and/or SUDS)?	Yes. The proposed basement will extend 4.5m into the rear garden and an area of about 31m^2 will become a hard-surfaced terrace above the basement that will generate surface water.

Surface flow and flooding

CPG 4 Query	Explanation
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?	Yes. The proposed basement will extend 4.5m into the rear garden and an area of about 31m^2 will become a hard-surfaced terrace above the basement that will generate surface water.
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?	Yes. The proposed basement will extend 4.5m into the rear garden and an area of about 31m^2 will become a hard-surfaced terrace above the basement.

9.2 Site Investigation

A ground investigation (GI) was completed by CET in December 2018 and comprised one windowless sampler borehole (WLS01) and a foundation trial pit. The borehole was undertaken in the rear garden of the property and encountered the following ground conditions:

Strata name	Depth to top of strata (mbgl)	Thickness (m)	Description
Made Ground	0	1.10	Soft, dark brown, slightly fine to coarse sandy, gravelly CLAY. Gravel is angular and sub-angular, fine to coarse brick and mortar. Low cobble content of angular brick.
London Clay Formation	1.10	Proven to 8m depth. Base not reached. Expected to be over 60m thick.	Firm, brown mottled orange brown and grey CLAY with rare fine to coarse sand and fine and medium gravel size selenite. (Weathered London Clay Formation). Below 5.8m: Stiff, grey, very closely fissured CLAY with rare fine and medium sand size selenite.

Groundwater was recorded in WS01 at 6.5m below ground level with no rise after 20 minutes on 6th March 2019. A subsequent reading made during a post site work monitoring visit, recorded groundwater at a depth of 0.99m below ground level on the 13th of March 2019.

9.3 Site Model

A conceptual ground model for the site is summarised as follows:

- **Excavation Depth** – Approximately 2.5m below ground level;
- **Site Topography** – Relatively flat at 70mAOD;
- **Surface Water Bodies** – None within 500m;
- **Flood Risk** – Low from flooding and very low from surface water;
- **Ground Conditions**
    - Made Ground from 0 to 1.1m below ground level;
    - Firm Weathered London Clay Formation from 1.1m to 5.8m below ground level; and
    - Stiff Unweathered London Clay Formation below 5.8m depth.
- **Aquifer** – None 'Unproductive' stratum (London Clay Formation); and
- **Groundwater** – Groundwater level of 0.99mbgl.

9.4 Scoping and Impact Assessment

A summary of issues identified in the scoping stage is provided below.

- Slope stability issues within the London Clay Formation will be highly unlikely to impact the site or surrounding area due to the relatively level ground profile;

- Some trees are due to be felled, and the roots of another tree will be affected as part of construction. In the rear garden the proposed works include: 1 x False Acacia (T1) - Fell to ground level, 1 x Sycamore (T3) - Prune encroaching roots to allow repair / deepening of foundations of garden wall, and 1 x Portuguese laurel (T4) - Fell to ground level. Approval for this work has been granted by the London Borough of Camden. The affect of tree root removal on ground heave will need to be considered if tree removal is carried out close to construction;

- The site is on the London Clay Formation that has a high-volume change potential and will be prone to shrinkage/swelling. The proposed basement will extend to below the recorded groundwater table, although the long-term groundwater profile at the site has not been assessed. Therefore, heave as a result of tree roots will need to be considered. Heave as a result of net unloading from the basement excavation is expected to occur in the order of -15kN/m^2 that could result in heave of around 3mm.

- The site is not located above an aquifer however a measured groundwater level of 0.99m below ground level in a monitoring standpipe indicates the proposed basement will extend below the groundwater table. The strata above and immediately below founding level (London Clay Formation) are expected to have a low permeability and this combined with the low topographic profile would likely create minimal groundwater flow at the level of the proposed basement. Therefore, it is considered unlikely that the basement would cause any significant adverse impact on groundwater flows. Groundwater level monitoring readings should be taken during the detailed design period and prior to construction;

- Construction of the new basement will reduce the proportion of the existing soft standing garden area and increase the proportion of hard standing resulting in the generation of surface water run-off. The control of surface water will be via new drainage. There is an existing terrace which drains into the ground that will be improved with a soakaway for the top of the terrace;

- Construction of the basement will result in lowering of the foundations compared to adjacent sites by a net value of about 2m, and excavation of the basement will result in some ground movements. The effect of this has been reviewed in ground movement and damage category assessments. Contour plots of displacement in response to the changes in vertical pressure caused by the excavation and construction of the proposed basement are included. Based upon the maximum displacements predicted by PDISP analyses, Damage Category Assessments were undertaken for the worst-case scenarios in the adjoining properties and these combined with the ground movements alongside the basement in response to the lateral stress release are as predicted by Figure 6.15b of the CIRIA publication C760;

- In the assessed cases, the nearest walls of 47a Belsize Lane are classified as Category 1 'slight' and the nearest walls on 51 Belsize Lane is Category 0 'Negligible' (as given in CIRIA SP200). The damage category results have been plotted graphically in Figure 4. No further Damage Category Assessments have been carried out as other structures in the vicinity are further away and/or have a similar founding depth to the proposed basement and therefore considered lower risk. Therefore, all other walls are considered to be classified as Category 0 'negligible'. The above assessment assumes the use of best practice construction methods to ensure that the ground movements are kept in line with the above predictions. If the appropriate mitigation measures and monitoring strategies are applied, and transitional underpinning adopted, then the damage category rating of all assessed walls would reasonably be considered to fall within Burland Category 1 or less. Pre-construction condition surveys of neighbouring properties are also recommended, and a system of monitoring adjoining and adjacent structures should be established before the works start.

10. REFERENCES

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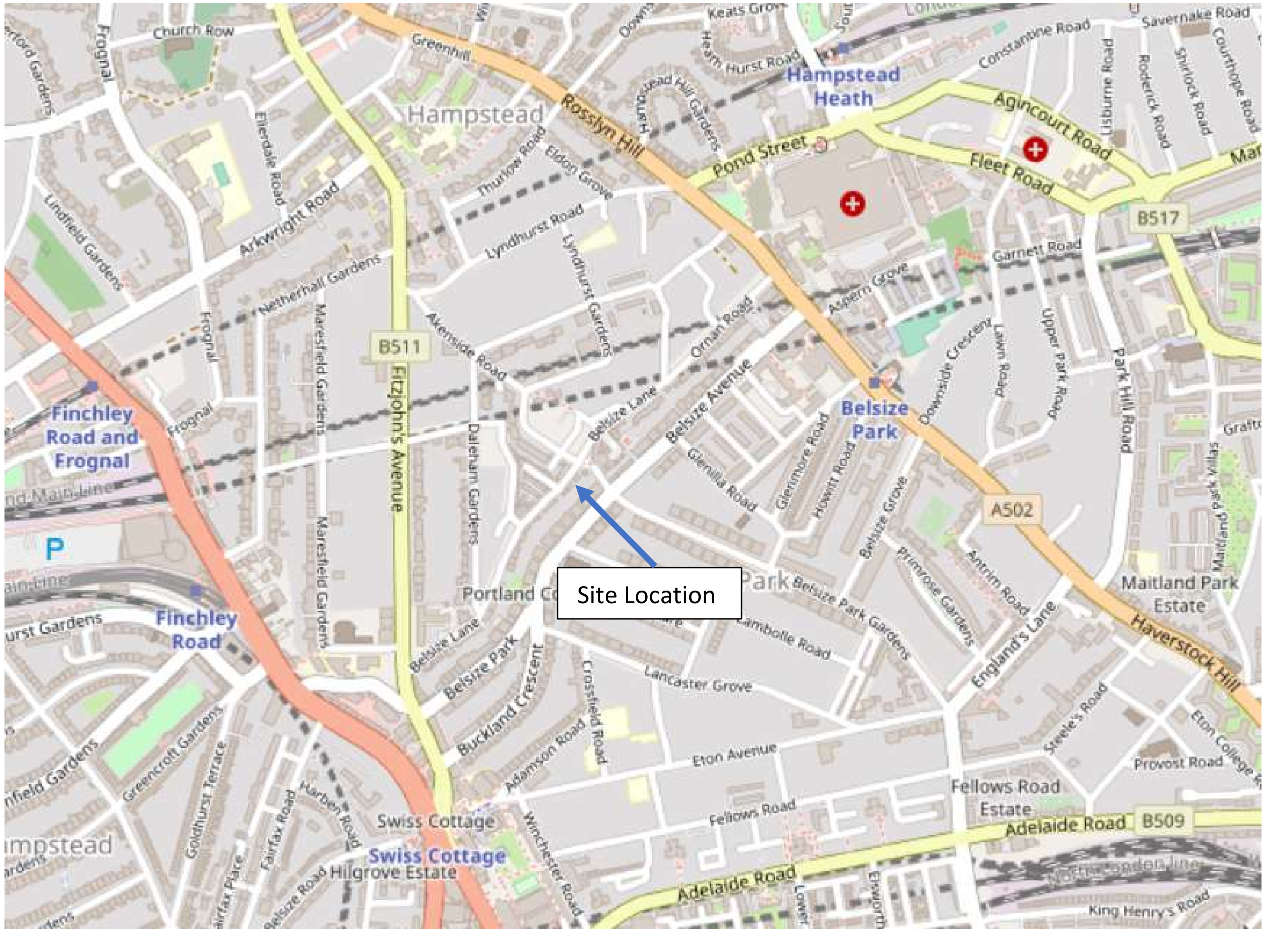
APPENDIX A FIGURES

INFRASTRUCTURE
Giving our all

Northdown House, Ashford Road, Harrietsham, Maidstone
Kent, ME17 1QW
Telephone: 01622 858545 Facsimile: 01622 858544

49 Belsize Lane, Hampstead

Lead No.	527194
Created By:	GRH
Checked:	PTE
Approved:	PTE
Date:	July 2019



North

Site Location Plan

Scale: NTC

FIGURE A1

CET INFRASTRUCTURE
Giving our all

Northdown House, Ashford Road, Harrietsham, Maidstone
Kent, ME17 1QW
Telephone: 01622 858545 Facsimile: 01622 858544

49 Belsize Lane, Hampstead

Lead No.	
	527194

Created By:	Checked:	Approved:	Date:
GRH	PTE	PTE	July 2019

Transport for London Property Asset Manager

Tunnel Asset Locations

Scale: As shown

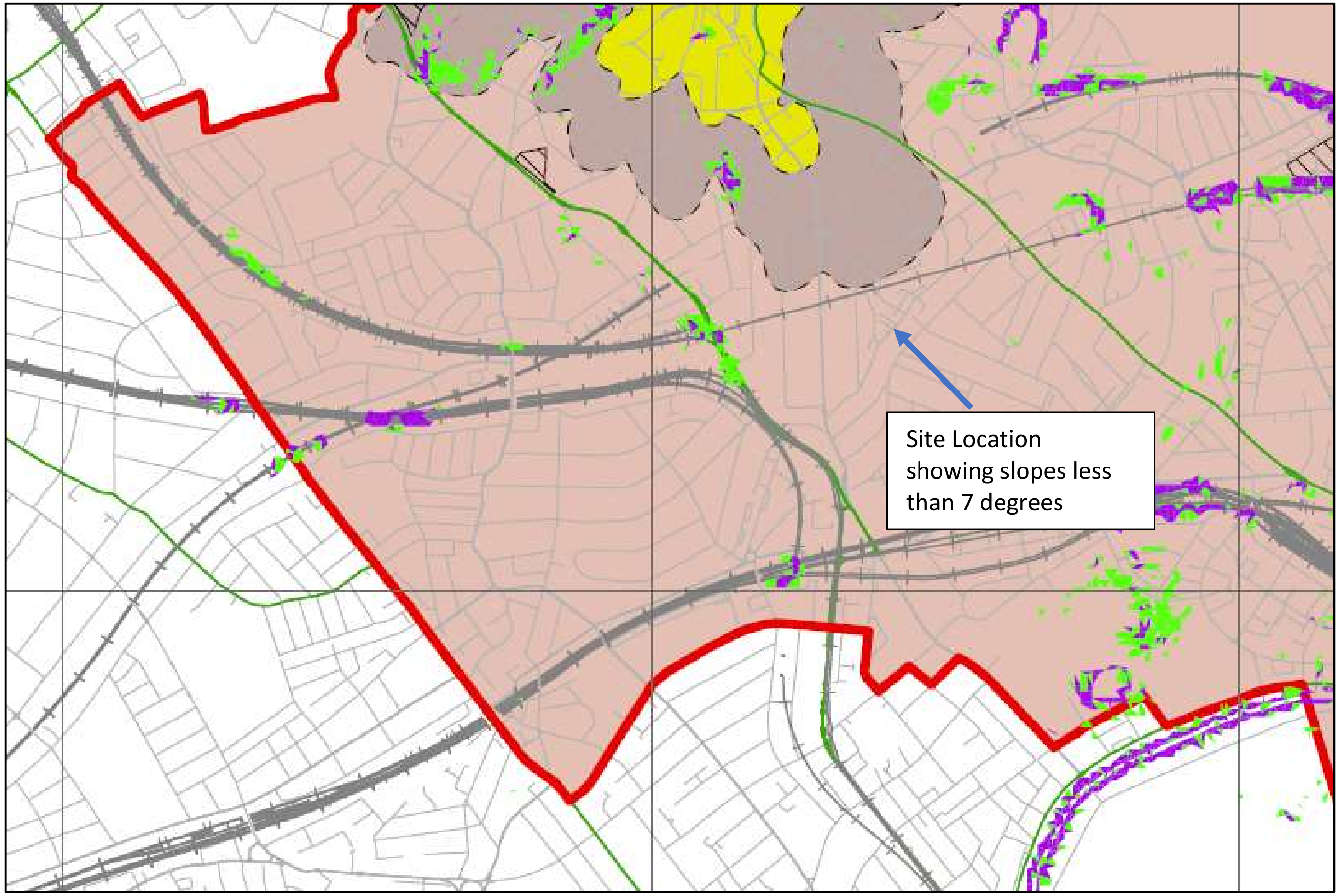
FIGURE A2

INFRASTRUCTURE
Giving our all

Northdown House, Ashford Road, Harrietsham, Maidstone
Kent, ME17 1QW
Telephone: 01622 858545 Facsimile: 01622 858544

49 Belsize Lane, Hampstead

Created By: GRH	Checked: PTE	Approved: PTE	Lead No. 527194
			Date: July 2019



North

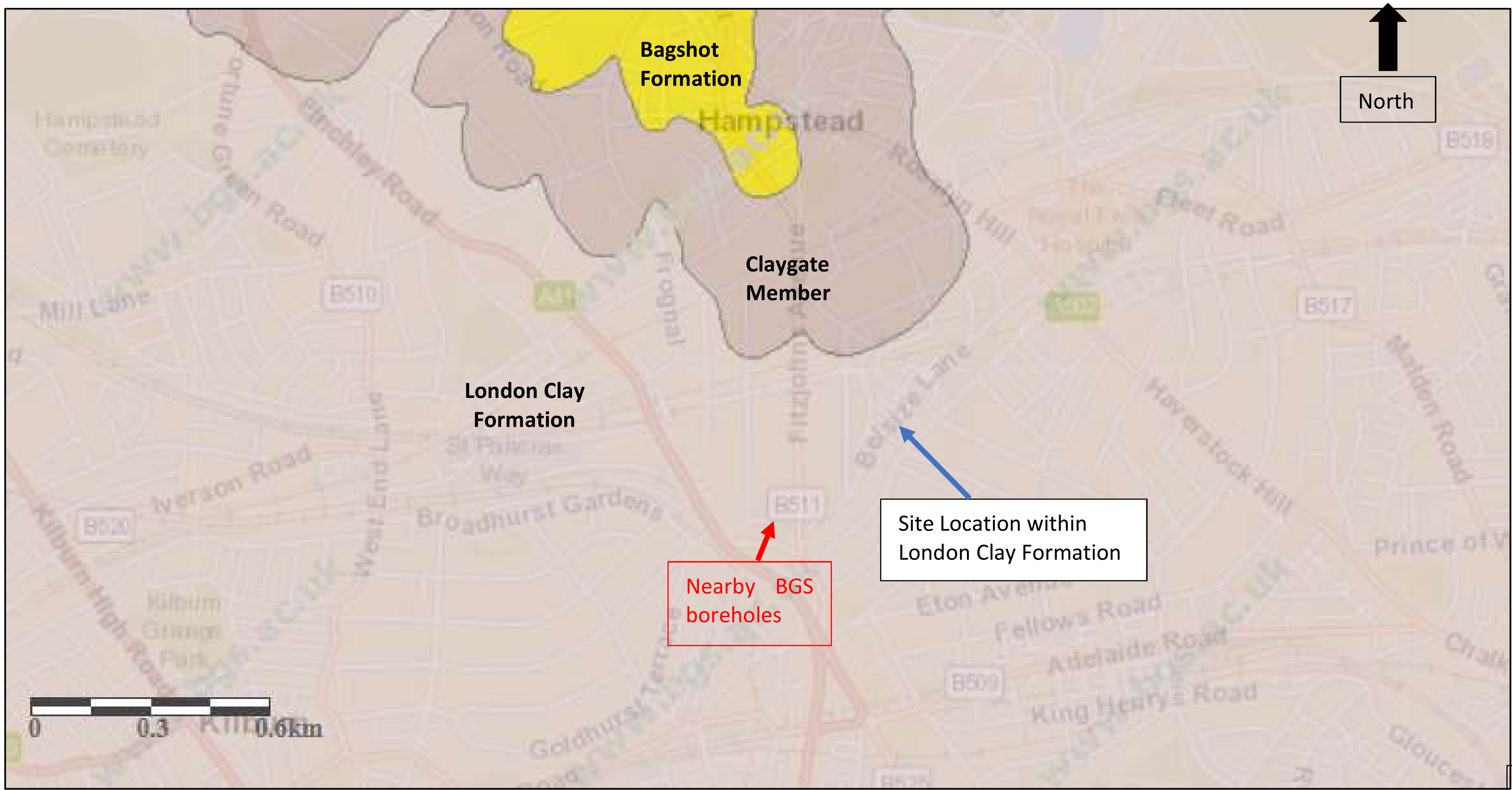
GHHS Fig 16

Slope Angle Map

Scale: NTS

FIGURE A3

INFRASTRUCTURE Giving our all	49 Belsize Lane, Hampstead			Lead No. 527194
Northdown House, Ashford Road, Harrietsham, Maidstone Kent, ME17 1QW Telephone: 01622 858545 Facsimile: 01622 858544	Created By: GRH	Checked: PTE	Approved: PTE	Date: July 2019



Geological Map

Scale: As shown

FIGURE A4

CET INFRASTRUCTURE
Giving our all

Northdown House, Ashford Road, Harrietsham, Maidstone
Kent, ME17 1QW
Telephone: 01622 858545 Facsimile: 01622 858544

49 Belsize Lane, Hampstead

Lead No.			527194
Created By: GRH	Checked: PTE	Approved: PTE	Date: July 2019

North

'The Lost Rivers of London' by Barton

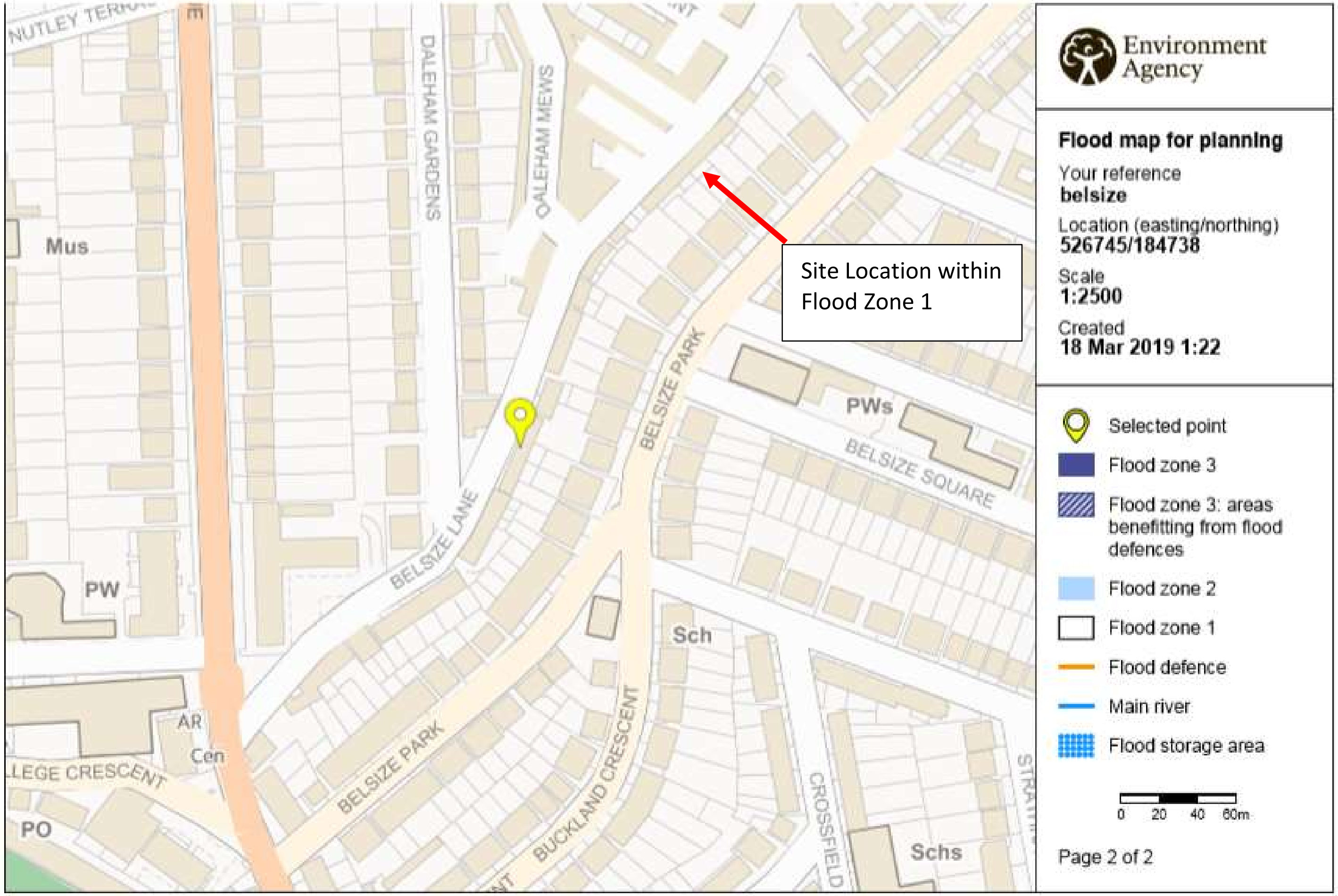
Lost Rivers

Scale: NTS

FIGURE A5

CET INFRASTRUCTURE Giving our all Northdown House, Ashford Road, Harrietsham, Maidstone Kent, ME17 1QW Telephone: 01622 858545 Facsimile: 01622 858544	**49 Belsize Lane, Hampstead**	Lead No. **527194**

Created By:	Checked:	Approved:	Date:
GRH	**PTE**	**PTE**	**July 2019**



North

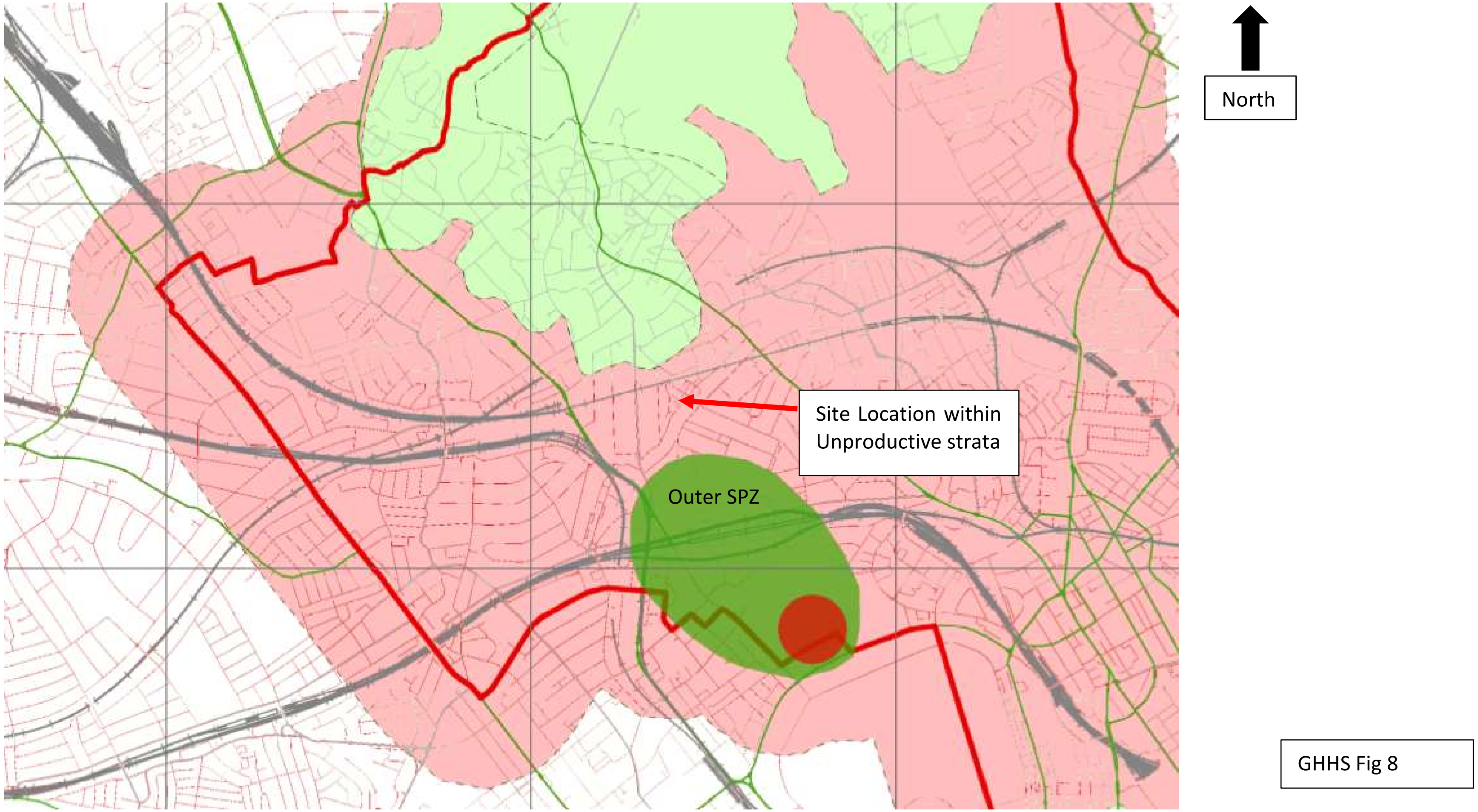
Flood Zone Map	Scale: As shown
	FIGURE A6

INFRASTRUCTURE
Giving our all

Northdown House, Ashford Road, Harrietsham, Maidstone
Kent, ME17 1QW
Telephone: 01622 858545 Facsimile: 01622 858544

49 Belsize Lane, Hampstead

			Lead No. 527194
Created By: GRH	Checked: PTE	Approved: PTE	Date: July 2019



Groundwater Aquifers

Scale: NTS

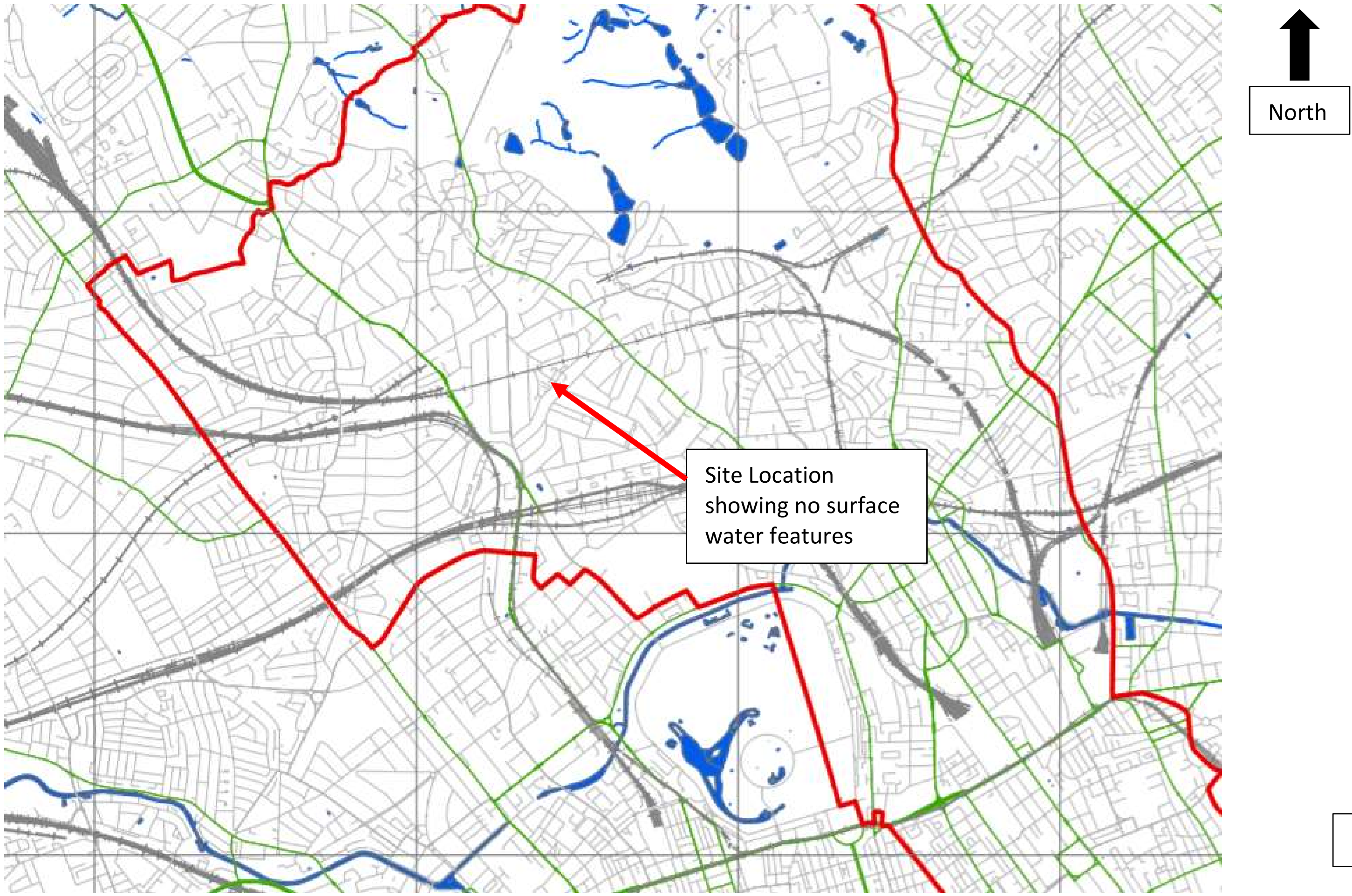
FIGURE A7

INFRASTRUCTURE
Giving our all

Northdown House, Ashford Road, Harrietsham, Maidstone
Kent, ME17 1QW
Telephone: 01622 858545 Facsimile: 01622 858544

49 Belsize Lane, Hampstead

Lead No.	527194
Created By:	GRH
Checked:	PTE
Approved:	PTE
Date:	July 2019



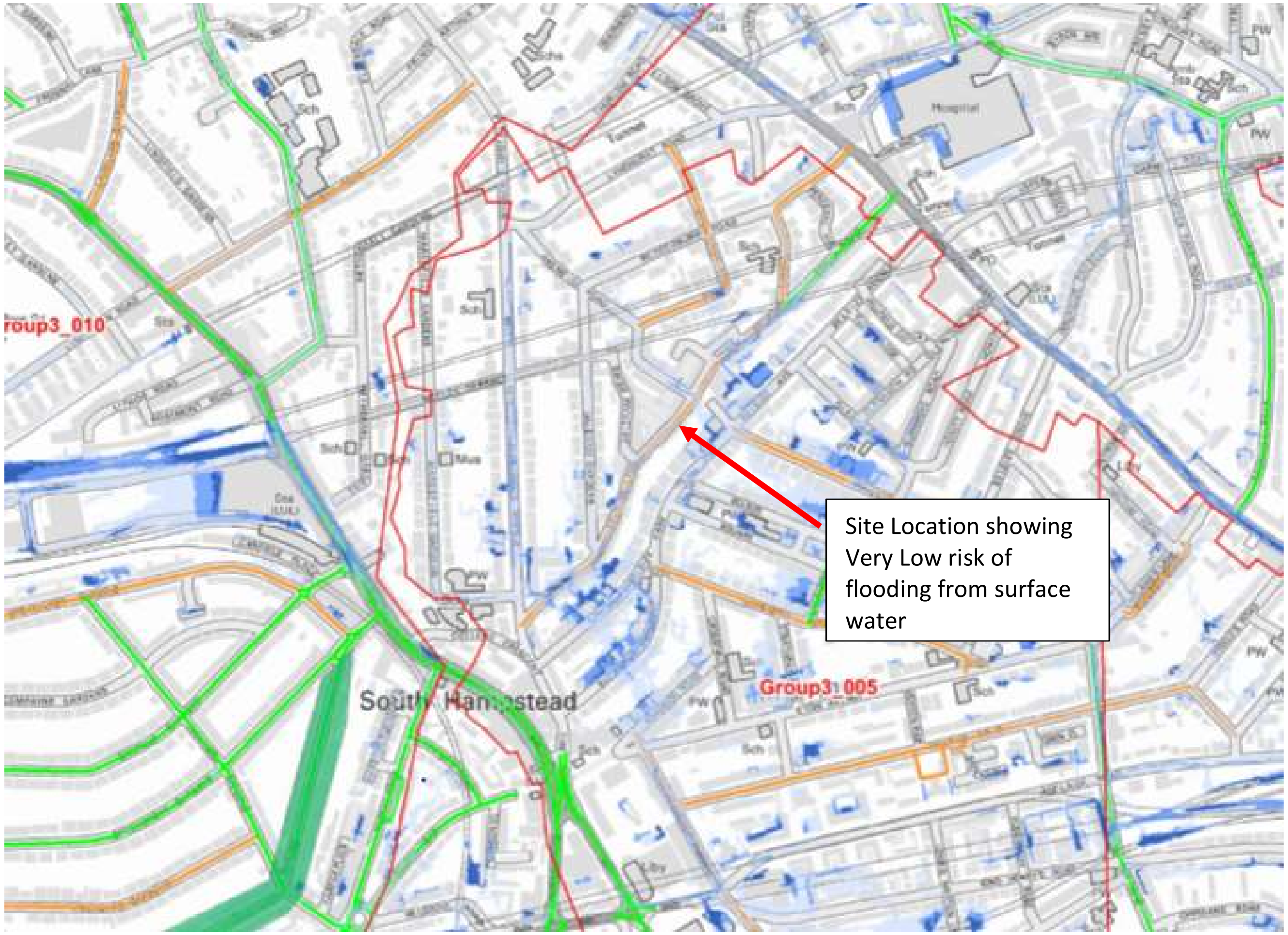
GHHS Fig 12

Surface Water Features

Scale: As shown

FIGURE A8

CET INFRASTRUCTURE Giving our all Northdown House, Ashford Road, Harrietsham, Maidstone Kent, ME17 1QW Telephone: 01622 858545 Facsimile: 01622 858544	49 Belsize Lane, Hampstead			Lead No. **527194**
	Created By: **GRH**	Checked: **PTE**	Approved: **PTE**	Date: **July 2019**



North

URS 2014: Fig 3v

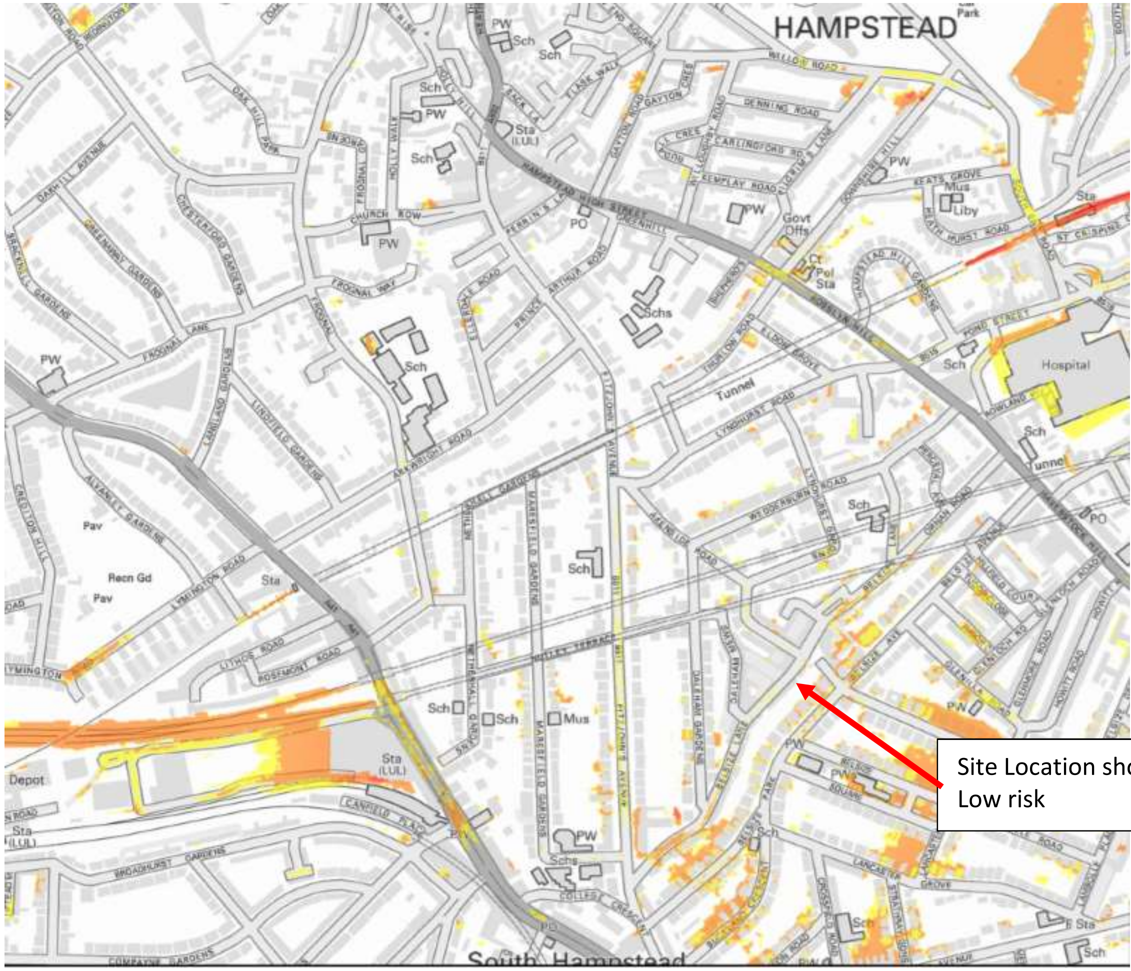
Surface Water Flooding	Scale: As shown
	FIGURE A9

INFRASTRUCTURE
Giving our all

Northdown House, Ashford Road, Harrietsham, Maidstone
Kent, ME17 1QW
Telephone: 01622 858545 Facsimile: 01622 858544

49 Belsize Lane, Hampstead

Created By:	Checked:	Approved:	Lead No.
GRH	PTE	PTE	527194
			Date: July 2019



North

Site Location showing
Low risk

URS 2014: Fig 3ix

Flooding 1:1000 year event

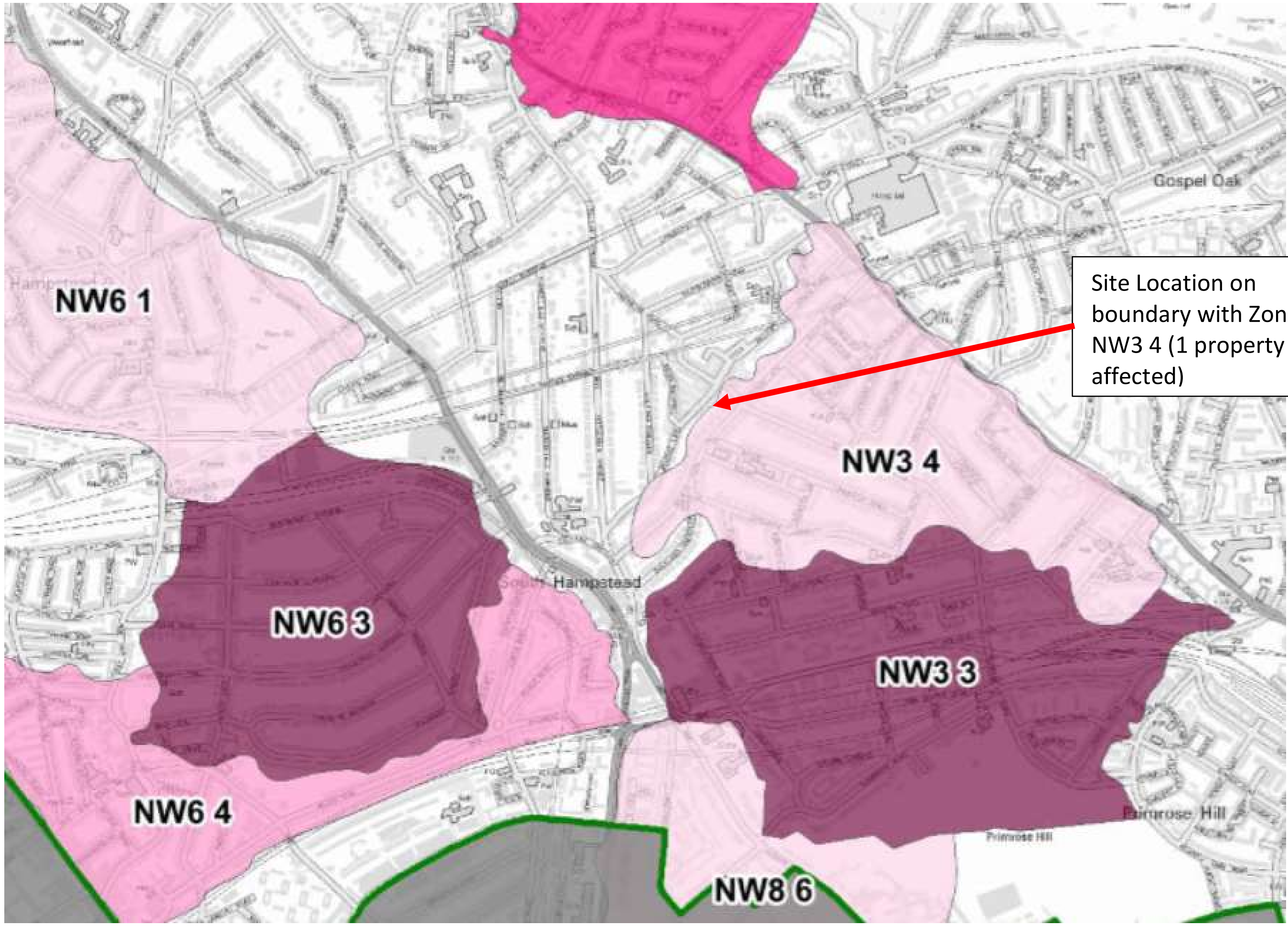
Scale: As shown

FIGURE A10

CET INFRASTRUCTURE
Giving our all
Northdown House, Ashford Road, Harrietsham, Maidstone
Kent, ME17 1QW
Telephone: 01622 858545 Facsimile: 01622 858544

49 Belsize Lane, Hampstead

Lead No.	527194
Created By: GRH	Checked: PTE
Approved: PTE	Date: July 2019



North

Site Location on boundary with Zone NW3 4 (1 property affected)

URS 2014: Fig 5a

Internal Sewer Flooding

Scale: As shown

FIGURE A11

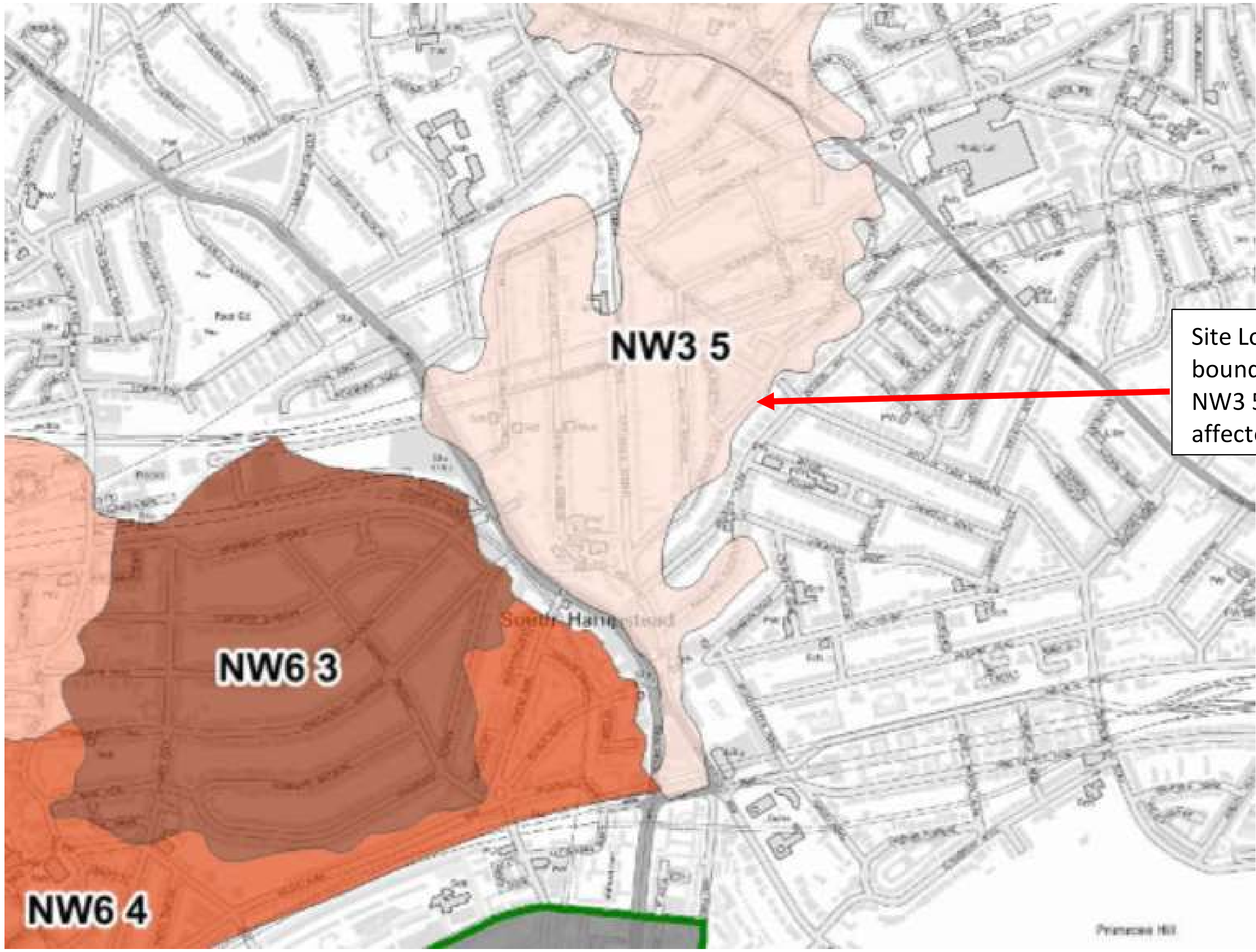
INFRASTRUCTURE
Giving our all

Northdown House, Ashford Road, Harrietsham, Maidstone
Kent, ME17 1QW
Telephone: 01622 858545 Facsimile: 01622 858544

49 Belsize Lane, Hampstead

Lead No.	527194

Created By:	Checked:	Approved:	Date:
GRH	PTE	PTE	July 2019



North

Site Location on boundary with Zone NW3 5 (1 property affected)

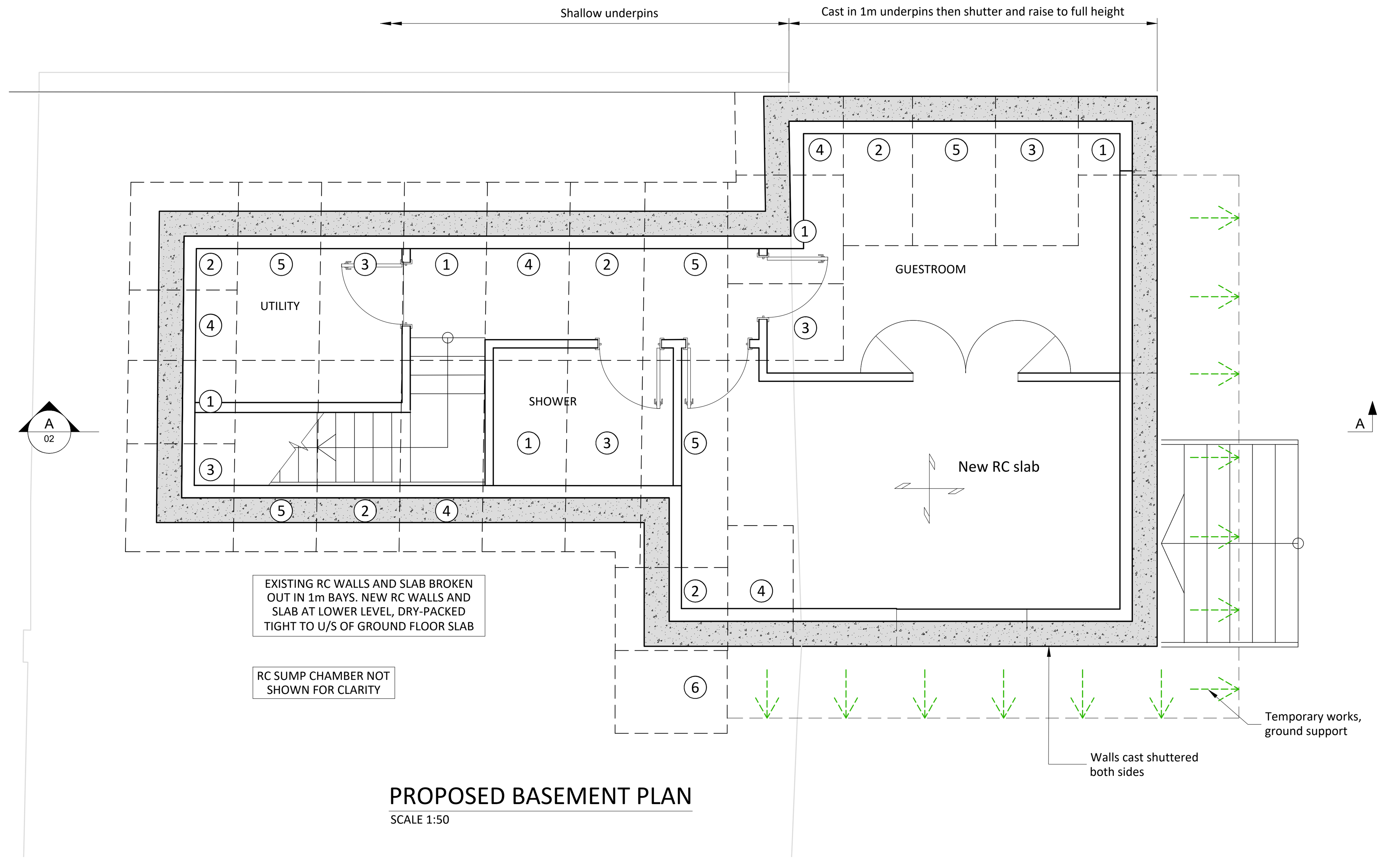
URS 2014: Fig 5b

External Sewer Flooding

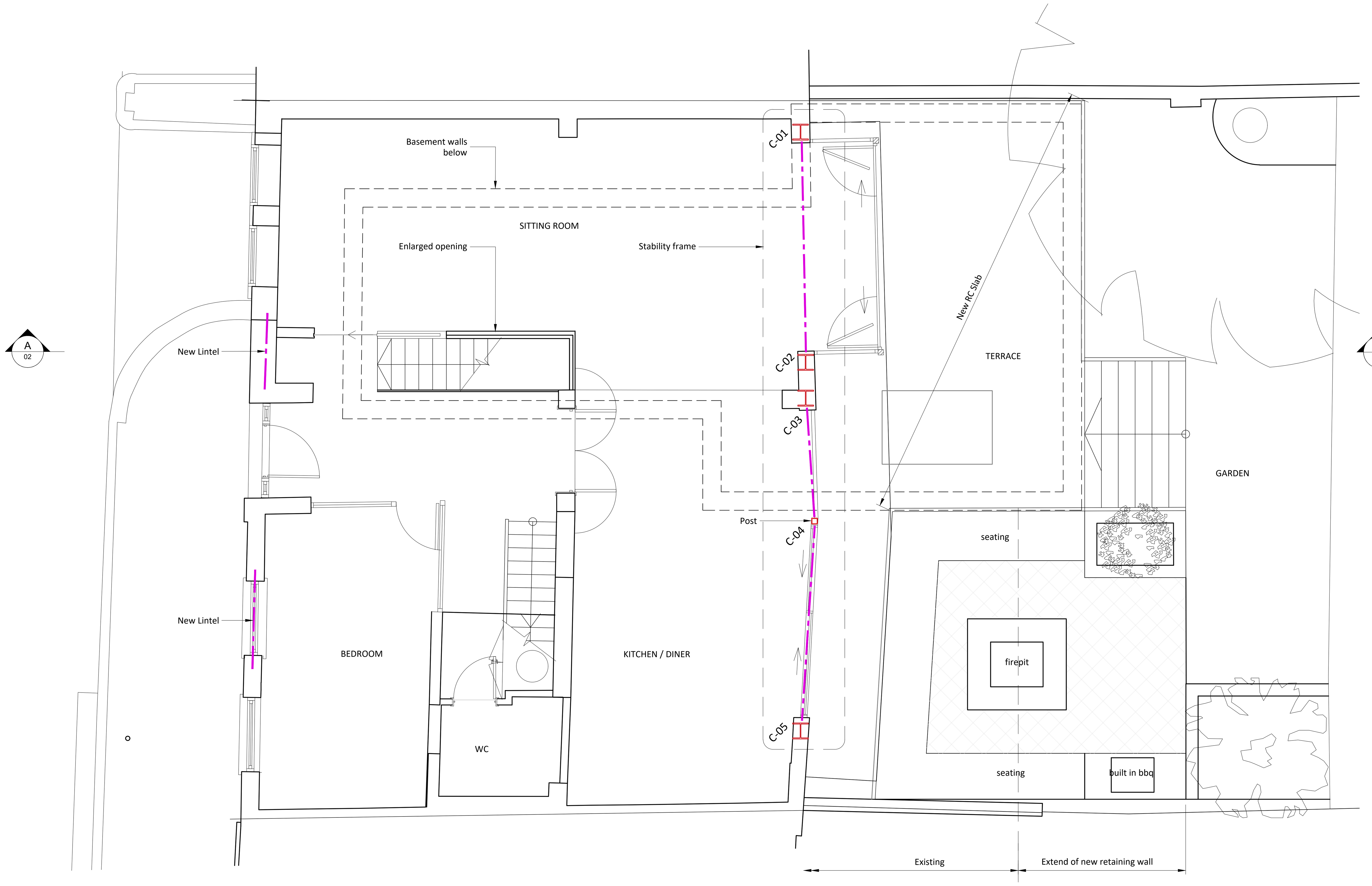
Scale: As shown

FIGURE A12

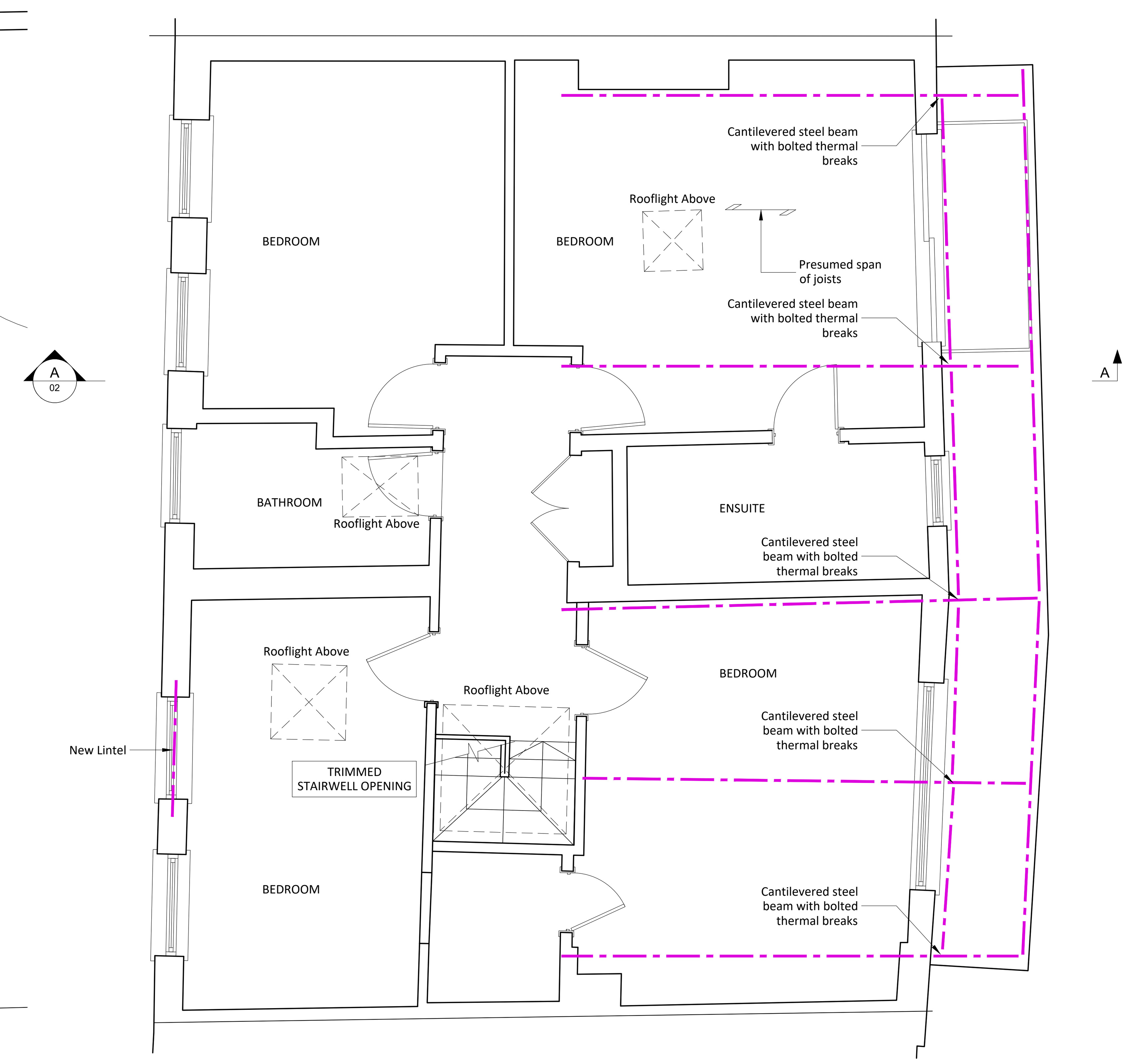
APPENDIX B PROPOSED DEVELOPMENT PLANS



PROPOSED BASEMENT PLAN
SCALE 1:50



PROPOSED GROUND FLOOR PLAN
SCALE 1:50



PROPOSED FIRST FLOOR PLAN
SCALE 1:50

0 0.5 1 1.5 2m

Notes:

1. This drawing is to be read in conjunction with all relevant architects, engineers & specialist sub-contractors drawings and the specification.
2. Any discrepancies between the site conditions and these drawings to be reported to Elite Designers. Dimensions must not be scaled and should be checked on site.
3. All dimensions are in millimetres, levels are in metres a.o.d. (above ordnance datum).

FOR PLANNING

Rev.	Date	Description	by	ch'd	app
A	31/07/19	ISSUED FOR INFORMATION	OT	SB	BH

Project
46 Belsize Lane
LONDON
NW3 5AU

Title
PROPOSED PLANS

C/A
N. Panigirtzoglou & M. Sebastia

Elite Designers Structural Engineers
3 Princeton Court
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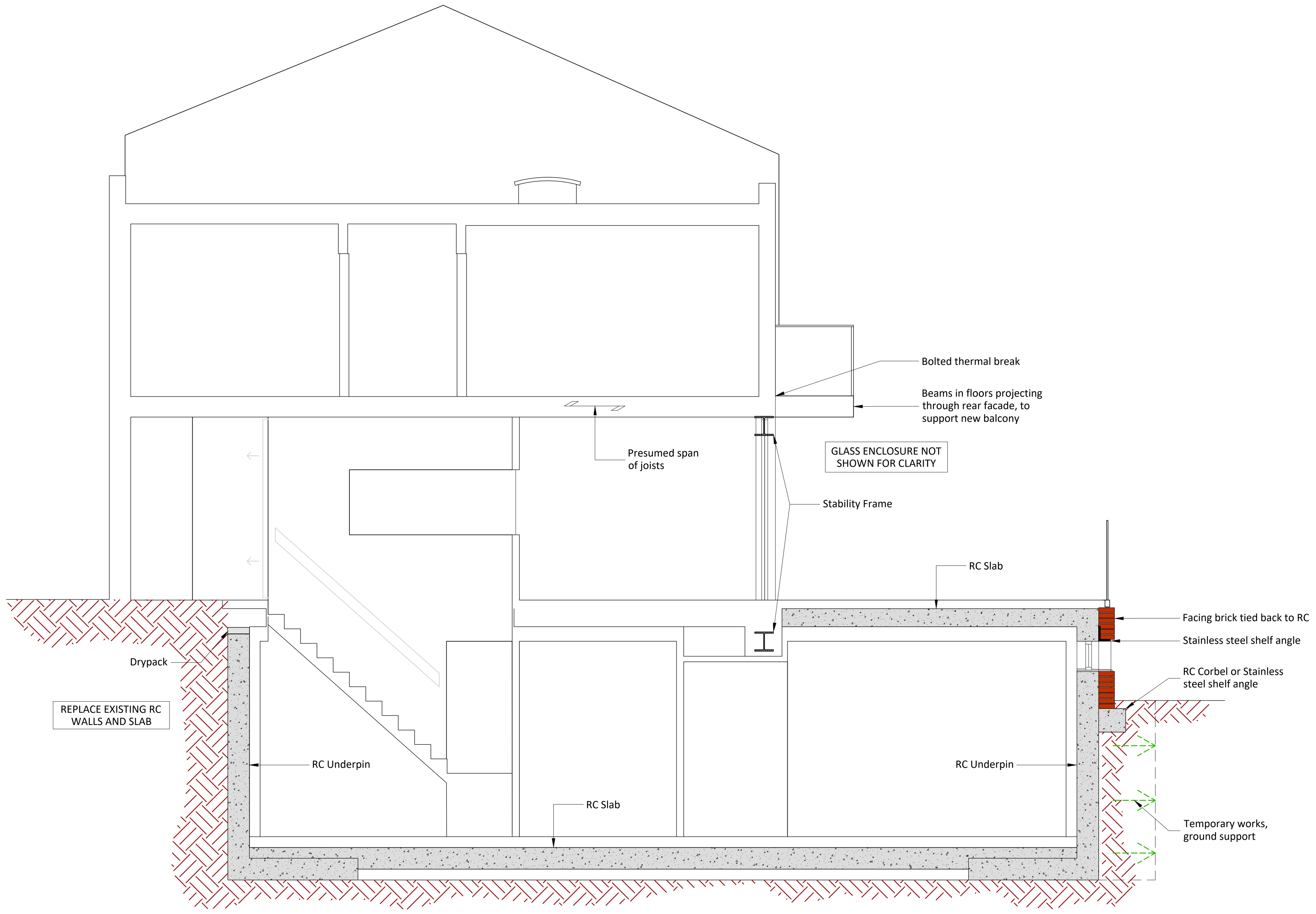
Putney
London SW15 1AZ
+44 (0)20 8785 4499
elitedesigners.co.uk

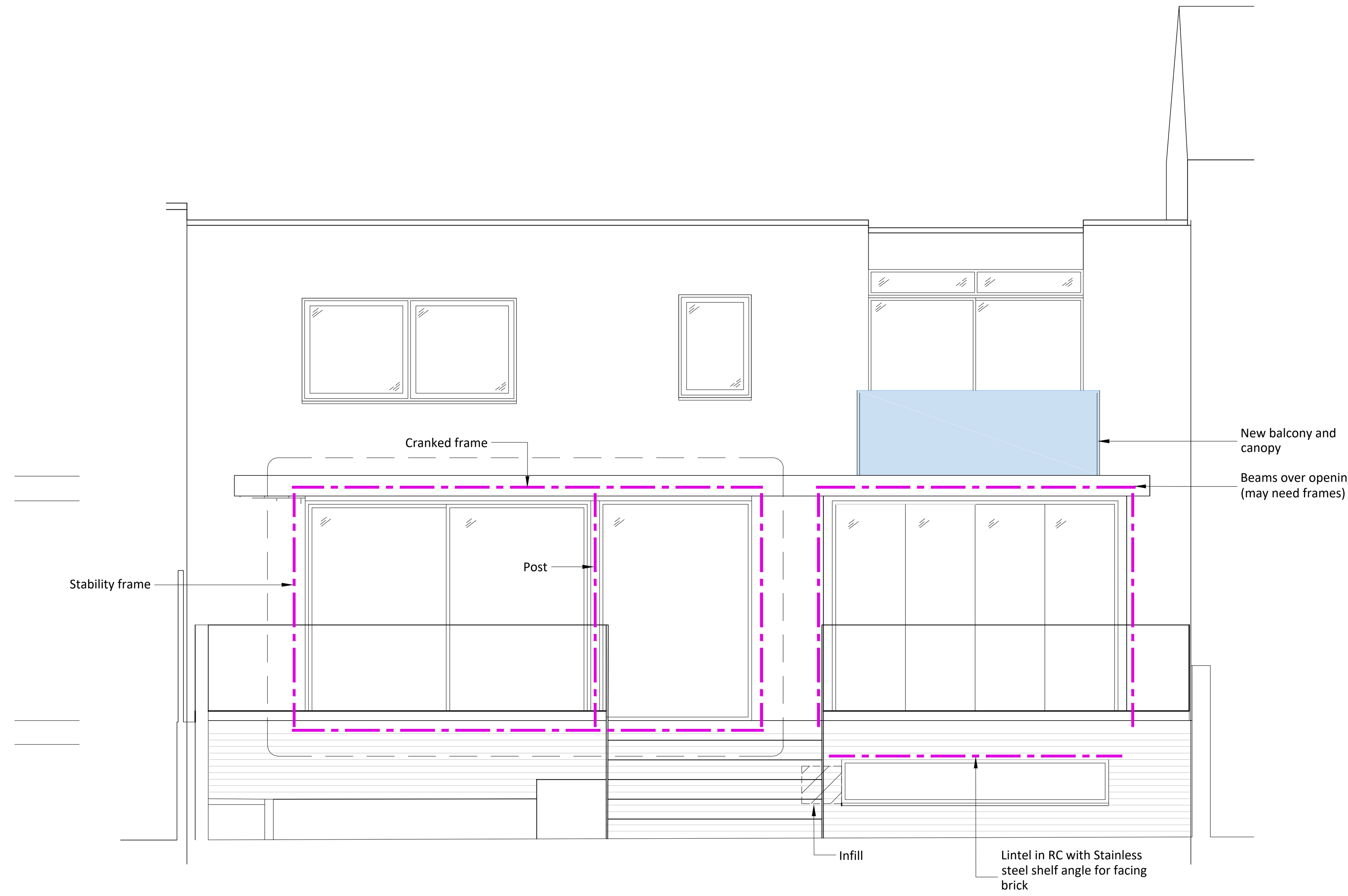
Scales (A1)	AS SHOWN	Drg. No.	Rev.
Drawn OT	31/07/19	2019-051- 01	A
Ch'd(Eng.) SB	31/07/19		
Approved BH	31/07/19		



PROPOSED SECTION A-A

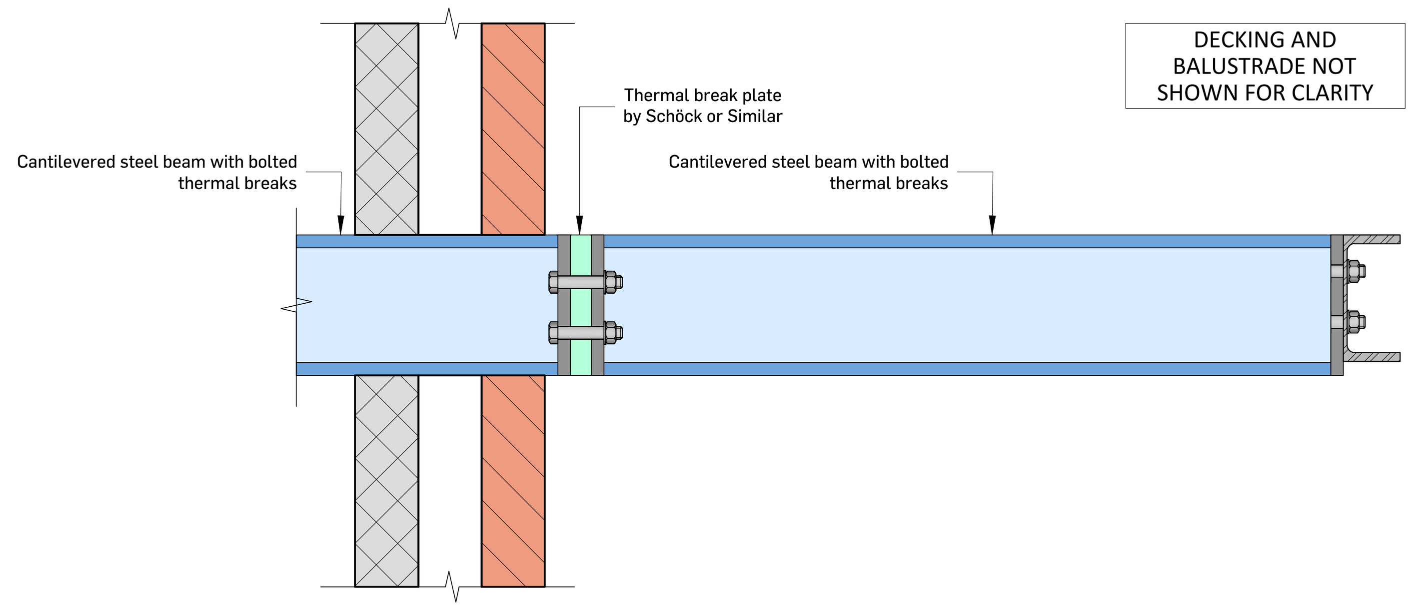
SCALE 1:50

0 0.5 1 1.5 2m



PROPOSED REAR ELEVATION

SCALE 1:50



BALCONY SUPPORT STEEL CONNECTION

SCALE 1:10

Notes:

1. This drawing is to be read in conjunction with all relevant architects, engineers & specialist sub-contractors drawings and the specification.
2. Any discrepancies between the site conditions and these drawings to be reported to Elite Designers. Dimensions must not be scaled and should be checked on site.
3. All dimensions are in millimetres, levels are in metres a.o.d. (above ordnance datum).

FOR PLANNING

Rev.	Date	Description	by	ch'd	app
A	31/07/19	ISSUED FOR INFORMATION	OT	SB	BH

Project

46 Belsize Lane
LONDON
NW3 5AU

Title

PROPOSED PLANS

C/A N. Panigirtzoglou & M. Sebastia

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3 Princeton Court
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elitedesigners.co.uk

Scales (A1)	AS SHOWN	
Drawn	OT	31/07/19
Ch'd(Eng.)	SB	31/07/19
Approved	BH	31/07/19

Drg. No. 2019-051- 01

Rev. A

APPENDIX C ENVIROCHECK REPORT

Issued separately

APPENDIX D SITE INVESTIGATION LOGS

Client: **Nikos Panigirtzoglou**	Hole Diameter (mm): 75 tapering with depth to 8.00m	**BOREHOLE NUMBER**
Method: Window Sampler		**WS01**
Date: 06/03/19 | Co-ordinates E N	Ground Level (m AOD) | Ref. No: 527194	Sheet 1 of 2

Backfill/Well (m)	Water Depth (m)	Samples Depth (m)	Samples Type	In Situ Tests Results	Reduced Level (m AOD)	Depth & (Thickness) (m)	Description of Strata
0.10		0.20	D			(0.50)	Soft, dark grey, fine to coarse sandy, slightly gravelly CLAY. Gravel is angular to rounded, fine to coarse, flint and brick. Low cobble content of angular brick. (Made Ground)
						0.50	
		0.80	D			(0.60)	Soft, dark brown, slightly fine to coarse sandy, gravelly CLAY. Gravel is angular and sub-angular, fine to coarse brick and mortar. Low cobble content of angular brick. (Made Ground)
1.00							
		1.10	D	Vh = 69 pp = 2.0		1.10	Firm becoming stiff with depth, brown mottled orange brown and grey CLAY with rare fine to coarse sand and fine and medium gravel size selenite. (Weathered London Clay Formation)
		1.50		Vh = 76 pp = 2.0			
		2.00	D	Vh = 86 pp = 3.2			
		2.50	D	Vh = 88 pp = 2.9			
		3.00	D	Vh = 97 pp = 3.2			
		3.50	D	Vh = 112 pp = 3.5		(4.70)	
4.00		4.00	D	Vh = 120 pp = 4.0			
		4.50	D	Vh = 140 pp = 3.9			

Continued on next sheet

General Remarks:
1. Borehole remained stable to 8m below ground level.
2. Water strike at 6.5m below ground level with no rise after 20 minutes.
3. Roots and rootlets encountered to 4.7m below ground level.

Driler:	DI
Logged:	JM
Chked:	
Appr'd:	

BOREHOLE RECORD

Scale 1:25

See Key Sheet for explanation of symbols, etc.

INFRASTRUCTURE
Giving our all

49 Belsize Lane

FIG A1

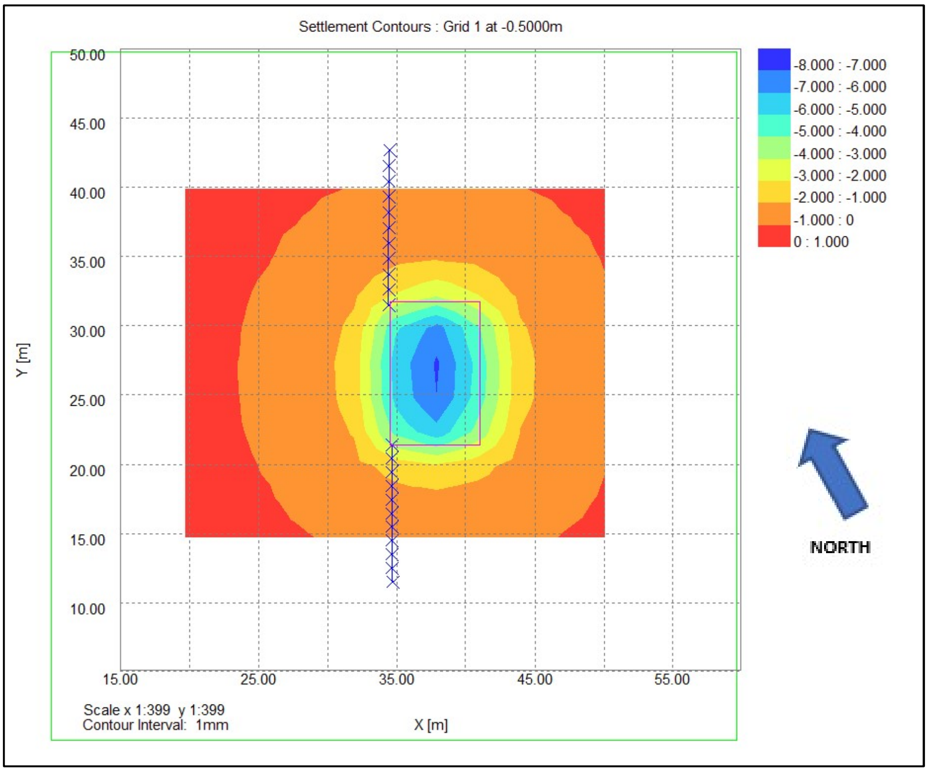
Client: **Nikos Panigirtzoglou**	Hole Diameter (mm): 75 tapering with depth to 8.00m	**BOREHOLE NUMBER**
Method: Window Sampler		**WS01** Sheet 2 of 2
Date: 06/03/19 — Co-ordinates E N	Ground Level (m AOD) — Ref. No: 527194	

Backfill/Well (m)	Legend	Water Depth (m)	Samples Depth (m)	Samples Type	In Situ Tests Results	Reduced Level (m AOD)	Depth & (Thickness) (m)	Description of Strata	Legend
			5.00	D	pp = 3.9			Firm becoming stiff with depth, brown mottled orange brown and grey CLAY with rare fine to coarse sand and fine and medium gravel size selenite.	
							5.80	Stiff, grey, very closely fissured CLAY with rare fine and medium sand size selenite. (London Clay Formation)	
			6.00	D					
		6.50							
							(2.20)		
			7.00	D					
			7.90 - 8.00	D					
8.00			8.00				8.00	*End of Borehole at 8.00 m*	

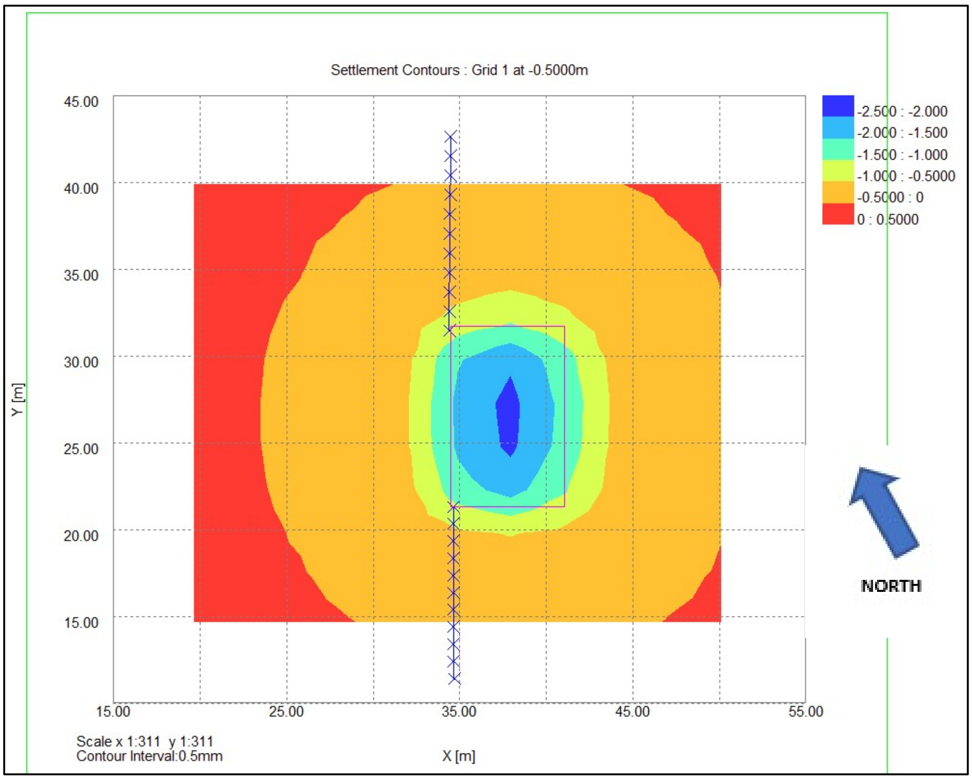
General Remarks:
1. Borehole remained stable to 8m below ground level.
2. Water strike at 6.5m below ground level with no rise after 20 minutes.
3. Roots and rootlets encountered to 4.7m below ground level.

Driler:	DI	BOREHOLE RECORD	CET INFRASTRUCTURE Giving our all
Logged:	JM	Scale 1:25 See Key Sheet for explanation of symbols, etc.	
Chked:		49 Belsize Lane	**FIG A1**
Appr'd:			

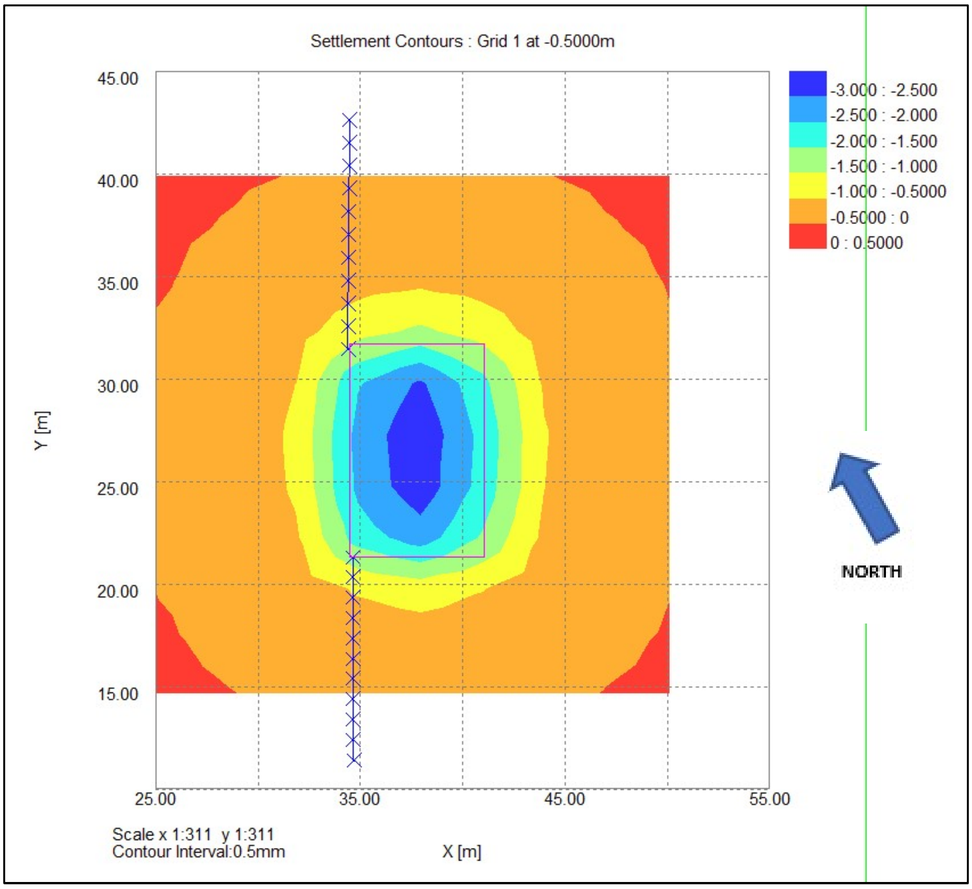
APPENDIX E PDISP EXPORTS



Retaining wall and basement excavation short term settlement contours at 0.5m depth



Basement excavation and raft construction short term settlement at 0.5m depth



Basement excavation and raft construction long term settlement at 0.5m depth