Symmetrys Limited
Consulting Structural Engineers

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Job Title 66 SOUTHHILL PARK	Job No.	Sheet No.	Revision
		9	
Section	Date	Made By	Checked By

TYPICAL PROPPING FORCES.

OVERTURNING MOMENT = 101 kNm

LE = 3350 - 500 = 2850 mm.

FPROPS = $101 \times 10^3 / 2.850$ = 35.4 kN.

SAY PROPS @ 2m CTS.

FPROP @ 2m CTS = 35.4×2 = 70.9 kN.

USE RMD SUPERSLIM SOLDIER WITH ADJUSTABLE ENDS - ALLOWABLE HORIZONTAL MEMBERS IN COMPRESSION WORKING LOAD = 100 kN.

19

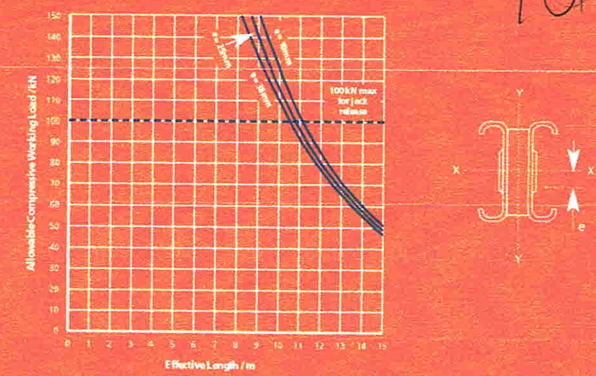
design and loading data

Section Properties

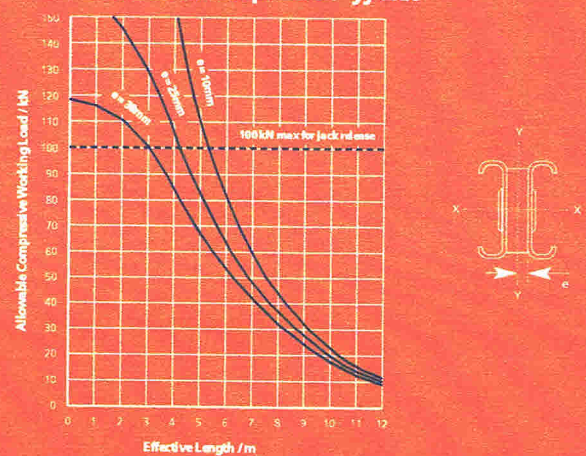
Soldier characteristics	
Area: Gross	26.06 cm^2
Area: Nett	19.64 cm^2
I xx	1916 cm^4
I yy	658 cm^4
r xx	9.69 cm
r yy	5.70 cm
Z xx	161 cm^3
Z yy	61 cm^3
EI xx	4020 kNm^2
EI yy	300 kNm^2
GAxx	17350 kN
M max x	40 kNm
M max y	6.24 kNm
Mean compressive yield stress	370 N/mm^2
Bending Moment on joint using 6 No. Bolts	18 kNm

Please contact your local technical office for full technical data when using the load graphs.

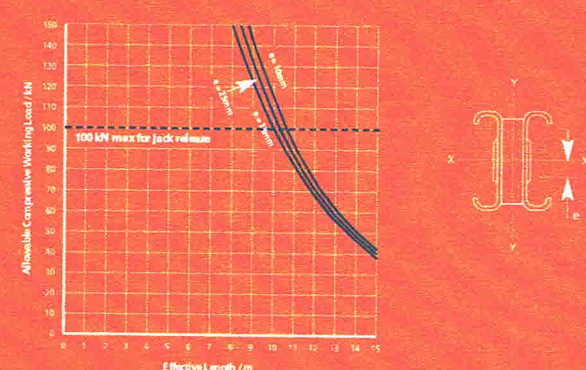
Vertical members in compression- xx axis



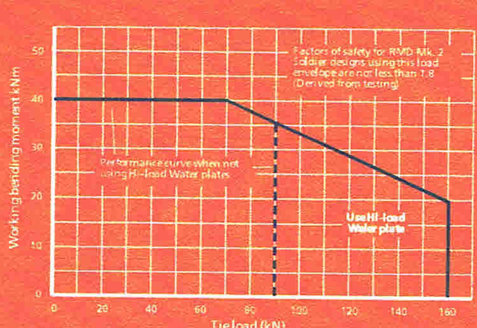
Vertical members in compression- yy axis



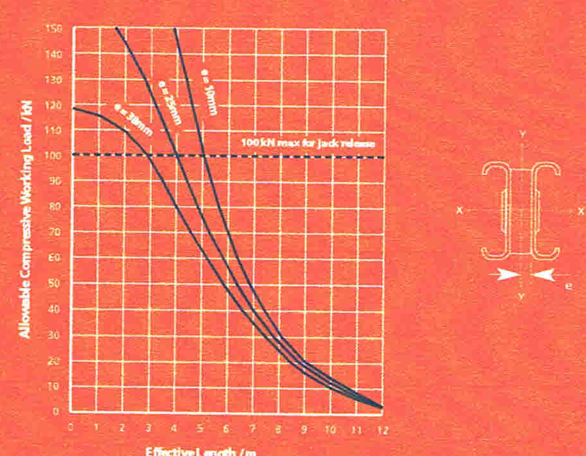
Horizontal members in compression - xx axis



Bending Moment Envelope



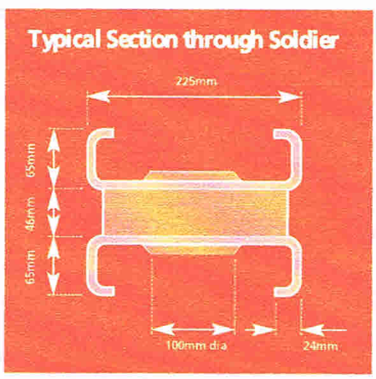
Horizontal members in compression - yy axis

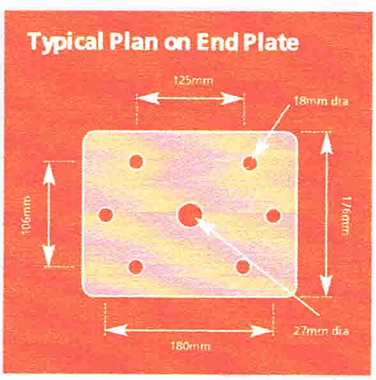


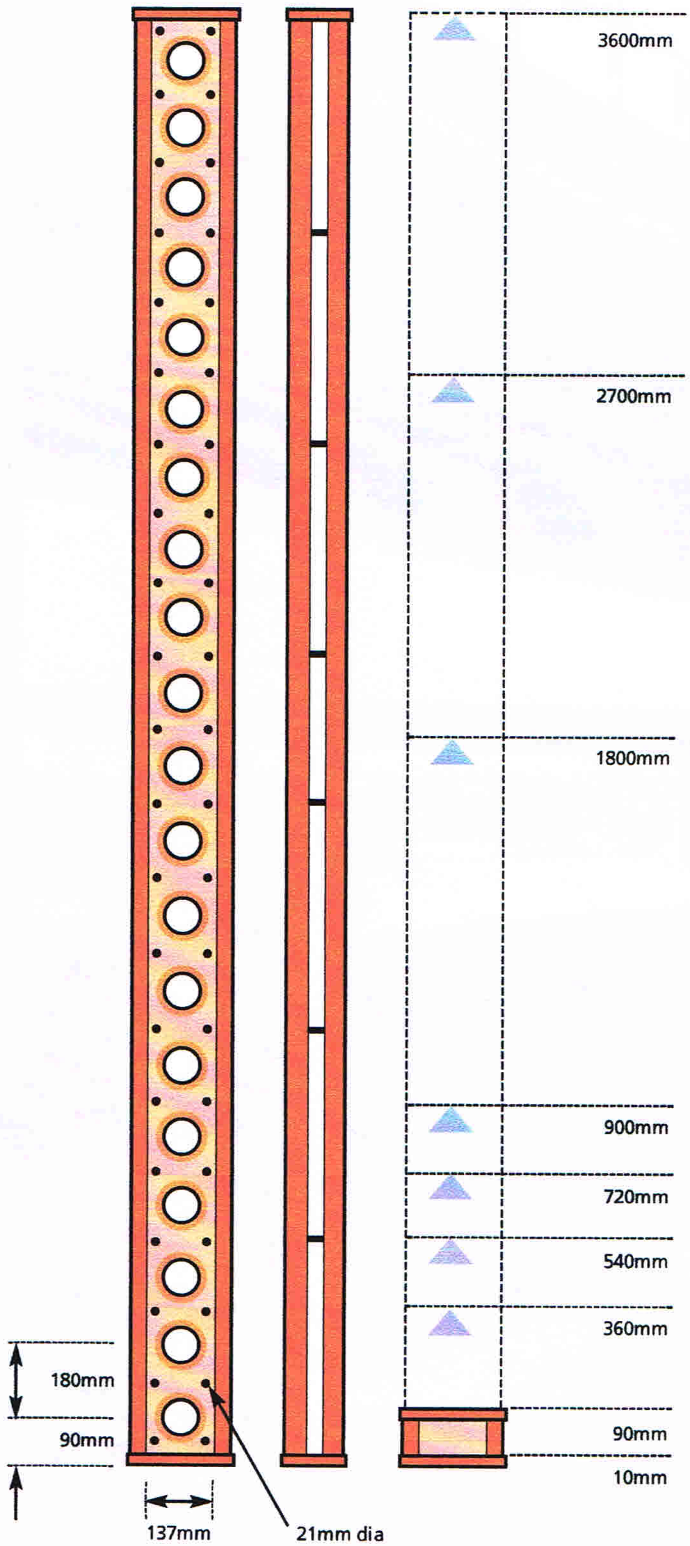
technical specification

Superslim Soldier Beams

Code	Description	Wt. (Kg)
SSX13600	Superslim Soldier 3600mm	72.18
SSX12700	Superslim Soldier 2700mm	55.38
SSX11800	Superslim Soldier 1800mm	38.80
SSX10900	Superslim Soldier 900mm	22.00
SSX10720	Superslim Soldier 720mm	18.74
SSX10540	Superslim Soldier 540mm	15.24
SSX10360	Superslim Soldier 360mm	11.98
SSX10090	Superslim Soldier 90mm	7.32
SSU 10035	Superslim Soldier - Open End 360mm	11.69
SSX10040	End Plate 10mm	2.91







66 SOUTH HILL PARK - BASEMENT IMPACT ASSESSMENT

APPENDIX C: GCG Hydrogeological and Ground Movement Report

SYMMETRYS LIMITED

66 SOUTH HILL PARK, LONDON NW3

HYDROGEOLOGICAL AND GROUND MOVEMENT REPORT

September 2013

Revision 0

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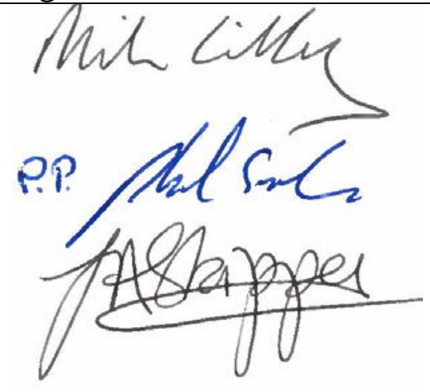
66 SOUTH HILL PARK, NW3

HYDROGEOLOGICAL AND GROUND MOVEMENT REPORT

Revision	Date	Prepared by	Signature
Revision 0	17/9/13	Mike Crilly MSc DIC Apollonia Gasparre MICE PhD DIC Dott. Ing. Jackie Skipper PhD DIC FGS CGeol	

SYMMETRYS LIMITED

66 SOUTH HILL PARK, NW3

HYDROGEOLOGICAL AND GROUND MOVEMENT REPORT

Revision 0

September 2013

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SYMMETRYS LIMITED

66 SOUTH HILL PARK, NW3

HYDROGEOLOGICAL AND GROUND MOVEMENT REPORT

Revision 0

September 2013

1 INTRODUCTION

The proposed redevelopment of 66 South Hill Park, London NW3 includes the refurbishment of the existing building, the extension of the lower ground floor under the front garden and the construction of a new single level basement structure underneath the footprint of the existing house. Geotechnical Consulting Group LLP (GCG) has received an instruction from Symmetrys Limited to undertake a review of the local hydrogeological conditions and the impact that the proposed basement may have on the flow of groundwater across the area.

This report reviews the available information about the site and the proposed scheme and aims to produce a hydrogeological impact assessment for the proposed basement construction on this site in accordance with the requirements of the London Borough of Camden. These requirements are set out within the Development Policy DP27, the Camden Planning Guidance CPG4 - Basements and Lightwells and the London Borough of Camden guidance document entitled 'Camden geological, hydrogeological and hydrological study – Guidance for subterranean development'.

GCG have been supplied with information by Symmetrys Limited.

This report has been prepared for Symmetrys Limited as part of the requirements set by the DP27/CPG4 and LB Camden's 'Guidance for Subterranean Development'. It addresses the issues of the surface flow and flooding screening, the subterranean (groundwater) flow screening and the slope stability screening flowcharts that are shown in full detail in Appendices A, B and C.

2 THE PROPERTY AND THE PROPOSED RE-DEVELOPMENT

The property is located to the south of Hampstead Heath, north of Hampstead Heath Railway Station as shown in Figure 1. The property has a rectangular shape of about 12m x 6m in plan, orientated in an approximate east to west direction (Figure 2). It is bounded by South Hill Park to the east and Hampstead Heath to the west. The Hampstead Ponds are immediately to the west of the site.

The property includes an end of terrace house with front and rear gardens. The house has five storeys including a lower ground floor and a mansard roof and it is set about 5m from the road. The lower ground floor is around 3m below the existing ground floor level. At the rear of the house it is fully exposed as the ground level falls westwards from the front to the rear of the site. Figures 3 and 4 show plans and sections of the existing property.

Mature trees are located at the front of the property and along the edges of the rear garden.

An examination of historical maps shows that property was already in place in 1895. The Hampstead Ponds appear on all historical maps available since 1871, with little change in size or shape. In the early maps they are marked as ‘New River Company’s Water Works Reservoirs’. They are man-made and follow streams that fed the western branch of the lost Fleet River originally running across the area. Figure 5 shows the approximate location of former water courses in the area, taken from Barton (1962).

It is proposed to refurbish the property extending the existing lower ground floor to the front part of the property and, partly, to the northern side and to construct a new basement under the footprint of the existing house. The finished level of the proposed new basement is approximately 3.2m below the existing lower ground floor level, but it deepens to about 4.5m along the southern edge of the site, where a swimming pool will be located. Figures 6 and 7 show plans of the proposed basement and lower ground floors and sections through the house.

It is understood that the basement will be formed by underpinning the walls of the existing house.

3 TOPOGRAPHY AND GEOLOGY

The property lies on the west flank of Parliament Hill near the bottom of the shallow valley within which the Hampstead Ponds have formed. The ground rises in the north-west direction towards Hampstead Heath, whose top is around 25m above the site. A topographical survey of the property shows that the ground level at the front of the property is about 79.4mOD and the ground falls some 4m from front to back.

The geology of the area is shown on the British Geological Survey (BGS) 1:10560 map sheet I, SE and on the 1:10560 map sheet TQ28NE (Figure 8).

The site is underlain by London Clay. The Claygate Member outcrops at about 500m to the north of the site and at about 300m to the west. The Heath is capped by the Bagshot Formation, predominantly composed of horizontally bedded sands. These outcrop at about 600m from the site.

The geological section, shown in Figure 8c, shows that the London Clay lies above the Lambeth Group and Thanet Sand which are underlain by Chalk. In a record borehole about 200 meters to the south west of the site (TQ28NE5 in Figure 9) the London Clay was found to be about 88m thick; the underlying Lambeth Group and Thanet Sand have a combined thickness of about 27m.

The site-specific ground investigation (Chelmer Consultancy Services, 2013) generally confirms the stratigraphy indicated by the geological maps. Under a variable thickness of Made Ground the London Clay was encountered at 3.1m below ground level (bGL) in BH1 at the front of the property. The thickness of Made Ground in this borehole is likely to be associated with excavations for the adjacent lower ground floor. At the rear of the property, where ground level is around 3m deeper, material categorized as Head or Alluvium was encountered under 0.25m of Made Ground and overlies the London Clay at 3.6m bGL. The

London Clay extended to the base of both boreholes at 15m and 10m depth.

The Head/Alluvium is described as a firm to stiff clay, which becomes firm and then soft with depth, before becoming firm again deeper than 3m bGL. Limited index testing indicates that this material is an inorganic clay of high plasticity.

The London Clay is described as a firm to stiff or stiff clay, becoming generally stiffer with depth. Index tests on the London Clay indicate that it is an inorganic clay of high or very high plasticity. Limited hand vane shear measurements over the upper 3m of the London Clay indicate an undrained shear strength of 80-120kPa.

It appears likely that the existing house is founded on the London Clay at the front, though it is possible that it is founded on the Head/Alluvium to the rear. The proposed new basement is likely to extend further into the London Clay.

4 HYDROGEOLOGICAL CONDITIONS AND HAZARDS

Figure 10 shows that the site is located on an unproductive stratum. The bulk permeability of the London Clay is very low (lower than 10^{-8}m/s) and as such the clay acts as a barrier between the superficial groundwater and the lower aquifer.

Horizontal flow within the clay is very limited and water infiltrating the clay tends to percolate vertically downward at very low rates towards the lower aquifer (Chalk).

The water head in the lower aquifer has been rising since the demand for water abstraction began to diminish after the 1960s; the water level in the chalk was about -35mOD in 1965 and approximately -20mOD in 2006 (see Figures 11 and 12). The current policy, implemented by the Environment Agency, is to maintain water levels in the chalk at about their present levels. Thus, the property is unlikely to be influenced directly by groundwater levels in the chalk, even in the long-term. In addition, there are no known underground structures in the vicinity of the site that might indirectly induce local changes of water pressures in the London Clay, which could affect the development.

Perched water could exist above the clay layer. Figure 13 shows the site being in the Hampstead Chain Catchment area. The preferential routes for the superficial water in the area of the site can be identified from Figures 5 and 8a. Rainfall on the Heath percolates down through the permeable Bagshot Formation. Further downward flow is slowed by the successively less permeable clayey and silty strata below. This is reflected by the Heath’s landscape of swampy hollows, springs and man-made ponds. The superficial water in the immediate area of the site runs above the clay layer and accumulates in the Hampstead Ponds just behind the site. The water level at the lower pond is some 3 to 4m below the upper pond. The water flows out of the pond at the southern end into the western branch of the Fleet River which joins the eastern branch at Camden and thereon towards the Thames. There is no evidence, either currently, or from historical records, of any streams or springs in the immediate vicinity of the site.

The Environment Agency flood plan shows that the property is not in an area at risk of flooding (Figure 14). However, South Hill Park has been identified as a ‘secondary area’ at risk of flood by the London Borough of Camden because it has been flooded in 2002 (Figure 15). Given the ground conditions and the discussion above, the flooding is likely to have resulted from a lack of land drainage for the superficial water rather than from groundwater. Nevertheless, measures to minimize flood risks are discussed in the next section.

The foundation level of the existing property is at approximately 3m below street level. On the basis of the survey levels and taking into account the expected stratigraphy and the results of the site-specific ground investigation, the existing lower ground floor is likely to be embedded partly in the London Clay and partly in the clayey Head/Alluvium. The existing house therefore already at least partly obstructs any superficial water flow above the clay level.

Monitored groundwater levels indicate a groundwater level below the top of the London Clay (at about 4m bGL) at the front of the property and in the Head/Alluvium at around 2m bGL at the rear, indicating that there is an approximately 1m difference in the water level across the depth of the building. This may indicate a general flow of groundwater from east to west, though the permeability of the clay is such that flow rates would be very small.

The new basement will form a watertight box within the London Clay. Given the low permeability of the clay and considering that the current lower ground floor is already partly cut into the London Clay with the remainder being cut into another low permeability clay, the construction of a basement downwards will have no significant effects on the local groundwater flow and hydrogeology. The existing lower ground floor is to be extended by approximately 3m towards the front of the property (Figure 6). Although unlikely, this could potentially extend the existing barrier to the most superficial water flow across the site. This effect would be very limited due to the size of the proposed extension.

The presence of the large body of water to the west of the site also makes it very unlikely that the trees which will be retained will suffer as a result of the construction of the basement.

5 LAND DRAINAGE REQUIREMENTS

As discussed above the existing house already extends into the London Clay and probably already obstructs, to some extent, any potential water running across the site near the surface, above the clay. An extension of the existing house into the clay is unlikely to have any significant impact on the local groundwater. The part of the proposed basement extending at the front of the existing house could create an additional barrier to the potential groundwater flow. However, this effect would be limited because the size of the basement extension is small and the superficial water flow across the site is not expected to be abundant.

It is unlikely that significant groundwater is encountered during the excavation of the main basement area because the permeability of the clay is low and horizontal water flow is restricted. Minor seepage could be encountered within the siltier and sandier lenses of the clays, but this is not likely to significant and would be very limited. However some perched water could be encountered during construction of the extension of the lower ground floor to the front part of the property. Although the water ingress is not expected to be large, provision for dewatering during construction should be made.

In the permanent condition there will need to be a suitable internal construction to bring the structure to an acceptable standard with regard to moisture ingress.

The retaining walls and the basement slabs should be designed for water pressure and uplift.

A land drainage system should be provided (or implemented) that includes collector drains to intercept rain water from paved and garden areas and discharge into the storm water system.

5.1 Soil Make-Up in garden areas

Where new garden areas are to be created above the basement, the soil make-up should include a thickness of topsoil and light loam of at least 0.5m thickness. This should be underlain by a minimum thickness of 200mm of type B drainage material (63mm – 10mm size), separated from the overlying loam by a non-woven geotextile (Terram 500 or similar). Alternatively, a composite material or reservoir board may be used to facilitate lateral drainage to the collector drains forming part of the land drainage system.

6 LAND STABILITY

The Hampstead area and the surroundings are considered to be vulnerable to slope instability due to the ground conditions and the sloping gradient of the ground. Potential land instability has generally been associated with slopes of 8° or greater both in the London Clay and in the Claygate Member (Deness et al., 1976; Ellison et al. 2004) although the mechanisms that could drive the potential instability are different in the two types of soils.

Figure 16 shows that the site is located in an area with a slope higher than 10^{o} and therefore potentially prone to becoming unstable if the land topography is adversely disturbed.

However, the site is outside the areas identified by the BGS as being at significant landslide potential and prone to slope stability issues (Figure 17). The BGS mapping is based on factors such as geology and groundwater conditions, in addition to the slope angle.

The proposed basement extension into the London Clay is not likely to adversely change the topographical profile of the area and the existing groundwater conditions. As such it is not expected to trigger land instability.

Good workmanship should be used and full support should be provided to the underpinning pits during construction in order to avoid ground settlements that could have adverse effects on adjacent structures.

7 GROUND MOVEMENT ASSESSMENT

It is proposed to construct the basement by underpinning of the existing building walls. The underpins are to be reinforced and, in the temporary condition will act as L-shaped retaining walls to support the soil on the outside face of the wall. Temporary propping will be provided to the party or perimeter walls and to the underpins during excavation. When the excavation is complete, the ground slab will be formed between the underpins, providing a low-level permanent prop, while the new lower ground floor slab will act a as a prop towards the top of the underpins.

66 South Hill Park shares a party wall with 64 South Hill Park and is adjacent to 68 South Hill Park with the buildings being around 1.5m apart at the closest point.

During the course of the works to form the basement, there are a number of sources of movement of the party and external walls and adjacent structures:

- Movements due to underpinning
- Movements due to excavation
- Long term heave of the ground

These effects are considered below.

Movements due to underpinning

The new basement will be founded in the London Clay. The front of the existing property appears to be founded in the London Clay, but founding conditions at the rear of the property are less clear. The ground investigation encountered Head/Alluvium down to 3.6m bGL in the borehole at the rear; this material was generally described as firm or stiff, though between 2m and 3m bGL it was described as soft/firm. Therefore it is likely that the rear of existing building is founded in either London Clay or firm/stiff Head/Alluvium, though this should be established by further investigation.

The underpins will extend into the London Clay, and will be formed through clayey material, (either London Clay or Head/Alluvium). Consequently, the underpinning is likely to be formed in the dry.

Underpins having a maximum depth of about 5m from existing lower ground floor level will be created underneath the existing perimeter walls, in a traditional ‘hit-and-miss’ sequence. The amount of movement associated with the underpinning work is dependent on the quality of workmanship. Experience shows that where the underpinning is carried out in the dry, loads on the underpins are small and the workmanship is of a high quality, the ground movements are limited to settlements of the underpinned walls of about 5mm, unless particularly deep. In this case, because of potentially poorer ground conditions at the rear of the property, it should be assumed that the movement of the underpinned wall could approach 10mm, though this estimate may be reduced following further investigation of the founding conditions.

Movements due to excavation

During excavation the reduction of lateral support to the underpins would induce the ground behind the walls to settle and move towards the excavation as the walls move towards the excavation.

Figure 18 shows empirical data based on the movements of ground behind embedded retaining walls as a result of excavations in typical London ground conditions. The movements depend on the propping sequence and on the depth of the excavation and although there is a considerable scatter, the data lies within an envelope, which can be used to predict the likely upper limit of movement at any particular distance from the excavation. Horizontal movements due to excavation will generally reduce linearly with distance from the excavation. Peak (maximum) settlements generally occur about half the excavation depth from the wall, with movement at the wall being 0.05% of the excavation depth or even less.

It should be noted that while C580 is applicable to embedded retaining walls, not underpinning, there is a lack of reliable data on ground movements from underpinning, hence C580 has been used. The reason that the process of excavation to construct the underpins is considered to result in similar reduction in lateral support to the ground, hence resulting in similar magnitude of movement, is due to the ‘hit-and-miss’ construction approach; by this approach only a short face is open and unsupported at any time. Hence the 3-D stiffening effects are quite significant and, provided that the underpins are designed to adequately restrict ground movements and props are installed in a timely fashion, conditions during underpinning are comparable to a ‘stiff propped’ excavation.

Assuming that the excavation for the new basement will be carried out propping the underpins from a high level, the data in Figure 19 suggest that the maximum settlements resulting from 4.5m deep excavation carried out with stiff support of the walls/underpins would be about 4mm and that the maximum lateral movements would be in the order of about 6mm.Comparable figures for a 3.2m deep excavation are 3mm vertical movement and 4mm horizontal movement. These movements are shown to tend to reduce to zero at a distance of about three to four times the excavation depth behind the walls.

The movements estimated from Figure 18 are plane strain movements and do not account for the stiffening 3D effect of the corners; this will tend to reduce the calculated movements. In addition, where high level props are supplied early in the excavation process, the lateral movements that can occur close to the wall are much reduced from those calculated.

As the ground is excavated, there will also be a tendency for heave of the ground as a result of stress relief. This will tend to cause some uplift of the underpinned walls. In order to assess this, an analysis has been carried out using the program PDISP. Short term movements have been estimated by assuming that London Clay underlies the underpinned foundations and that the undrained stiffness, E_u, of the clay is given by $400c_u$, where c_u, is the undrained shear strength which has been taken to be 60+7z kPa where z is the depth below formation level. A rigid boundary was taken at 30m below formation level.

Figure 19 shows the short term movements from the PDISP analysis, which indicates around 4mm heave of the party wall and other external walls.

Long term movements

In order to assess longer term movements, a further PDISP analysis has been carried out using a drained stiffness, E’, for the London Clay, assuming that $E' = 0.75E_u$, and including for the change in foundation loading resulting from the development. The resulting movement contours are shown in Figure 20. The long term movements are the differences in movements between those shown in Figure 20 and those in Figure 19. These indicate less than 1mm change in movement for the external walls.

Impact of movements on adjacent properties

Assuming that they are on relatively shallow foundations, the movements described above can be used to assess the impact of the development on adjacent buildings. It has been assumed that the buildings are in good condition currently.

In this case, the effects of the underpinning process should have no significant impact on no 68. For no 64, damage should be limited to minor cracking localised at the junctions of the underpinned walls and cross walls; for 5mm movement, damage should not be greater than the ‘very slight’ category of the BRE damage classification shown in Figure 21, though if the movements approach 10mm damage could approach the ‘slight’ category.

During the excavation process, there is likely to be some limited settlement of no 68, of the order of 4mm at the closest point, accompanied by around 3mm of lateral movement. Such movements are unlikely to cause damage greater than the ‘very slight’ category of the damage classification in Figure 21.

Similarly, during excavation there will be a tendency for no 64 to move downwards by up to 4mm and for there to be a movement towards the excavation, though provided high level stiff propping is provided, the lateral movement will be limited adjacent to the excavation and will generally tend to put the building into compression. At the same time, there may be a tendency for the party wall to heave as a result of short term excavation unloading, partly reversing movements resulting from the underpinning process. Such movements are unlikely to cause damage greater than the ‘very slight’ category of the damage classification in Figure 21.

Long term movements are unlikely to have any significant impact on adjacent properties.

8 CONCLUSIONS

A review of the hydrogeological conditions at 66 South Hill Park has been carried out on the basis of site specific ground investigation and record information on stratigraphy and ground conditions.

The site is underlain by London Clay, which is expected to extend to about 80m depth.

It is proposed to refurbish the existing house, extend the existing lower ground floor to the front of the property and construct a new basement underneath the footprint of the existing house. A garden will be created above the roof of the lower ground floor. The new basement will extend to about 3.5m below the existing lower ground floor and will be created by underpinning the perimeter walls.

The existing property is founded on the London Clay and possibly clayey Head/Alluvium and probably obstructs, to some extent, the most superficial water flow across the site above the clay layer. The new basement will extend further into the clay layer. Given the low permeability of the clays the horizontal flow within this layer is very limited. The proposed extension of the basement into the London Clay is therefore unlikely to have any significant effect on the local hydrogeology or on adjacent properties.

Minor water ingress might be observed during the extension of the existing lower ground floor to the front part of the property and simple means of dewatering could be required during the construction of the underpinnings.

Water pressure and uplift should be accounted for when designing the basement walls and slabs.

A land drainage system should be provided or implemented to deal with water run-off from hard surfaces and garden areas.

Assessments have been made of horizontal and vertical movements associated with the formation of the basement. These have been based on envelopes of published data on movements during wall construction and excavation, together with an assessment of long term movements. These have been used to assess potential damage to adjacent buildings. On the assumption that the buildings are currently in good condition, it is concluded that 64 and 68 South Hill Park should not experience damage greater than Category 1 (very slight).

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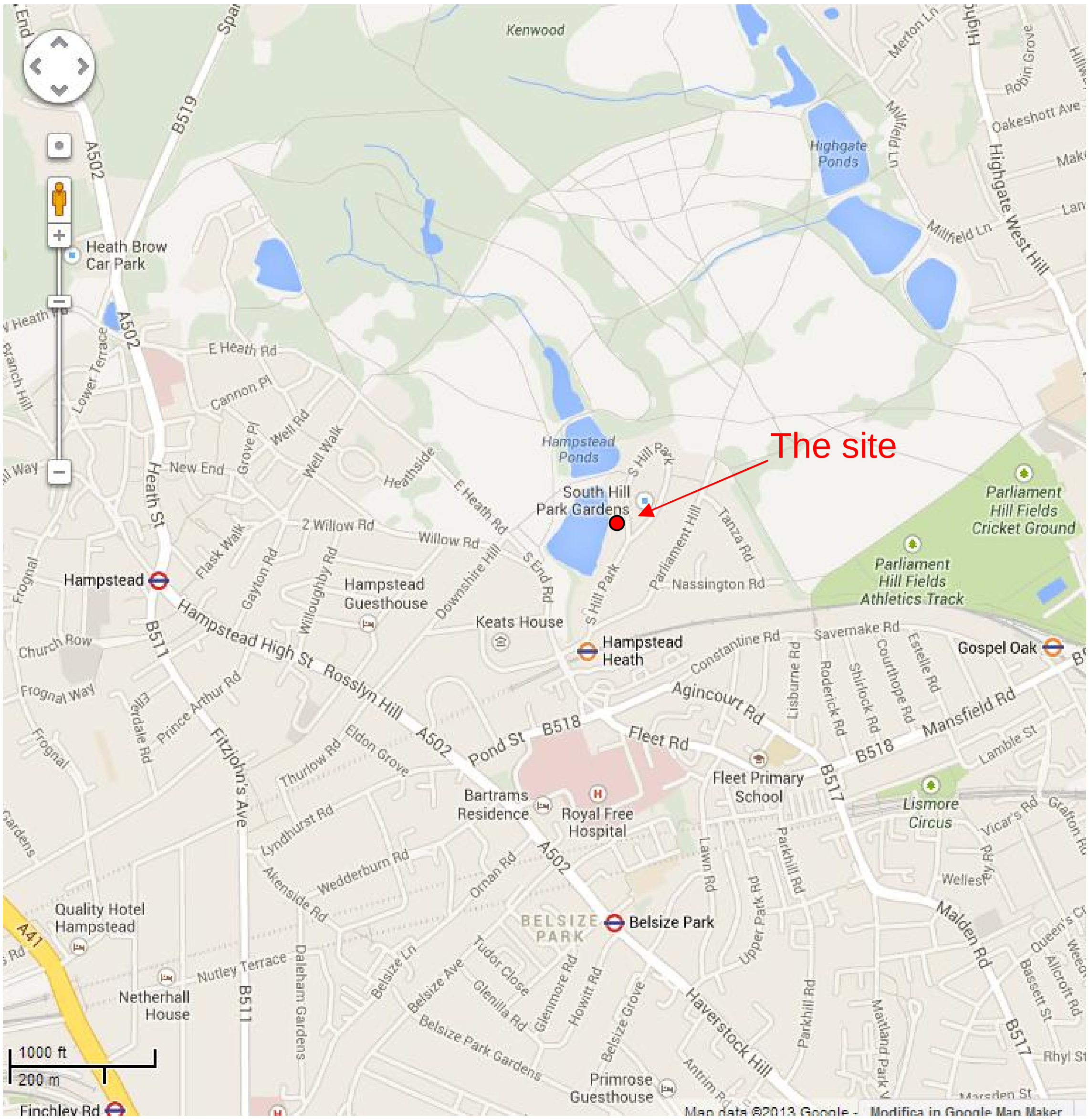
FIGURES

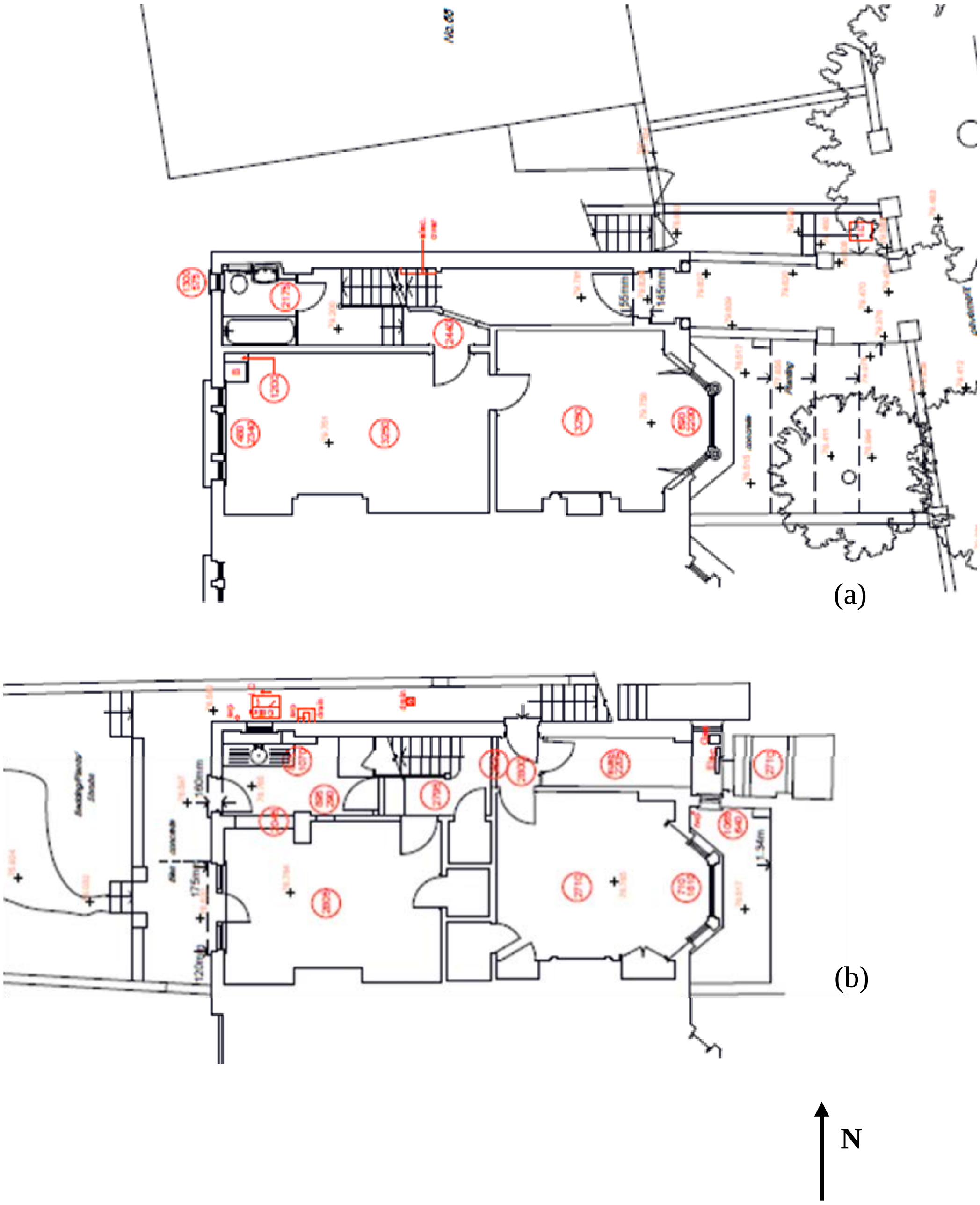


Geotechnical Consulting Group	**Site location**	Figure 1
66 South Hill Park		

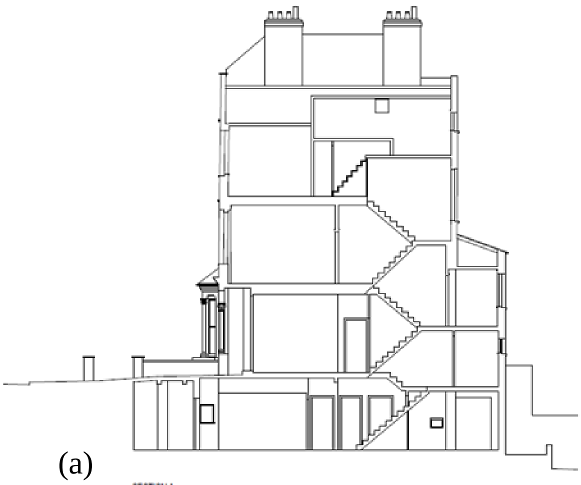
(a)

(b)

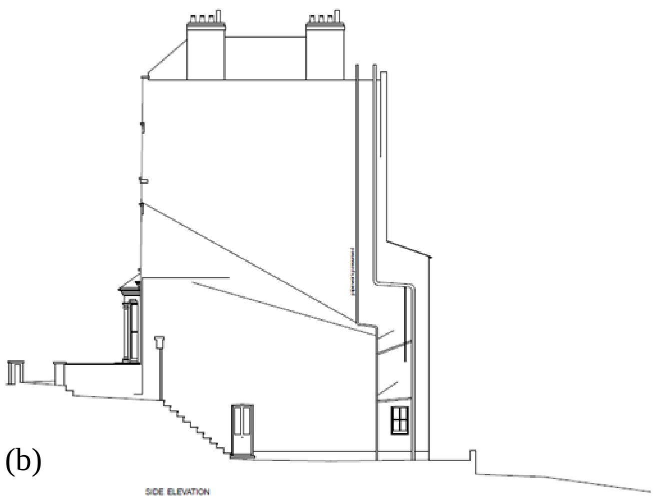
Geotechnical Consulting Group	**Existing property (a) Aerial view and (b) location plan**	Figure 2
66 South Hill Park		



Geotechnical Consulting Group	**Existing (a) Ground Floor and (b) Lower Ground Floor**	Figure 3
66 South Hill Park		

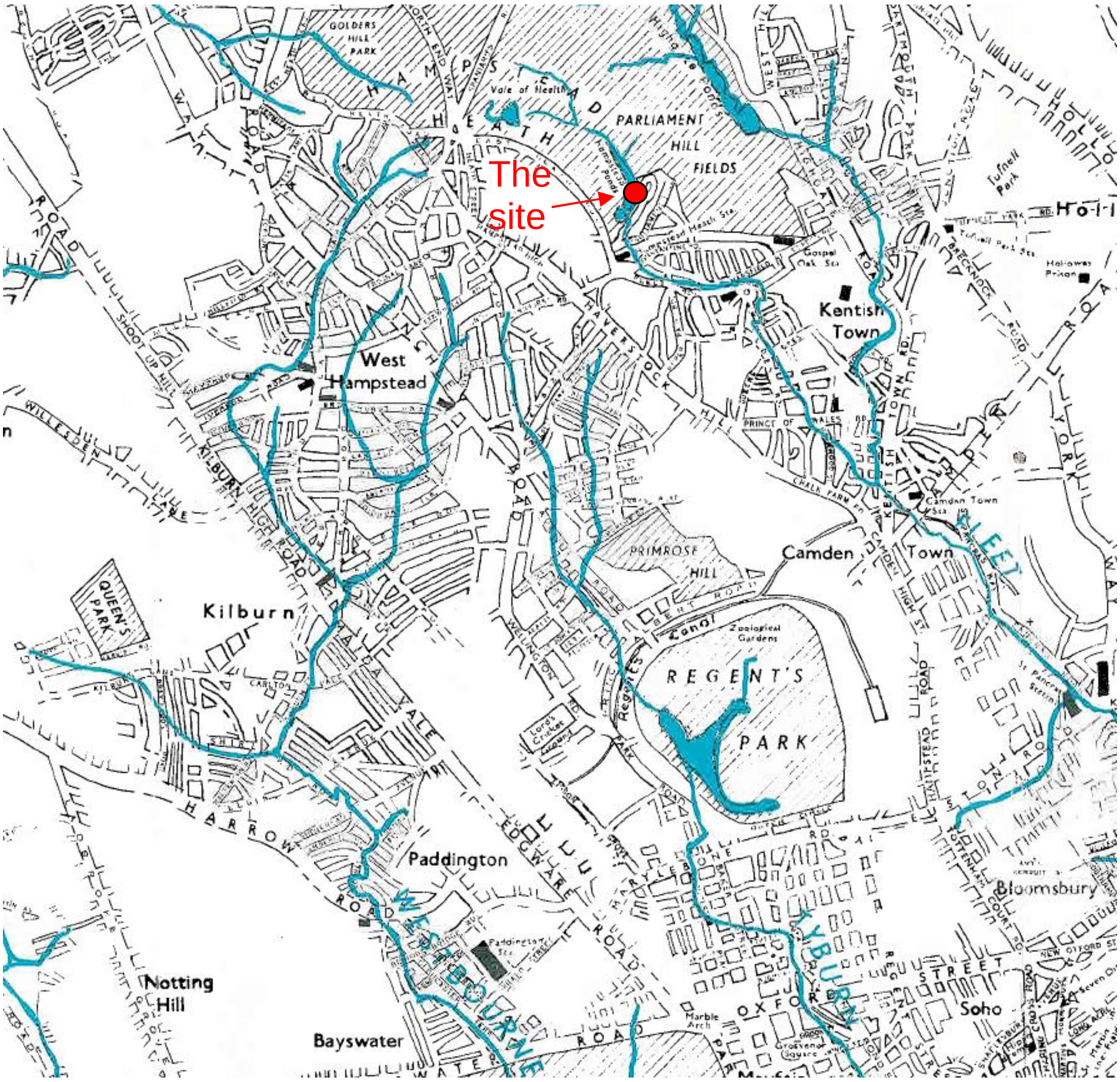


(a)

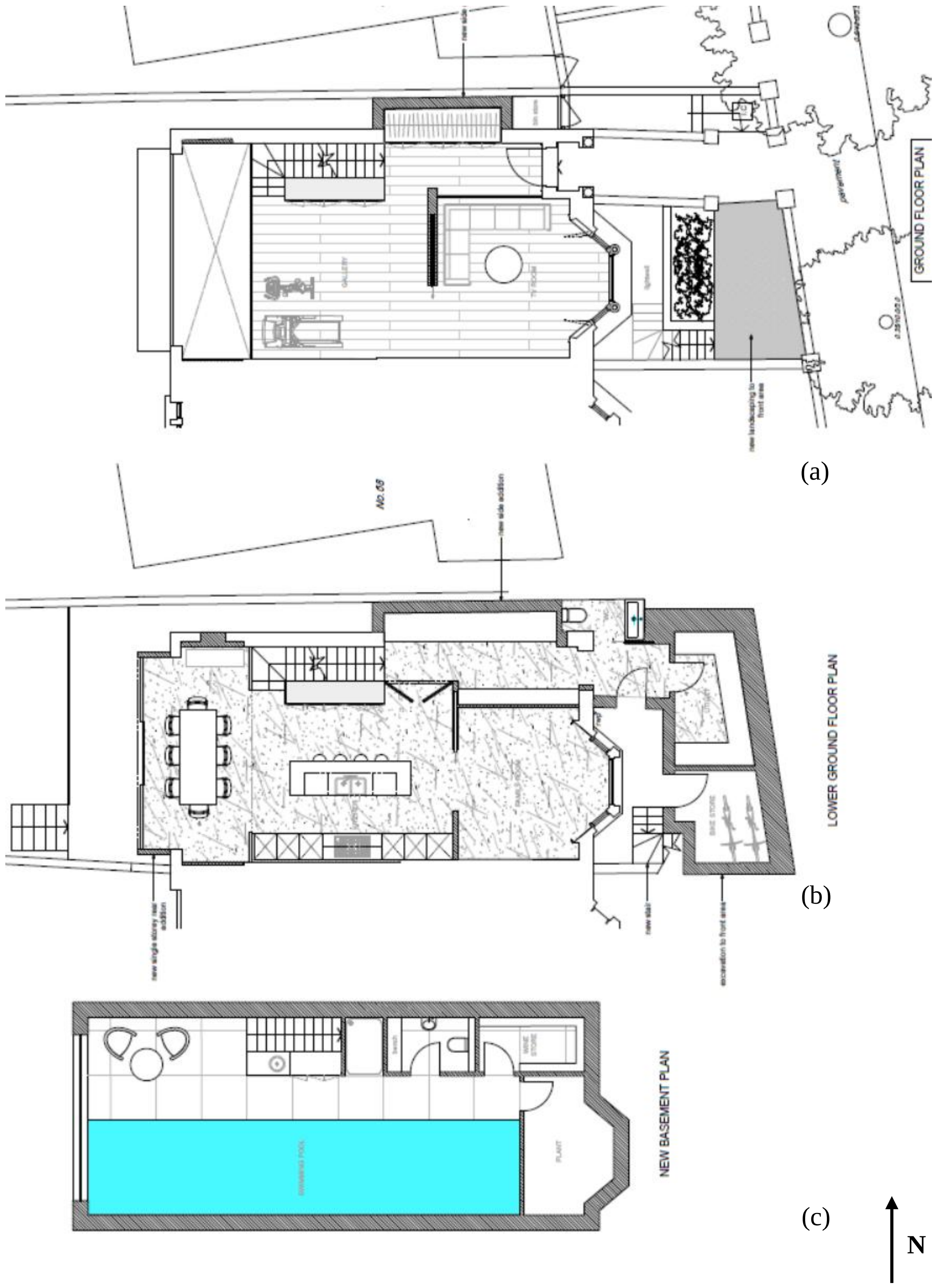


(b)

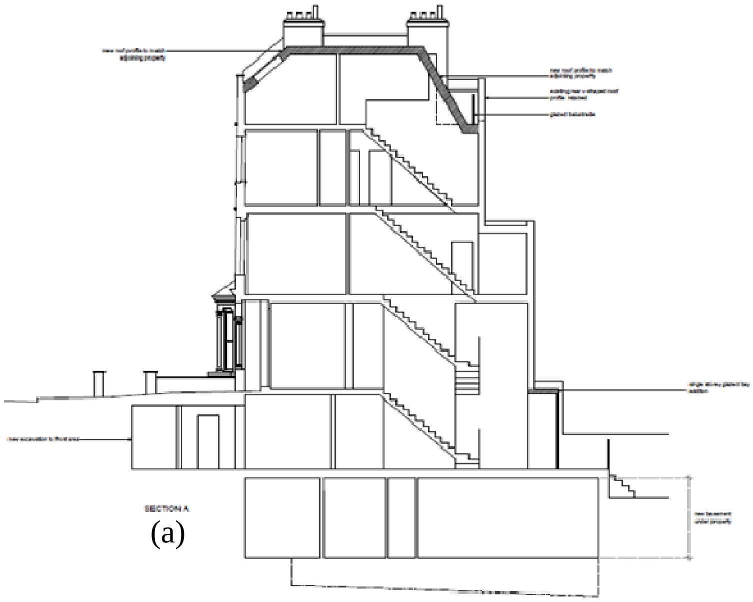
Geotechnical Consulting Group	**Existing (a) Cross Section and (b) Side Elevation**	Figure 4
66 South Hill Park		



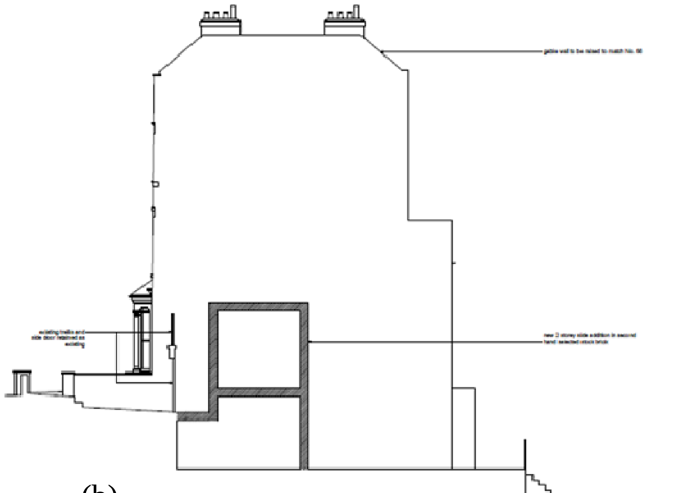
Geotechnical Consulting Group	**Extract from The Lost Rivers of London Map (Burton N., 1962)**	Figure 5
66 South Hill Park		



Geotechnical Consulting Group	**Proposed (a) Ground Floor, (b) Lower Ground Floor and (c) Basement**	Figure 6
66 South Hill Park		

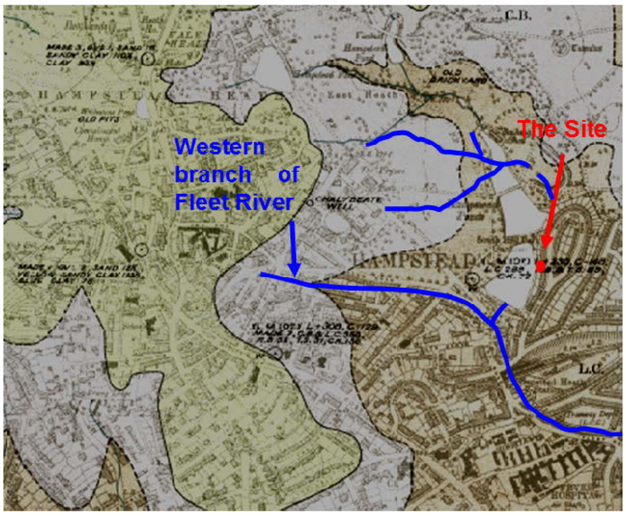


(a)

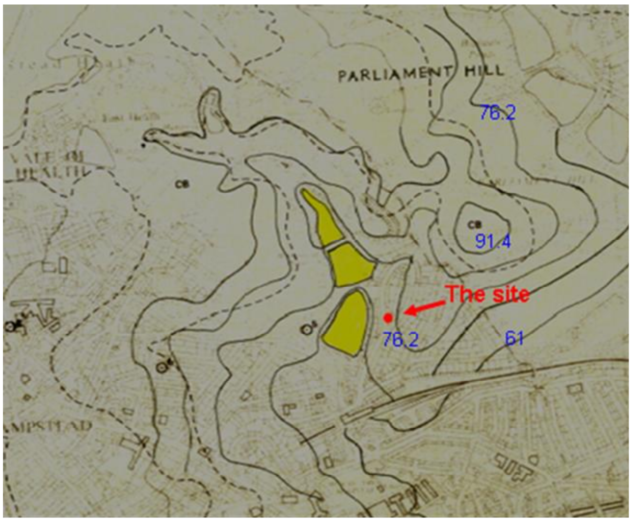


(b)

Geotechnical Consulting Group	**Proposed (a) Cross Section and (b) Side Elevation**	Figure 7
66 South Hill Park		



(a)



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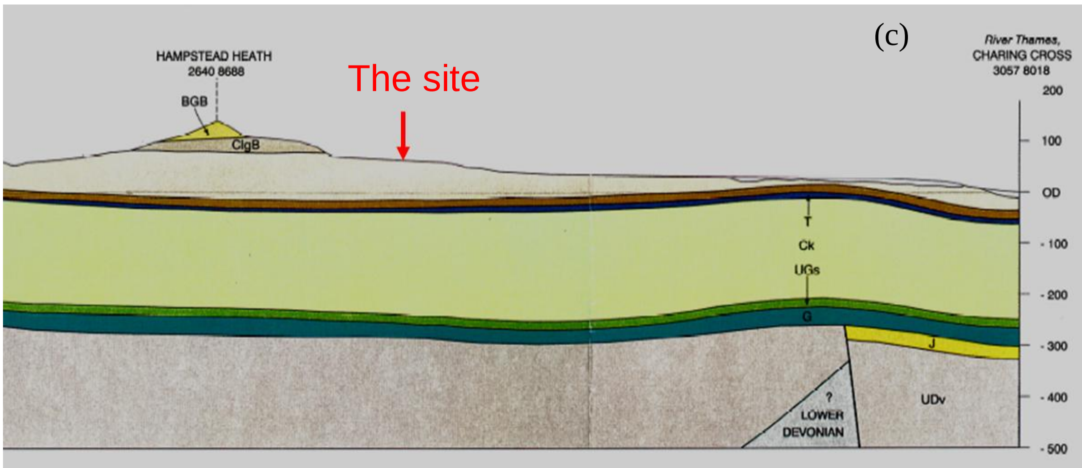

(c)

Geotechnical Consulting Group	Geology of the area extract from the British Geological Survey maps 1:10560 (a) No. 1SEand (b) sheet TQ28NE. (c) Section through Hampstead Heath.	Figure 8
66 South Hill Park		

Geotechnical Consulting Group	**Location of borehole TQ28NE5**	Figure 9
66 South Hill Park		