Report

Basement Impact Assessment

55 Ornan Road,
London, NW3 4QD

for

Lynette & Paul Gardner-Bougaard

Ref: 15406/R1

March 2015

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Basement Impact Assessment

Site: **55 Ornan Road, London, NW3 4QD**

Client: **Lynette & Paul Gardner-Bougaard**

Report Status: **FINAL**		
Role	**By**	**Signature**
Lead author:	Keith Gabriel MSc DIC CGeol FGS UK Registered Ground Engineering Adviser	[signature]
Slope/ground stability aspects approved by:	Mike Summersgill MSc CEng MICE C.WEM FCIWEM	[signature]
Subterranean (Groundwater) flow aspects approved by:	Keith Gabriel MSc DIC CGeol FGS	[signature]
Surface flow and flooding aspects approved by:	Mike Summersgill MSc CEng MICE C.WEM FCIWEM	[signature]

Foreword

This report has been prepared in accordance with the scope and terms agreed with the Client, and the resources available, using all reasonable professional skill and care. The report is for the exclusive use of the Client and shall not be relied upon by any third party without explicit written agreement from Gabriel GeoConsulting Ltd.

This report is specific to the proposed site use or development, as appropriate, and as described in the report; Gabriel GeoConsulting Ltd accept no liability for any use of the report or its contents for any purpose other than the development or proposed site use described herein.

This assessment has involved consideration, using normal professional skill and care, of the findings of ground investigation data obtained from the Client and other sources. Ground investigations involve sampling a very small proportion of the ground of interest as a result of which it is inevitable that variations in ground conditions, including groundwater, will remain unrecorded around and between the exploratory hole locations; groundwater levels/pressures will also vary seasonally and with other man-induced influences; no liability can be accepted for any adverse consequences of such variations.

This report must be read in its entirety in order to obtain a full understanding of our recommendations and conclusions.

Contents

1. INTRODUCTION

1.1 This Basement Impact Assessment (BIA) has been prepared in support of a planning application to be submitted to the London Borough of Camden (LBC) for the construction of a basement beneath No.55 Ornan Road, NW3 4QD. The proposed works comprise a single storey basement beneath the full footprint of the house, with lightwells extending into part of the front and rear gardens. The assessment is in accordance with the requirements of the London Borough of Camden (LBC) Development Policy DP27 in relation to basement construction, and follows the requirements set out in LBC's guidance document CPG4 'Basements and Lightwells' (September 2013).

1.2 This assessment has been prepared by Keith Gabriel, a Chartered Geologist with an MSc degree in Engineering Geology, and Mike Summersgill, a Chartered Civil Engineer and Chartered Water and Environmental Manager with an MSc degree in Soil Mechanics. Both authors have previously undertaken assessments of basements in several London Boroughs.

1.3 A preliminary site inspection (walk-over survey) of the front of the house and the surrounding area was undertaken on Tuesday 24th February; no access was available to the house or rear garden. Photos from that visit are presented in Appendix A. Desk study data have been collected from various sources including borehole records (Appendix B) and geological data, environmental data and historic maps from GroundSure which are presented in Appendices E, F and G. Relevant information from the desk study and site inspections is presented in Sections 2–6, followed by the Basement Impact Assessment in accordance with CPG4 Stages 1–4 in Sections 7–10 respectively. The factual report on the ground investigation is included in Appendix C and the findings are summarised in Section 9.

1.4 The following site-specific documents in relation to the proposed new basement and planning application have been considered:

Neale & Norden Consultants:

- Drg No. 421/D02 Location Plan as Existing
- Drg No. 421/D01 Ground & First Floor Plans as Existing
- Drg No. 421/D02 Basement & Ground Floor Plans as Proposed
- Drg No. 421/D03 First Floor & Roof Plans as Proposed
- Drg No. 421/D04 Sections AA, BB & CC as Existing
- Drg No. 421/D05 Elevations Existing and Proposed
- Drg No. 421/D06 Sections AA, BB & CC as Proposed

No structural engineering drawings were available at the time of writing. This report should be read in conjunction with all the documents and drawings listed above.

1.5 Instructions to prepare this Basement Impact Assessment were confirmed by email from Nick Norden of Neale and Norden Consultants, on behalf of the clients, on 2nd February 2015.

2. THE PROPERTY, TOPOGRAPHIC SETTING AND PLANNING SEARCHES

2.1 No.55 Ornan Road is a two-storey terraced house (see cover photo) in the London Borough of Camden (LBC). Ornan Road is located between Belsize Lane to the north-west, and Belsize Avenue to the south-east, and can be accessed at its north-eastern end where it joins Haverstock Hill (A502), at its south-western end where it joins Belsize Lane, and opposite the property where it joins Perceval Avenue. No.55 is situated on the south-eastern side of Ornan Road, between No's 53 & 57, and the plot is bounded to the south-east by the rear garden to the Porticos, as shown in Figure 1 below and Photo 1 in Appendix A.

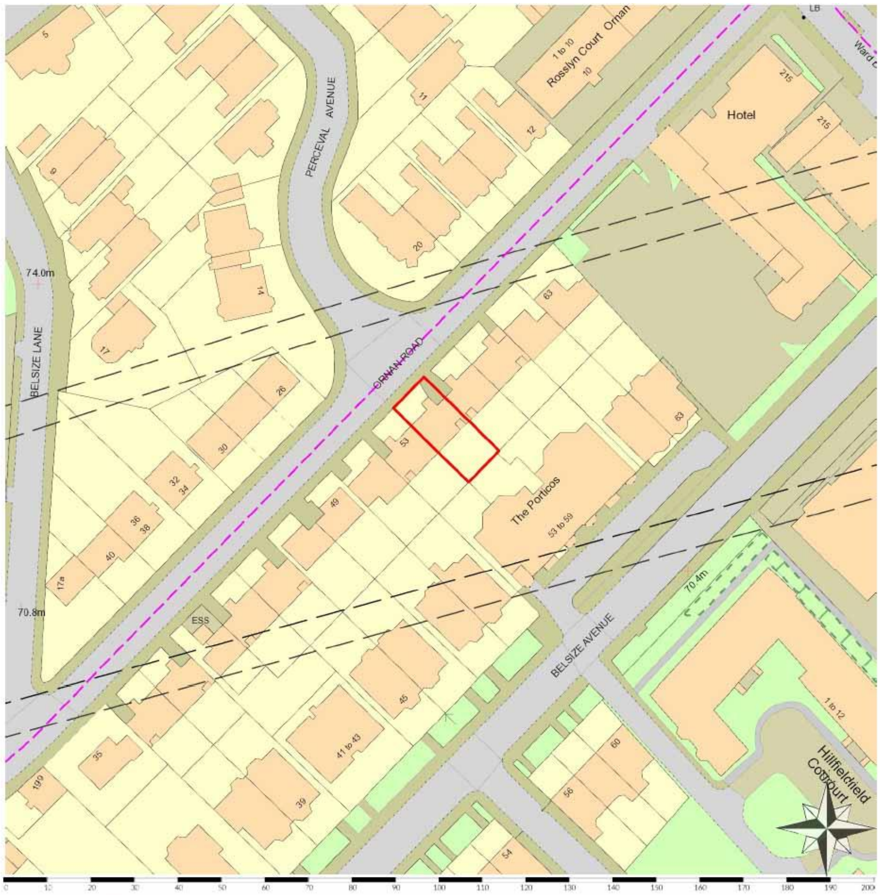


Figure 1: Extract from 1:1,250 OS map (not to scale) with the site outlined in red.

2.2 Reference to the historic OS map dated 1871, shows the plot of No.55 Ornan Road straddling the boundary between two fields, however much of the surrounding road network including Belsize Lane, Belsize Avenue and Haverstock Hill had already been constructed prior to this date. Large scale development in this area occurred between publication of the 1879 and 1894 OS maps, during which time the Ornan Road carriageway was constructed, and numerous semi-detached properties were built on the north-west side of Belsize Avenue, with gardens stretching to the newly built Ornan Road. The majority of the houses on the south-east side of Ornan Road, including No's 53, 55 and 57, were then constructed within the rear part of these gardens, between publication of the 1955 and 1965 OS maps.

2.3 As shown in Figure 1, two tunnels which form part of Network Rail's Midland Main Line pass just to the north and south of the site. The historic OS map dated 1871 shows that the tunnel which passes just south of the site had already been constructed prior to this date, whereas the northern tunnel does not appear until the 1953 OS map. It should be noted however that many of the maps between 1871 and 1953 do not show either of the tunnels. Also shown on the 1871 OS map is a well, located just to the west of the plot of No.55.

2.4 Externally, there is a front garden which is mostly paved, with the exception of perimeter and inset flower beds, and is set below the height of both the driveway, which leads to the integral garage, and the public footway. The drive is supported by a low brick retaining wall and is open to No.57's adjoining driveway. The raised flower bed alongside the footway is also supported by a brick retaining wall and is separated from the footway by upstanding low edgings except at the access steps (Photos 4 & 5). The front garden is bounded to the south-west by a wooden fence. The rear garden is mostly laid to lawn, with perimeter flower beds and a small patio area (Photo 6).

2.5 The bomb map for Hampstead shows that a high explosive or incendiary bomb landed just to the north of No.55, on the north-west side of Ornan Road.

Topographic Setting:

2.6 Ornan Road is located on a generally south-east-facing slope, which leads down from Hampstead Heath. The north-east end of Ornan Road is on a slight promontory, as illustrated by the 75m contour line which is located just upslope of the property (see Figure 2). As a result, the area within the direct vicinity of No.55 falls to the south and south-west. To the south of No.55 the west side of this promontory leads down to a weakly developed valley, where a former tributary to the river Tyburn was once present.

2.7 To the north-west of the site, the contours on Figure 2 indicate an overall slope angle of around 2.9° towards the south-east (between the 75m and 80m contours); however, using spot heights obtained from the 1974 historic OS map, an overall slope angle of around 1.5° to the south-west was calculated for Ornan Road. Between the 75m and 70m contours, downslope of No.55, an overall slope angle of around 5.2° towards the south was calculated, decreasing to around 2.9° between the 70m and 65m contours further downslope.

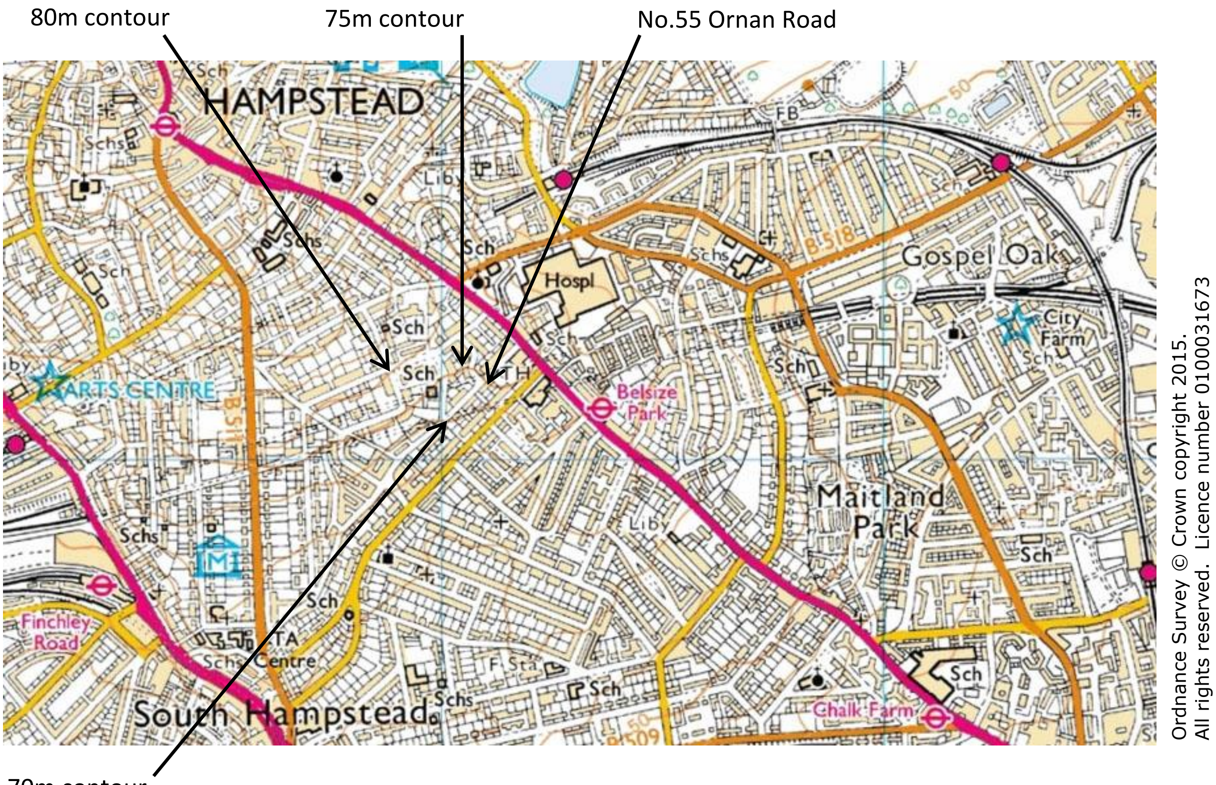


Figure 2: Extract from Ordnance Survey map showing site location.

Planning Searches:

2.8 It was known that a basement had been constructed beneath No.53. A search was made of planning applications on the Camden Council's website in order to obtain further details of that and any other basements which have been constructed or are planned in the vicinity of the property. This search found:

- No 53 Ornan Road: Application (2010/5783/P) involving the "*Construction of new basement storey under existing property including front and rear lightwells and associated works to a residential dwelling (Class C3)*" was granted planning permission on 20th December 2010. Documents provided by Neale & Norden included details of the on-site ground conditions found by the ground investigation (within the 'Detailed assessment of the proposed basement extension') and structural drawings.

- No.30 Ornan Road: Application (2009/0532/P) involving the "*Enlargement of the basement and provision of an additional front light well as an amendment to planning permission granted on 24/11/2008 (Ref: 2008/4462/P) for excavation of a new basement floor level, including front and rear lightwells, to single dwellinghouse (Class C3)*" was granted planning permission on 10 March 2009. No documents relating to a ground investigation were available on the website.

- No's 59-53 Belsize Avenue (The Porticos): Application (9400002) involving the "*Erection of a pair of four storey buildings plus roof storey and basement carpark to provide eighteen flats with private amenity space to rear as shown on drawing no(s) 1460SK01A 002C 003C 004C 005C 006C 007C 008C as revised on 17.03.94 18.04.94 16.05.94 and 06.07.94*" was granted planning permission on 25th August 1994. No documents relating to a ground investigation were available on the website.
- No.51 Ornan Road: Application (8400510) involving the "*Erection of a semi-basement and 2 storey detached house with integral garage.(Revision of the scheme approved on the 10th January 1983) as shown on drawing No.549/23 as revised on 17th July 1984*" was granted planning permission on 15th August 1984. No documents relating to a ground investigation were available on the website.

3. PROPOSED BASEMENT

3.1 Drawings by Neale & Norden Consultants show that the proposed basement for which planning permission will be sought comprises a single storey beneath the full footprint of building, including the existing conservatory at the rear of the house, and the entrance /WC at the front of the house. New lightwells are proposed either side of the entrance at the front of the property, as well as to the rear of the property, adjacent to the existing conservatory.

3.2 Scaling from Neale & Norden's Sections AA, BB, CC As Proposed (Drg No. D06) gives an internal Finished Floor Level (FFL) of 3.25m below the level of the ground floor above. No structural drawings were available at the time of writing, however, with an allowance of 0.50m for the basement slab, insulation, cavity drainage and floor structure, the founding level (formation) of the proposed basement is estimated to be 3.75m below the level of the ground floor above.

4. GEOLOGICAL SETTING

4.1 Mapping by the British Geological Survey (BGS) indicates that the site is underlain by the London Clay Formation. The boundary between the London Clay Formation and the overlying Claygate Member (also part of the London Clay Formation) is located approximately 145m to the north-west of the site. Figure 3 shows an extract from Figure 16 of the Camden GHHS (Camden Geological, Hydrogeological and Hydrological Study by Arup, November 2010) which illustrates the site geology of the Hampstead area.

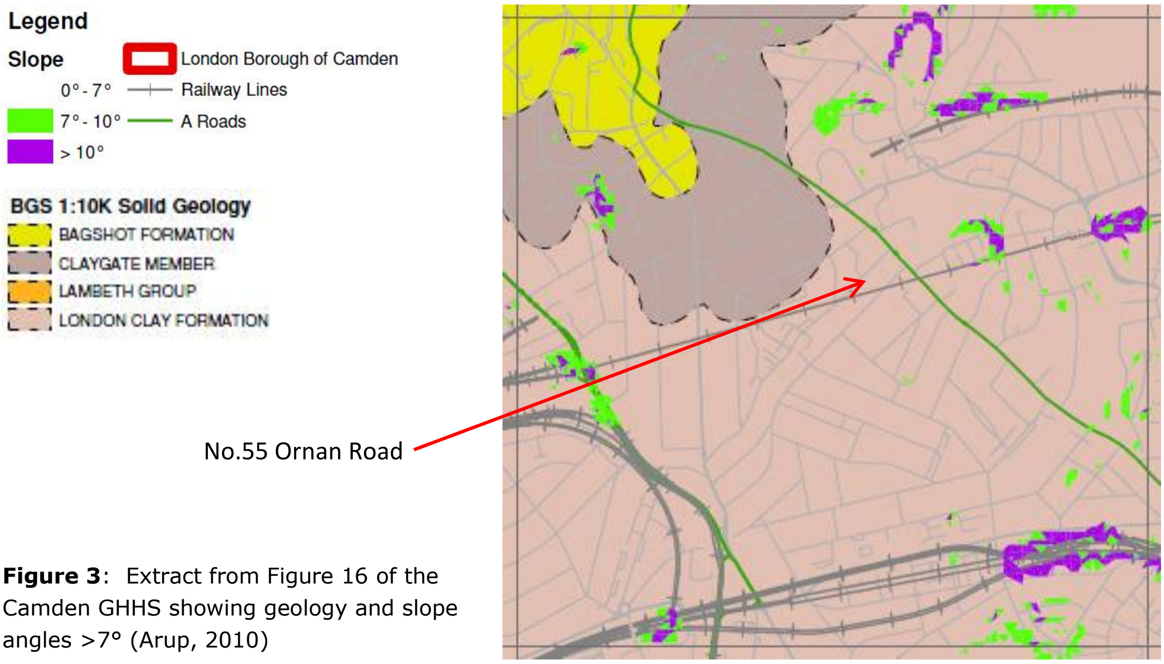


Figure 3: Extract from Figure 16 of the Camden GHHS showing geology and slope angles >7° (Arup, 2010)

4.2 In urban parts of London, the London Clay is typically overlain by Made Ground. A thin superficial layer of natural, locally-derived re-worked soils called Head deposits may also be present (because these are not mapped by the British Geological Survey where they are expected to be less than 1.0m thick). In the areas which have been excavated, some or all of these deposits may have been removed.

4.3 The London Clay is well documented as being a firm to very stiff over-consolidated clay which is typically of high or very high plasticity and high volume change potential. As a result it undergoes considerable volume changes in response to variations in its natural moisture content (the clay shrinks on drying and swells on subsequent rehydration). These changes can occur seasonally, in response to normal climatic variations, to depths of up to 1.50m and to much greater depths in the presence of the trees whose roots abstract moisture from the clay. The clay will also swell when unloaded by excavations such as those required for the construction of basements.

4.4 The results of the BGS natural ground subsidence hazard classifications are provided in the GroundSure GeoInsight report (Appendix E); all indicated 'Negligible' or 'Very Low' hazard ratings with the exception of 'Shrink – Swell Clay' for which a 'Moderate' hazard rating was given, which reflects the outcrop of the London Clay Formation at surface.

4.5 The GroundSure GeoInsight report (Appendix E, Sections 2, 3 & 7) records:

- Historic underground workings, the closest of which are tunnels at 16m to the north and 20m to the south of the site which are thought to form part of National Rail's Midland Main Line (see App.E, map on page 15, Section 2.2 and Section 7.1).
- A number of Historic 'mining' features within 1000m of the site, the closest of which are 'Air Shafts' located 176-183m to the north-east (see App.E, Section 3.1).
- A tunnel which forms part of London Underground's Northern Line, 123m to the north-east of the site at a depth of 45m below ground level (bgl) (see App.E, Section 7.1).
- Historical surface ground working features, the closest of which are a 'pond' located 200m to the south-west, and an unspecified pit located 201m to the west of the site (Section 2.1).

It should be noted that these databases are based on mapping evidence so inevitably will provide an incomplete record of underground workings.

4.6 A search of the BGS borehole database was undertaken for information on previous ground investigations and any wells in the vicinity of the site, the locations of which are presented on the location plan in Appendix B. The strata depths in a selection of these boreholes are summarised in Table 1. Few BGS boreholes were available close to the site, so borehole data gleaned from the planning search and other nearby ground investigations is also included within Table 1. For full strata descriptions reference should be made to the logs in Appendix B. General points of note from these boreholes were:

- With the exception of the two boreholes drilled at Ornan Court, the boreholes in Table 1 do not provide detailed descriptions of the London Clay, therefore it is unclear if the upper parts of the London Clay appeared weathered at these locations, as is commonly found within this unit.
- The ground investigation at No's 2 & 3 Akenside Road found 3.3-3.7m of the Claygate Member overlying the London Clay Formation, which is consistent with BGS mapping in this area (see Figure 3).

Table 1: Summary of Strata in BGS and other Boreholes							
Strata (abbreviated descriptions)	**Depths (m) and levels (m AOD) to base of strata in BGS Boreholes**						
	TQ28NE/277 (177m deep)		**TQ28NE/38**		**No.53 Ornan Road**	**No's 2&3 Akenside Road**	**Ornan Court**
GL (mAOD)	Depth	**Level 59.28**	Depth	**Level 71.32**	Depth	Depth	Depth
Made Ground and/or Topsoil	-	**-**	1.22	**70.10**	2.40	0.70-0.90	0.80-1.00
Mottled orange/brown silty sandy CLAY (Claygate Member)	-	**-**	-	**-**	-	4.00-4.60	-
Very Stiff, fissured silty CLAY (London Clay Fm)	69.00	**-9.72**	>6.10	**<65.22**	>7.00	>8.00	>5.00
Seepage/Strike	-	**-**	-	**-**	dry	4.00	dry
Groundwater standing level	95.65	**-36.37**	-	**-**	dry	1.85-2.68	dry

5. HYDROLOGICAL SETTING (SURFACE WATER)

Approximate location of No.55 Ornan Road

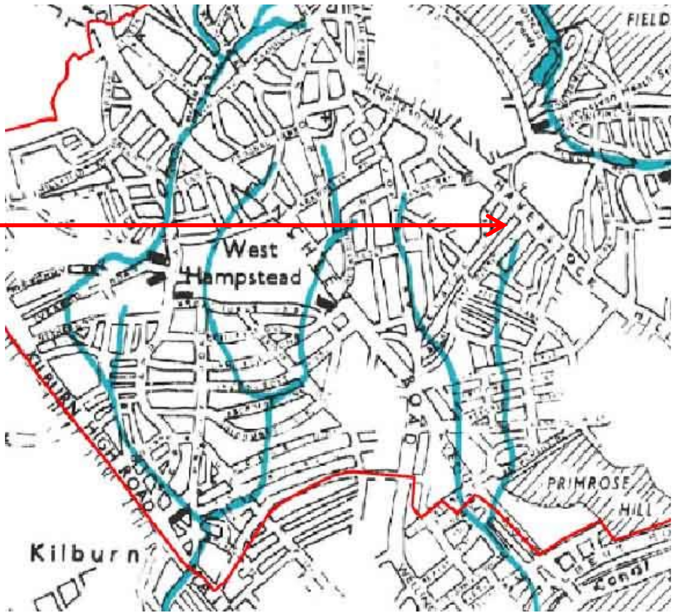


Figure 4: Extract from Figure 11 of the Camden GHHS (Arup, 2010) showing former watercourses, based on Barton (1992).

5.1 Ornan Road is within the catchment of the former river Tyburn, one of the 'lost' rivers of London which now runs in dedicated culverts or the sewer system. The closest former watercourse to the property is a tributary of this river, the source of which is shown on Figure 4 approximately 75m to the south-east of the site. Also shown on Figure 4 is the river Fleet which is located approximately 450m to the north-east of the site, on the other side of the ridge which broadly follows the alignment of Haverstock Hill, so is therefore not considered relevant.

5.2 The gentle fall of the footway away from the front of the property, together with the south-westwards fall of Ornan Road are likely to prevent surface water from reaching the property under most conditions. The wooden fence which separates the front garden to No.55 from the front garden/amenity area to No.53, is unlikely to prevent surface water flow from or to these areas. Thus, the surface water catchment for the front garden/amenity area may include the adjacent part of the front garden/amenity area to No.53, as well as direct rainfall. A low upstand on the south-west side of the driveway will prevent surface water run-off to the remainder of the front garden provided that the drainage system is able to remove all rain which falls directly onto the 55/57 driveways. Part of the front garden was surfaced with paving slabs so infiltration will be limited or nil in that area, whereas infiltration will occur in the adjacent soft landscaped areas, though that will be limited owing to the presence of clays at shallow depths (and nil when the ground is saturated or frozen).

5.3 Figure 5 shows that this particular road was subject to surface water flooding in 2002 but not in the 1975 floods. The implications of those historical events are addressed in Section 10.6. While the whole length of the road is recorded as having flooded, the floods generally affected only a short length of these roads; in the case of Ornan Road that was possibly at its low point which lies to the west of No.55, at the junction between Ornan Road and Belsize Lane. The adjoining Belsize Lane was subject to surface water flooding in both the 2002 and the 1975 flood events.

Figure 5: Extract from Figure 15 of the Camden GHHS (Arup, 2010) showing roads which flooded in 1975 (light blue), in 2002 (dark blue), and 'Areas with potential to be at risk of surface water flooding' (wide light blue bands).

5.4 Maps on the website of the Environment Agency (EA) show that the site lies within Flood Zone 1, which is defined as areas where flooding from rivers and the sea is very unlikely, with less than a 0.1 per cent (1 in 1000) chance of such flooding occurring each year. The EA's website also shows that this area does not fall within an area at risk of flooding from reservoirs.

5.5 The following hydrological data for the site has been obtained from the GroundSure EnviroInsight report (see Appendix F), including:

- The closest 'river' (or more specifically "Detailed River Network" entry) is a culvert, 93m to the east of the site (see App.F, Section 5.10). The almost north-south orientation suggests that this is probably the culverted former river Fleet (see paragraph 5.1).
- There are no surface water features within 250m of the site (see App.F, Section 5.11).
- The closest surface water abstraction licences are 1781m and 1789m to the south-east of the property, at the Grand Union Canal (App.F, Section 5.4), which are irrelevant to the proposed basement.
- There are no flood defences, no areas benefitting from flood defences, and no flood storage areas within 250m of the site (App.F, Sections 6.3, 6.4 & 6.5).

5.6 The latest modelling of surface water flooding has been undertaken by the Environment Agency and was published on its website in January 2014; an extract from their model is presented in Figure 6. While this map identifies four levels of risk (high, medium, low and very low), it is understood that it is based at least in part on depths of flooding. This modelling shows a 'Very Low' risk of flooding for the site of No.55 Ornan Road and the adjoining properties, which is the lowest, national background level of risk. Areas at 'Low' risk of flooding from surface water are shown on the opposite side of Ornan Road, south-west of the junction with Perceval Avenue.

These areas extend south-westwards along the Ornan Road carriageway onto Belsize Lane, and include localized areas at 'Medium' and 'High' risk of surface water flooding further downslope. A small area at 'Low' risk of flooding from surface water is also shown to the east of the property, at the site of No.61 Belsize Avenue.

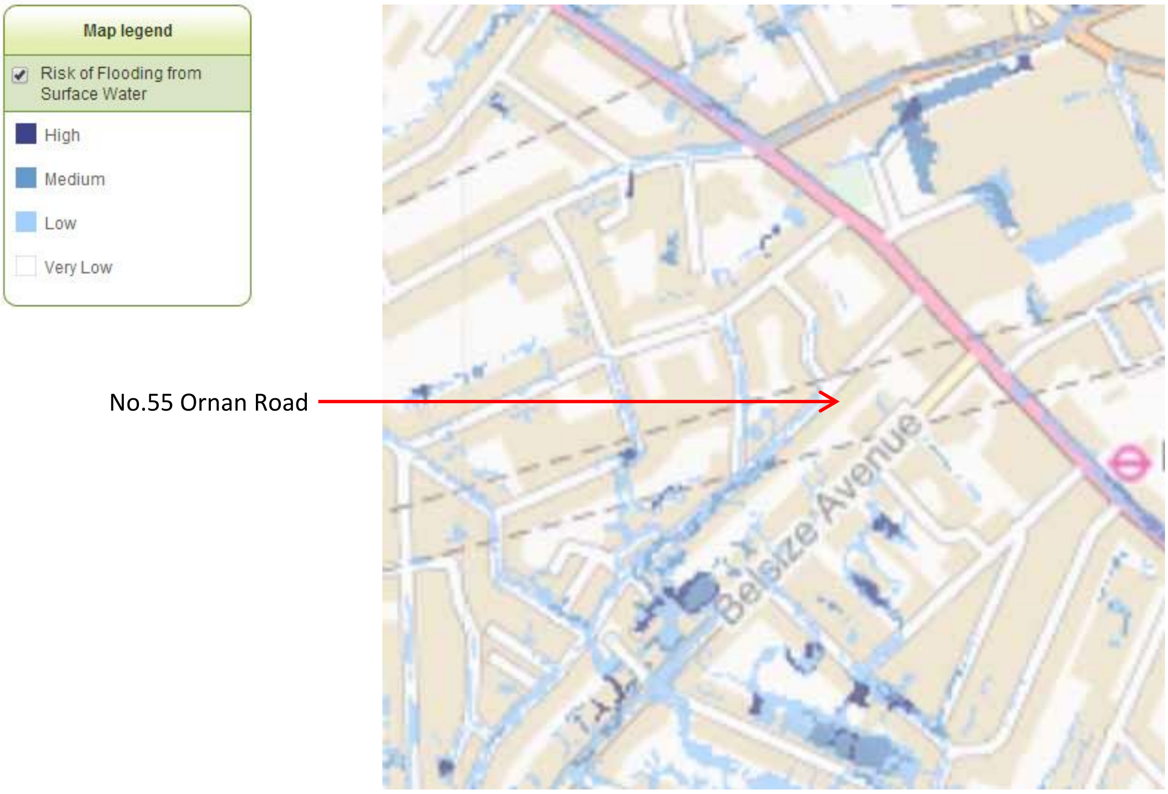


Figure 6: Extract from the Environment Agency's 'Risk of Flooding from Surface Water'.

5.7 The implications from these flood models are discussed in Section 10.8.

5.8 A 'Sewer Flooding History Enquiry' report has been obtained from Thames Water Utilities Ltd (TWU). In response to the question 'Is the requested address or area at risk of flooding due to overloaded public sewers?' (TWU's wording) the response given was: "*The flooding records held by Thames Water indicate that there have been no incidents of flooding in the requested area as a result of surcharging public sewers*". A copy of the report is available on request.

6. HYDROGEOLOGICAL SETTING (GROUNDWATER)

6.1 The London Clay Formation is classified by the Environment Agency as an 'Unproductive Stratum', as indicated in Figure 7.

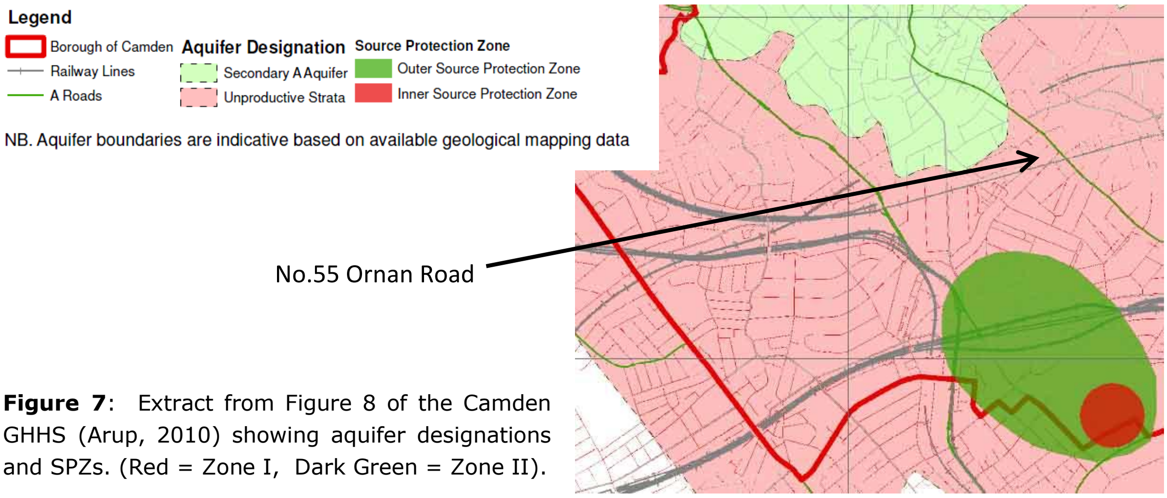


Figure 7: Extract from Figure 8 of the Camden GHHS (Arup, 2010) showing aquifer designations and SPZs. (Red = Zone I, Dark Green = Zone II).

6.2 Under the old groundwater vulnerability classification scheme, which now applies only to superficial soils, the area is unclassified.

6.3 While the London Clay Formation is classified as an 'Unproductive Stratum', it can still be water-bearing. The water pressures within the clay in the depths of current interest are likely to be hydrostatic, which means they increase linearly with depth, except where they are modified by tree root activity or the influence of man-made changes such as utility trenches (which can act either as land drains or as sources of water and high groundwater pressures). Any silt or sand partings, laminations or thicker beds are likely to contain free groundwater and, where these are laterally continuous, they can give rise to moderate water entries into excavations. In most cases, there will be only very limited or no natural flow in these silt/sand horizons.

6.4 Perched groundwater would typically be expected in any Made Ground, and possibly also in any Head deposits which overlie the London Clay, in at least the winter and early spring seasons. Variations in groundwater levels and pressures will occur seasonally and with other man-induced influences.

6.5 Details of the hydrogeology (geology and groundwater regime) found by the site-specific ground investigation in February 2015 are presented in Section 9. The boreholes recorded no sand or sandy silt horizons within the London Clay of sufficient thickness to warrant identifying them separately on the borehole logs.

6.6 The groundwater catchment areas upslope of No.55 are likely to differ for each of the main stratigraphic units:

- Made Ground: The catchment for any perched groundwater in the Made Ground is probably limited to the immediately adjoining areas of Made Ground, as well as No.55's own garden, except where the trenches for drains and other services provide greater interconnection.

- London Clay Formation: The catchment for the underlying London Clay will comprise recharge from the overlying soils in the vicinity of the site plus, possibly, a much wider area determined by the lateral extent of any interconnected silt/sand horizons.

6.7 Other hydrogeological data obtained from the GroundSure EnviroInsight report (Appendix F) include:

- The nearest groundwater abstraction licence is 919m to the south of the site at the Swiss Cottage Open Space Borehole (TQ28SE1769) with a maximum permitted abstraction of 28.8 m^3/day/ (App.E, Section 5.3). This borehole is 159m deep with 6" steel casing grouted into the London Clay and abstracts water from the Chalk below -56mOD, so it will have no effect on the proposed basement.
- The closest abstraction licence for potable water is 1542m to the south of the site at Barrow Hill Pumping Station (App.E, Section 5.5), with a maximum permitted abstraction of 2000 m^3/day. These boreholes abstract water from the Chalk so are also irrelevant to the proposed basement.
- A Source Protection Zone 2 – 'Outer Catchment' is located 496m to the south of the site (App.E, Section 5.6, and Figure 7). This is understood to relate to the above abstraction licence for potable water at Barrow Hill Pumping Station, therefore is also considered irrelevant to the proposed basement.
- The BGS has classified the area within 50m of the site as 'Not Prone' to groundwater flooding, based on the presence of London Clay to surface (App.E, Section 6.6).

7. STAGE 1 - SCREENING

7.1 The screening has been undertaken in accordance with the three screening flowcharts presented in LBC's CPG4 guidance document. Information to assist with answering these screening questions has been obtained from various sources including the site-specific ground investigation, the Camden geological, hydrogeological and hydrological study (Camden GHHS – Arup, 2010), historic maps and data obtained from GroundSure (see Appendices E, F & G) and other sources as referenced.

7.2 Subterranean (groundwater) flow screening flowchart:

Question		**Response, with justification of 'No' answers**	**Clauses where considered further**
1a	Is the site located directly above an aquifer?	No – Site underlain by London Clay	4.1 & Figure 3
1b	Will the proposed basement extend beneath the water table surface?	No, not beneath the water table in an aquifer. However, recent monitoring recorded water above the founding level of the basement, and higher levels are expected.	8.2, Sections 9, 10.2 & 10.3
2	Is the site within 100m of a watercourse?	No – There are no surface water features within 250m of site.	5.1 & 5.5
3	Is the site within the catchment of the pond chains on Hampstead Heath?	No – Site is approx 650m south of the nearest pond chain catchment.	Figure 2
4	Will the proposed basement development result in a change in the proportion of hard surfaced/ paved areas?	Yes – the southwest end of the front lightwell will replace a very small area of flower bed	Carried forward to Scoping: 8.2, Section 10.2
5	As part of the site drainage, will more surface water (eg: rainfall and run-off) than at present be discharged to the ground (eg: via soakaways and/or SUDS)?	No – Soakaways would be inappropriate in London Clay.	
6	Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to, or lower than, the mean water level in any local pond (not just the pond chains on Hampstead Heath) or spring line?	No – There are no surface water features within 250m of the site. Nearest springs are likely to be over 145m to NW (at London Clay-Claygate Member interface).	4.1 & Figure 3

While the answer to question Q1b above was no, the design of the basement must allow for the presence of groundwater in the Made Ground, which was found to be predominantly clayey, and the London Clay. The temporary works during construction must also allow for the presence of groundwater. These matters are considered in Sections 10.1 to 10.3.

7.3 Slope/ground stability screening flowchart:

Question		Response, with justification of 'No' answers	Clauses where considered further
1	Does the existing site include slopes, natural or man-made, greater than 7°? (approximately 1 in 8)	No – The site is broadly level, other than the gently sloping driveway.	2.6
2	Will the proposed re-profiling of landscaping at site change slopes at the property boundary to more than 7°?	No – No re-profiling is proposed.	
3	Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	No – Figure 16 in the Camden GHHS shows no land greater than 7° in the vicinity of this property.	2.7 & Figure 3
4	Is the site in a wider hillside setting in which the general slope is greater than 7°?	No – The slope angle upslope of No.55 is around 2.9°, increasing locally to 5.2° to the south, while Ornan Rd slopes down to the southwest at around 1.5°.	2.7 & Figure 3
5	Is the London Clay the shallowest strata at the site?	Yes, it is the shallowest strata mapped by the BGS (though it may be overlain by Head Deposits).	Carried forward to Scoping: 4.1, 8.3, Section 9
6	Will any tree/s be felled as part of the proposed development and/or are any works proposed within any tree root protection zones where trees are to be retained?	No – There are no trees in the immediate vicinity of the proposed basement. Aerial photos indicate that the canopy of the large tree(s) in the rear garden of No.57 does not extend close to the proposed basement.	
7	Is there a history of seasonal shrink/swell subsidence in the local area, and/or evidence of such effects at the site?	Potentially, yes, although no evidence of damage consistent with differential foundation movement was seen in the front walls of the houses in this terrace.	Carried forward to Scoping: 8.3, Section 10.4
8	Is the site within 100m of a watercourse or potential spring line?	No – see Q2 & Q6 in subterranean flow screening above.	
9	Is the site within an area of previously worked ground?	No – See BGS map extract (Figure 3 herein) and maps on pages 8 & 15 of the GeoInsight report (in Appendix E).	4.1 & Figure 3
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 – London Clay Formation is classified as an 'Unproductive Strata'.	6.1
11	Is the site within 50m of the Hampstead Heath ponds?	No – Site is approx 650m from Hampstead No.1 Pond.	
12	Is the site within 5m of a highway or a pedestrian right of way?	Yes.	Carried forward to Scoping: 8.3, Section 10.4
13	Will the proposed basement substantially increase the differential depth of foundations relative to neighbouring properties?	No, for No.53, where a basement has already been built. Yes, for No.57.	Carried forward to Scoping: 8.3, Section 10.4
14	Is the site over or within the exclusion zone of any tunnels, eg railway lines.	Unknown – Re Midland Mainline tunnels and other tunnels.	2.3, Carried forward to Scoping: 8.3, 10.1.3

7.4 Surface flow and flooding screening flowchart:

Question		**Response, with justification of 'No' answers**	**Clauses where considered further**
1	Is the site within the catchment of the pond chains on Hampstead Heath?	No – Site is approx 650m south of the nearest pond chain catchment.	
2	As part of the proposed site drainage, will surface water flows (eg volume of rainfall and peak run-off) be materially changed from the existing route?	No – Drainage route from the property will remain as per existing route (though water from lightwells may need to be pumped).	
3	Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?	Yes, possibly – a very small area of a flower bed will be replaced by part of the front lightwell	5.2 Carried forward to Scoping: 8.4 & Section 10.8
4	Will the proposed basement result in changes to the profile of the inflows (instantaneous and long-term) of surface water being received by the adjacent properties or downstream watercourses?	No – No change in run-off to adjacent properties is anticipated. The historic natural watercourse downslope of the property has been culverted since the 1800's.	5.2
5	Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	No – As above, and the surfaces generating any run-off are expected to remain similar to the existing.	
6	Is the site in an area known to be at risk from surface water flooding, such as South Hampstead, West Hampstead, Gospel Oak and King's Cross, or is it at risk from flooding, for example because the proposed basement is below the static water level of a nearby surface water feature?	Yes – However, while Ornan Road is recorded as having flooded in the 2002 event, surface water flood modelling by the Environment Agency indicates only a Very Low flood risk for No.55 and adjoining properties.	5.3, 5.6 & Figures 5 & 6. Carried forward to Scoping: 8.4 & Section 10.8

7.5 Non-technical Summary – Stage 1:

The screening exercise in accordance with CPG4 has identified eight issues which need to be taken forward to Scoping (Stage 2); one is related to groundwater, five are related to ground stability and two are related to flooding potential. The presence of perched groundwater in the clays of the Made Ground must also be allowed for in the design of the basement and the associated temporary works; these matters are considered in Sections 10.2 and 10.3.

8. STAGE 2 – SCOPING

8.1 The scoping stage is required to identify the potential impacts from the aspects of the proposed basement which have been shown by the screening process to need further investigation. A conceptual ground model is usually compiled at the scoping stage however, because the ground investigation has already been undertaken for this project, the conceptual ground model including the findings of the ground investigation is described under Stage 4 (see Section 10.1).

8.2 Subterranean (groundwater) flow scoping:

Issue (= Screening Question)		**Potential impact and actions**
4	Will the proposed basement development result in a change in the proportion of hard surfaced/ paved areas?	**Potential impact:** Increased hard surfacing would decrease infiltration of surface water into the ground. Reduced hard surfacing above an aquifer, while generally beneficial in promoting recharge, might lead to local groundwater flooding elsewhere. **Action:** Review potential impacts of proposed changes, including appropriate types of SuDS for use as site-specific mitigation when relevant.

8.3 Slope/ground stability scoping:

Issue (= Screening Question)		**Potential impact and actions**
5	Is the London Clay the shallowest strata at the site?	**Potential impact:** Heave in response to the unloading caused by the basement excavations, and as Q6 and Q7 below. **Action:** Ground investigation required, followed by appropriate design.
7	Is there a history of seasonal shrink/swell subsidence in the local area, and/or evidence of such effects at the site?	**Potential impact:** Weakened structures from past movement would be more susceptible to damage during works. Future differential movement between the building above the basement and the adjoining structures. **Action:** Review potential impact of future vegetation growth. Designer and contractor to take account of any weakening of the structure caused by past movements.
12	Is the site within 5m of a highway or a pedestrian right of way?	**Potential impact:** Construction of basement causes loss of support to footway/highway and damage to the services beneath them. **Action:** Ensure adequate temporary and permanent support by use of best practice underpinning methods.
13	Will the proposed basement substantially increase the differential depth of foundations relative to neighbouring properties?	**Potential impact:** Loss of support to the ground beneath the foundations to neighbouring buildings if basement excavations are inadequately supported. **Action:** Ensure adequate temporary and permanent support by use of best practice underpinning methods. Consider the need for transition underpinning.
14	Is the site over or within the exclusion zone of any tunnels, eg railway lines.	**Potential impact:** Stress changes on any tunnel lining. Piles or boreholes penetrating the tunnel. **Action:** Contact Network Rail and undertake services search to check that there are no other tunnels / deep services in the vicinity.

8.4 Surface flow and flooding scoping:

Issue (= Screening Question)		**Potential impact and actions**
3	Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?	**Potential impact:** May increase flow rates to sewer, and thus increase the risk of flooding (locally or elsewhere). **Action:** Assess net change in hard surfaced/paved areas and, if required, recommend appropriate types of SuDS for use as site-specific mitigation.
6	Is the site in an area known to be at risk from surface water flooding, such as South Hampstead, West Hampstead, Gospel Oak and King's Cross, or is it at risk from flooding, for example because the proposed basement is below the static water level of a nearby surface water feature?	**Potential impact:** Flooding of the basement. **Action:** Review flood risk and provide flood resistance measures as appropriate**.**

8.4 <u>Non-technical Summary – Stage 2:</u>

The scoping exercise has reviewed the potential impacts for each of the items carried forward from Stage 1 screening, and has identified the following actions to be undertaken:

- A ground investigation is required (which has already been undertaken).
- Designer and contractor to take account of any weakening of the structure caused by past movements.
- Ensure adequate temporary and permanent support by use of best practice underpinning methods.
- Contact Network Rail – Neale & Norden have already made contact, though requested information regarding the depth of the tunnels has not been provided.
- Consider the need for transition underpinning to mitigate differential foundation depths.
- Undertake a services search to check whether there are any deep services/ other tunnels which might be affected by the basement.
- Review flood risk and include appropriate flood resistance and mitigation measures in the scheme's design.

All these actions are covered in Stage 4, or Stage 3 for the ground investigation.

9. STAGE 3 – GROUND INVESTIGATION

9.1 A site-specific ground investigation was undertaken by Herts & Essex Site Investigations (H&ESI) in February 2015 and comprised two window sampler boreholes (BH1 & BH2) drilled to depths of 5.0m below ground level (bgl) within the front and rear gardens to No.55. The findings from the investigation are presented in Herts & Essex Site Investigations' Factual Report (see Appendix C), which includes a site plan, borehole logs, and laboratory test results.

9.2 The site's geology as found by the boreholes may be summarised as:

- Made Ground: Discovered to depths of 0.50m and 0.75m bgl (including overlying topsoil/paving slabs) in BH1 and BH2 respectively, the Made Ground was described as "sandy clay FILL' and "sandy claybound brick FILL".
- Weathered London Clay Formation: proved from the base of the overlying Made Ground to the base of both BH1 and BH2 at 5.0m bgl; this clay was described as "Firm becoming stiff, orange brown CLAY".

9.3 No "significant roots" were encountered in the boreholes below 0.60m.

9.4 No groundwater entries were recorded in either of the boreholes and they were described as 'dry'.

9.5 A standpipe was installed to the base of BH1 at 5.0m. A water level reading was taken by Neale & Norden on 12th March 2015, when the water level in the standpipe was at 3.30m below ground level. This level is not considered to be representative of the groundwater levels/pressures in the surrounding ground.

9.6 Laboratory Testing:
Laboratory tests were carried out by Herts & Essex Site Investigations (H&ESI) on samples recovered from the boreholes. The testing comprised classification tests, including moisture content and plasticity, compressive strength tests and chemical testing to assess the potential for acid or sulphate attack on buried concrete. The results were presented in H&ESI's Factual Report (see Appendix C).

9.7 Plasticity tests were performed on a total of four samples of Weathered London Clay, recovered from BH1 at 1.0m and 3.0m bgl, and BH2 at 2.0m and 5.0m bgl. Three of the samples were found to be of Very High Plasticity as classified by BS5930 (1999, 2010), and High volume change potential, as defined by the NHBC (NHBC Standards, 2013, Chapter 4.2, Building near Trees). The sample recovered from BH2 at 2.0m bgl was found to be of High Plasticity and Medium volume change potential.

9.8 The moisture contents were generally consistent, with almost all values falling between 31% and 36%, however the sample recovered from BH2 at 2.0m had a notably lower moisture content of 27%. All the moisture contents were 7% or more above the Plastic Limit, which indicates that the samples tested were not desiccated.

9.9 Undrained strength tests (unconsolidated undrained triaxial compression) were undertaken on a total of ten samples recovered from BH1 and BH2 at 1.0m intervals. They gave apparent cohesion values in the range from 46kN/m² to 121kN/m². These strengths are somewhat lower than would normally be expected at these depths.

9.10 The chemical tests were performed on three samples of weathered London Clay in order to assess the potential for acid or sulphate attack on buried concrete, and were carried out in accordance with BRE Special Digest 1. The following ranges of results were recorded.

pH value:	7.05 – 7.31
Water-soluble sulphate (SO_4):	80 – 110 mg/l

These results suggest that the samples may fall within Design Sulphate Class 1 (DS-1), as defined by BRE Special Digest 1 (2005). It should be noted that the samples were not tested for total sulphur or acid-soluble sulphates, which can be high within London Clay, so higher design classes are likely to apply.

9.11 <u>Non-technical Summary – Stage 3:</u>

9.11.1 The ground investigation found, as anticipated, Weathered London Clay directly below Made Ground in both BH1 and BH2.

9.11.2 No groundwater entries were recorded in the borehole during drilling. The standpipe in BH1 recorded water levels to within 3.30m bgl during the short monitoring period, but this level is not considered to be representative of the conditions in the surrounding ground.

9.11.3 The laboratory testing has shown that the majority of the clay specimens from the Weathered London Clay were of Very High plasticity and High volume change potential. They had notably uniform moisture contents with depth, slightly lower strengths than normal and did not appear to be desiccated.

9.11.4 The chemical tests did not record any aggressive ground conditions as all samples fell within DS-1, though London Clay normally falls within DS-2 to DS-4 so more aggressive conditions may remain undetected.

10. STAGE 4 – BASEMENT IMPACT ASSESSMENT

10.1 Conceptual Ground Model

10.1.1 The desk study evidence together with the ground investigation findings suggest a conceptual ground model, including hydrogeological model, for the site characterised by:

- Made Ground: The site specific ground investigation recorded Made Ground to a maximum depth of 0.75m below ground level (bgl) (including overlying topsoil/paving slabs). 2.4m of Made Ground was recorded in a borehole in the adjoining No.53's garden, though no description of the materials has been seen. The Made Ground at No.55 was generally described as 'sandy **clay** fill' to 'sandy claybound brick fill', however other materials, as well as other soil types and greater thicknesses/depths are also likely to be present on site, owing to the inherent variability of Made Ground.
- Weathered London Clay Formation: Firm becoming stiff CLAYs were recorded from the base of the Made Ground to the maximum depth excavated (5.0m bgl). A more detailed description is given in paragraph 9.3. The strengths measured in the triaxial tests were lower than would be expected for a typical London Clay weathering profile, reaching only 68-71kPa at 4.0m bgl.
  The weathered zone extends to depths greater than 10m in this part of London, while the underlying blue-grey CLAYS are expected to reach depths in excess of 60m (see Table 1).
  These clays are likely to be fissured and will undergo heave movements in response to unloading by the basement excavation. They typically contain selenite and/or pyrite which is or has the potential to be aggressive to buried concrete.
- Hydrogeology:
  - Perched groundwater may occur locally within the Made Ground, supported on the London Clay or other horizons of lower permeability; such perched groundwater may only be present during the wetter winter and spring seasons.
  - Groundwater pressures in the London Clay are expected to be essentially hydrostatic within the depth of current interest, except where modified by tree root action or artificial influences (see below). Groundwater flow through these clays is likely to be minimal, in practice being limited to seepage through any of the silt/sand partings which are sufficiently interconnected.
- Other influences on the Groundwater regime:
  The hydrogeology may be complicated further by the backfill in service trenches and granular pipe bedding (where present) forming preferential groundwater flow pathways within the strata they pass through.

10.1.2 The hydrogeological regime outlined above will be affected by long-term climatic variations as well as seasonal fluctuations, all of which must be taken into account when selecting a design water level for the permanent works. No multi-seasonal monitoring data are available, so a conservative approach will be needed, in accordance with current geotechnical design standards which require use of 'worst credible' groundwater levels/pressures. See paragraph 10.2.5 for the recommended provisional design groundwater level.

10.1.3 Two railway tunnels are known to pass just north and south of the site; Network Rail have provided a plan showing the tunnel locations but have yet to advise whether any special precautions will be required in relation to these tunnels. That must be established. Other infrastructure (including tunnels), for sewers, cables or communications might be present within the zone of influence of the proposed basement, so an appropriate services search should be undertaken. If any such infrastructure is identified, then its potential influence on the proposed basement must be assessed. These searches will not identify any private services.

10.2 Subterranean (Groundwater) Flow – Permanent Works

10.2.1 The Made Ground, where seen, was recorded as sandy clays or claybound bricks, both of which would be expected to be relatively low permeability materials, so are likely to permit little or no flow of any perched groundwater (unless the clays are voided). No groundwater entries were recorded in the ground investigation's boreholes (during drilling), although the lack of a groundwater entry into a small diameter borehole in clayey strata does not necessarily mean that groundwater was absent; rather the low permeability of the clays merely means that the flow rate was too slow for groundwater entries to occur before the borehole was backfilled. Flow through the Made Ground is most likely to occur where service trenches or granular pipe bedding facilitates channelled flow. As the Made Ground was less deep than the likely founding depth of this house, the proposed basement will not have any impact of the flow of perched groundwater within the Made Ground.

10.2.2 The one groundwater level reading from the standpipe in BH1, at 3.3m bgl, was taken at least 5 weeks after completion of the borehole, though it is almost certain that the water level had not equilibrated with the surrounding groundwater, so was not entirely representative.

10.2.3 The basement is expected to be founded throughout in the weathered London Clay, with a founding depth (formation level) of approximately 3.75m bgl. The adjoining basement beneath No.53 is founded at approximately the same level. Groundwater levels (or the phreatic surface) are expected to rise to close to ground level in the winter. If there is any groundwater seepage through minor partings of silt/fine sand within the natural clays (none were recorded on the borehole logs) then it is likely to be towards the south-southwest, broadly following the topography. This means that the proposed basement beneath No.55 would represent only a very slight increase in cross-slope width relative to the existing basement beneath No.53. In addition, the lack of any groundwater entries during the drilling of the two boreholes on this site provides further evidence for a lack of any significant groundwater flow, so the proposed basement is considered acceptable in relation to groundwater flow and levels. Thus, no cumulative impact is anticipated.

10.2.4 In the unlikely event that the basement excavations encounter a local deposit of more permeable soils or a water-bearing claystone horizon which has remained undetected within the London Clay, of sufficient thickness and extent to permit significant flow, then it is possible that an engineered groundwater bypass might be required. This bypass would have to be detailed once the geometry of the permeable soil unit is known.

10.2.5 Current geotechnical design standards require use of a 'worst credible' approach to selection of groundwater pressures. On sites such as this where high plasticity clays are present close to surface, the groundwater table (or phreatic surface) may rise into the overlying Made Ground, at least in the wettest winters, unless mitigation measures such as land drainage can be installed. No acceptable disposal location exists for such water (because there is no accessible watercourse nearby, and Thames Water will not normally allow disposal of groundwater to the mains drainage system). As a result, use of a provisional design groundwater level equal to ground level is recommended for short-term (total stress) design situations, and equal to 0.5m below ground level for long-term (effective stress) design situations. If the design is undertaken in accordance with Eurocode 7 (BS EN 1997-1), then groundwater should be taken at ground level in both short-term and long-term situations.

10.2.6 The basement structure must be designed to resist the buoyant uplift pressures which would be generated by groundwater at the design level. For the founding depths currently proposed, the uplift pressures would be up to 38kPa (un-factored).

10.2.7 The proposed basement will need to be fully waterproofed in order to provide adequate long-term control of moisture ingress from the groundwater. Detailed recommendations for the waterproofing system are beyond the scope of this report although it is noted that, as a minimum, it would be prudent for the system to be designed in compliance with the requirements of BS8102:2009.

10.2.8 The National House Building Council published new guidance on waterproofing of basements in November 2014 (NHBC Standards, Chapter 5.4). Compliance would be compulsory if an NHBC warranty is required, otherwise it may provide a useful guide to best practice.

10.3 Subterranean (Groundwater) Flow – Temporary Works

10.3.1 Despite the lack of water entries into the two exploratory holes, the possibility remains that some groundwater entries will occur into the excavations for the basement. On current evidence, such water entries should be manageable by sump pumping. An appropriate discharge location must be identified for the groundwater removed by sump pumping.

10.3.2 A careful watch should be maintained to check that fine soils are not removed with the groundwater; if any such erosion/removal of fines is noticed, then pumping should cease and the advice of a suitably experienced and competent ground engineer should be sought.

10.3.3 The unloaded clays at/beneath formation level will readily absorb any available water which would lead to softening and loss of strength. It will therefore be important to ensure that the clays at formation level (onto which the underpins and the basement slab will bear) are protected from all sources of water, with suitable channelling to sumps for any groundwater seeping into the excavations. The formation clays should be inspected and then blinded with concrete immediately after completion of final excavation to grade. Any unacceptably soft/weak areas must be excavated and replaced with concrete.

10.3.4 A leaking water supply pipe to the property could increase significantly the volume of water entries, so it would be prudent to ensure the isolation stopcock is both accessible and operational before the start of the works.

10.4 Slope and Ground Stability

Slope Stability

10.4.1 With overall slope angles of approximately 2.9° upslope of this property, the proposed basement excavation raises no concerns in relation to the overall stability of the slope, subject to normal precautions in supporting the ground around the basement.

Underpinning Methods and Ground Movements alongside the Basement

10.4.2 In order to achieve the geometries shown on Neale & Norden's drawings it is anticipated that the basement will be constructed using underpinning techniques beneath the original building, together with similar reinforced concrete (RC) retaining walls for the lightwells. These RC retaining walls should be cast in-situ on the same 'hit and miss' basis as used for the underpins.

10.4.3 Underpinning methods involve excavation of the ground in short lengths in order to enable the stresses in the ground to 'arch' onto the ground or completed underpinning on both sides of the excavation, together with the ability of stiff homogenous clays to stand un-supported for a limited period of time. Loads from the structure above will similarly arch across the excavation, provided that the structure is in good condition.

10.4.4 Some ground movement is inevitable when basements are constructed. When underpinning methods are used, the magnitude of the movements in the ground being supported by the new basement walls is dependent primarily on:

- the geology,
- the adequacy of temporary support to both the underpinning excavations and the partially complete underpins prior to installation of full permanent support;
- the quality of workmanship when constructing the permanent structure.

A high quality of workmanship and the use of high stiffness temporary support systems, installed in a timely manner in accordance with best practice methods, are therefore crucial to the satisfactory control of ground movements alongside basement excavations (see 10.4.5 to 10.4.7 below). Any cracks in load-bearing walls which have weakened their structural integrity should be fully repaired in accordance with recommendations from the appointed structural engineers before any underpinning is carried out.

10.4.5 The minimum temporary support requirements recommended for the excavations for the proposed underpins and RC retaining walls at No.55, subject to inspection and review as described in 10.4.8 below, are:

- Full face support must be installed as the excavations progress for all excavations through the Made Ground.
- Closely spaced support where any firm clay is present in the London Clay.
- More widely spaced temporary support may be adequate in the stiff or very stiff clays of the London Clay Formation, depending on the degree of fissuring,

except at corner excavations where closely spaced support should be provided.

- Temporary support will be required to all the new underpins and RC retaining wall panels, and must be maintained until the full permanent support has been completed, including allowing time for the concrete to gain adequate strength.

10.4.6 Under UK standard practice, the contractor is responsible for designing and implementing the temporary works, so it is considered essential that the contractor employed for these works should have completed similar schemes successfully. For this reason, careful pre-selection of the contractors who will be invited to tender for these works is recommended. Full details of the temporary works should be provided in the contractor's method statements.

10.4.7 In accordance with normal health and safety good practice, the requirements for temporary support of any excavation must be assessed by a competent person at the start of every shift and at each significant change in the geometry of the excavations as the work progresses. London Clay is usually fissured; such fissures can cause seemingly strong, stable excavations to collapse with little or no warning. Thus, in addition to normal monitoring of the stability of the excavations, a suitably competent person should check whether such fissuring is present and, if encountered, should assess what support is appropriate.

10.4.8 The construction sequence will be covered in the structural engineer's Construction Method Statement.

<u>Geotechnical Design</u>

10.4.9 Design of the basement retaining walls must include all normal design scenarios (sliding, over-turning and bearing failure) and must take into consideration:

- Earth pressures from the surrounding ground (see also paragraph 10.4.10 below);
- Dead and live loads from the superstructure, including loads from the adjoining houses which are carried on the party walls;
- A surcharge, or increased earth pressure coefficient, to allow for the higher level of the driveway;
- Loads from vehicles on the driveway;
- Normal surcharge allowances elsewhere;
- Swelling displacements/pressures from the underlying clays;
- A provisional design groundwater level at GL/0.5m bgl (see paragraph 10.2.5);
- Precautions to protect the concrete from sulphate attack.

10.4.10 The following geotechnical parameters should be used when calculating earth pressures:

Made Ground (clays):	Unit weight, γ_b:	19.0 kN/m^3
	Effective cohesion, c':	0 kPa
	Angle of internal friction, φ':	25°
London Clay Fm:	Unit weight, γ_b:	20.0 kN/m^3
	Effective cohesion, c':	0 kPa
	Angle of internal friction, φ':	22°

Coefficient of earth pressure at rest, k_0: 1.0, after the likely existing higher stresses have been released by the excavations.

These parameters should be used in conjunction with appropriate partial factors dependent upon the design method selected.

10.4.11 The formation level clays onto which the underpins/RC walls and the basement slab will bear must be protected from water to prevent softening and loss of strength, as described in 10.3.3 above.

10.4.12 Normal good practice in foundation construction requires progressive stepping up between foundations of different depths beneath a single structure. Transitional underpins should therefore be considered for the load-bearing walls in No.57 which adjoin No.55, subject to agreement under the Party Wall Act negotiations.

10.5 Heave/Settlement Assessment

Basement Geometry and Stresses:

10.5.1 Analyses of vertical ground movements (heave or settlement) have been undertaken using PDISP software in order to assess the potential magnitudes of movements which may result from the changes of vertical stresses caused by excavation of the basement. These preliminary analyses have not modelled the horizontal forces on the retaining walls, so have simplified the stress regime significantly.

10.5.2 Figure D1 in Appendix D illustrates the layout of the proposed underpins and basement slab, based on Neale & Norden's Drg No. 421/D02. The maximum overall dimensions of the basement are approximately 10.4m wide by 12.7m long (front to rear, excluding the steps up to the rear garden).

10.5.3 Table 2 presents the co-ordinates of the zones used to input the main elements of the basement's geometry into PDISP based on the illustration in Figure D1, together with the changes in net bearing pressure for four major stages of the stress history of the basement's construction, as detailed in paragraph 10.5.6 below. Assumed loads were used for the superstructure.

Table 2: Coordinates and net bearing pressure for PDISP analyses

ZONE	Centroid		Dimensions		Angle with	Net change in vertical pressure (kPa)		
#	Xc(m)	Yc(m)	X(m)	Y(m)	X-Axis	Stage 1	Stage 2	Stages 3 and 4
1	3.50	1.25	1.80	2.50	0.0000	-26.94	-26.94	-26.94
2	8.83	0.75	8.85	1.50	0.0000	-25.67	-25.67	-25.67
3	14.28	1.35	2.05	2.70	0.0000	-27.66	-27.66	-27.66
4	14.28	3.95	2.05	2.50	0.0000	0.38	0.38	0.38
5	11.13	3.35	4.25	1.30	0.0000	-19.62	-19.62	-19.62
6	14.28	7.80	2.05	5.20	0.0000	-32.96	-32.96	-32.96
7	9.15	9.65	8.20	1.50	0.0000	-25.67	-25.67	-25.67
8	3.83	6.45	2.45	7.90	0.0000	-37.69	-37.69	-37.69
9	1.30	9.55	2.60	1.70	0.0000	-34.85	-34.85	-34.85
10	7.03	5.20	3.95	7.40	0.0000	0.00	-75.00	-65.00
11	11.13	6.45	4.25	4.90	0.0000	0.00	-75.00	-65.00
12	11.13	2.10	4.25	1.20	0.0000	0.00	-75.00	-65.00
13	4.73	2.00	0.65	1.00	0.0000	0.00	-75.00	-65.00

Ground Conditions:

10.5.4 The ground profile was based on the site-specific ground investigation by Herts & Essex Site Investigations, as presented in Sections 9 and 10.1 above, and the desk study information.

10.5.5 The short-term and long-term geotechnical properties of the soil strata used for the PDISP analyses are presented in Table 3, based on this investigation and data from other projects.

Table 3: Soil parameters for PDISP analyses				
Strata	**Level** (m bgl)	**Undrained Shear Strength,** Cu (kPa)	**Short-term, undrained Young's Modulus,** Eu (MPa)	**Long-term, drained Young's Modulus,** E' (MPa)
London Clay	1.00 3.75 25	65 86 245	32.5 43 122.5	19.5 26 74
Where: Undrained shear strength, Cu assumed as Cu = 65 + 7.5z kPa where z = depth below the top of the stratum (1.0m bgl) Undrained Young's Modulus, Eu = 500 * Cu Drained Young's Modulus, E' = 0.6 * Eu				

PDISP Analyses:

10.5.6 Three dimensional analyses of vertical displacements have been undertaken using PDISP software and the basement geometry, loads/stresses and ground conditions outlined above in order 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 underpins/retaining walls – Short-term condition
- Stage 2 – Bulk excavation of central area to formation level – Short-term condition
- Stage 3 – Construction of basement slab – Short-term (undrained) condition
- Stage 4 – As Stage 3, except – Long-term (drained) condition.

10.5.7 The results of the analyses for the Stages 2, 3 and 4 are presented as contour plots on the appended Figures D2 to D4 respectively.

Heave/Settlement Assessment:

10.5.8 Excavation of the basement will cause immediate elastic heave in response to the stress reduction, followed by long-term plastic swelling as the underlying clays take up groundwater. The rate of plastic swelling in the in-situ clays will be determined largely by the availability of water and as a result, given the low permeability of the clays in the London Clay Formation, can take decades to reach full equilibrium. The basement slab will need to be designed so as to enable it to accommodate the swelling displacements/pressures developed underneath it.

10.5.9 The PDISP analyses indicated only modest heave movements less than 10mm are likely to develop beneath the basement walls. The ranges of predicted short-term and long-term movements for each of the main walls are presented in Table 4 below.

Table 4: Summary of predicted displacements

Location	**Stage 2 (Figure D2)**	**Stage 3 (Figure D3)**	**Stage 4 (Figure D4)**
Front wall, porch & front lightwell	2 – 8mm Heave	2 – 5mm Heave	4 – 8mm Heave
53/55 Ornan Rd party wall	3 – 8mm Heave	2 – 5mm Heave	3 – 9mm Heave
Rear wall, conservatory & rear lightwell	3 – 9mm Heave	2 – 6mm Heave	3 – 10mm Heave
55/57 Ornan Rd party wall	2 - 8mm Heave	2 – 4mm Heave	3 – 9mm Heave
Centre of basement slab	Up to 12mm Heave	Up to 8mm Heave	Up to 13mm Heave

10.5.10 All the short-term elastic displacements would have occurred before the basement slab is cast, so only the post-construction incremental heave/settlements are relevant to the slab design. The analyses indicated that the maximum predicted post-construction displacements beneath the slab are likely to be about 5mm (total and differential).

10.6 Damage Category Assessment

10.6.1 When underpinning it is inevitable that the ground will be un-supported or only partially supported for a short period during excavation of each pin, even when support is installed sequentially as the excavation progresses. This means that the behaviour of the ground will depend on the quality of workmanship and suitability of the methods used, so rigorous calculations of predicted ground movements are not practical. However, provided that the temporary support follows best practice as outlined in Section 10.4 above, then extensive past experience has shown that the bulk movements of the ground alongside the basement caused by underpinning to this depth should not exceed 5mm either horizontally or vertically.

10.6.2 The existence of the new basement beneath No.53 which extends to the same depth as the proposed basement means that no further excavation will be required below the 53/55 party wall. Thus, no damage category assessment is applicable for that wall.

10.6.3 In order to relate these typical ground movements to possible damage which adjoining properties might suffer, it is necessary to consider the strains and the angular distortion (as a deflection ratio) which they might generate using the method proposed by Burland (2001, in CIRIA Special Publication 200, which developed earlier work by himself and others).

10.6.4 Ground movements associated with the construction of retaining walls in clay soils have been shown to extend to a distance up to 4 times the depth of the excavation. With allowance for a foundation depth of 1.0m to No.57, the depth of excavation for the proposed basement will be approximately 2.75m. So the damage category calculations for No.57 are as follows.

Zone of influence from basement = 2.75 x 4 = 11m = Width (L)
Height (H) = approx. 7.0m
Hence L/H = 1.57 = approx 1.5

Thus, for the anticipated 5mm maximum horizontal displacement the strain beneath the No.57 would, theoretically, be in the order of ε_h = 4.55 x 10^{-4} (0.045%).

10.6.5 The heave of the 55/57 party wall predicted by the PDISP analysis will offset the settlement resulting from relaxation of the ground alongside the excavation. The predicted heave directly beneath the party wall (see Figure D4) was 4.0-5.5mm. The 4.0mm value at the front end of the party wall represents the least favourable state, which gives a 1mm net predicted settlement of the ground below the footing to No.57's front wall. The settlement profile is expected to be convex, so the combined ground movement profile gave a maximum deflection, with a worst case ratio of 17%, so Δ = 0.2mm, which represents a deflection ratio, Δ/L = 1.8 x 10^{-5} (0.002%).

10.6.6 Using the graphs for L/H = 1.5, these deformations represent a damage category of 'negligible' (Burland Category 0, ε_{lim} = <0.05%) as given in CIRIA SP200, Table 3.1, and illustrated in Figure 8 below.

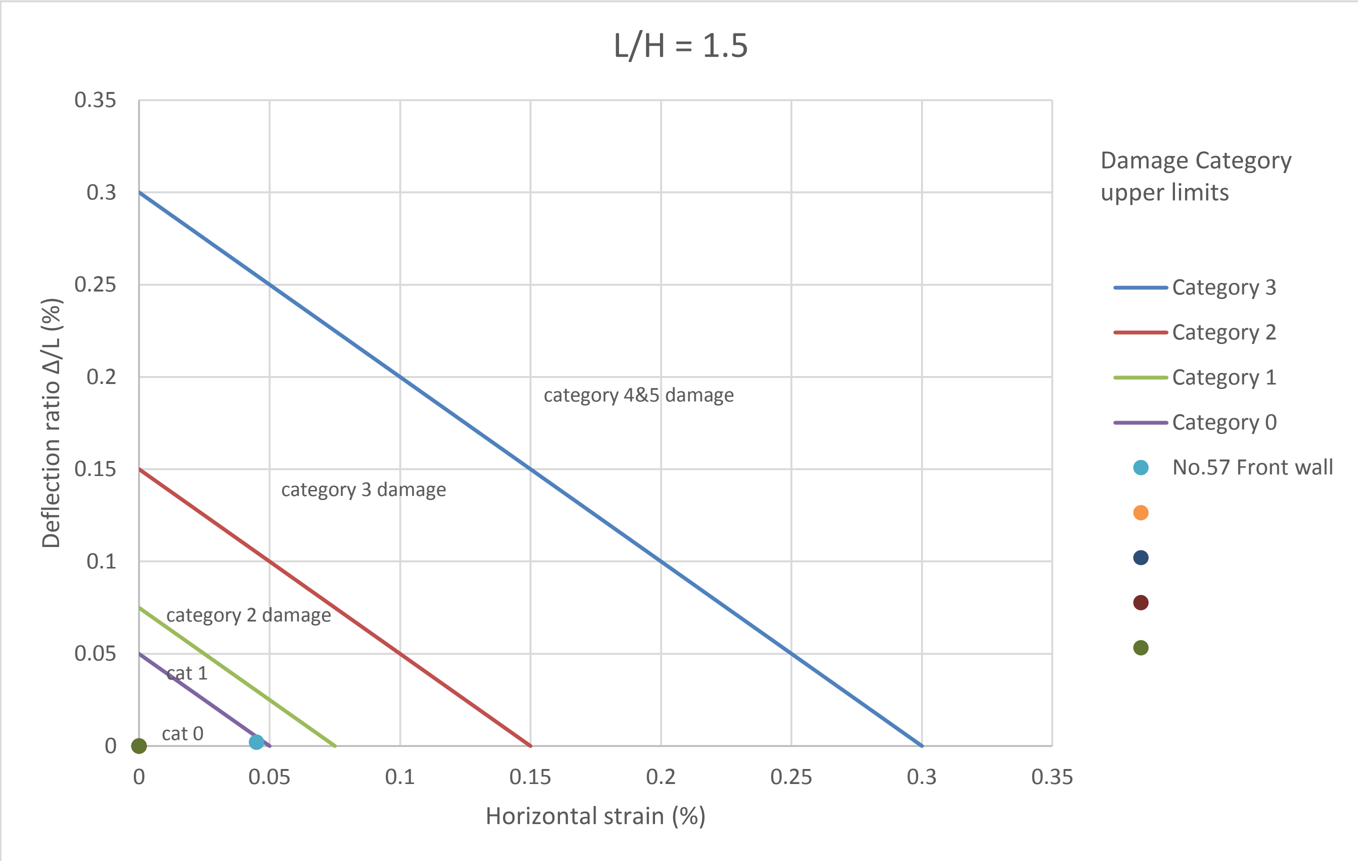


Figure 8: Damage category assessment for front wall of No.57, the critical location.

10.6.7 Use of best practice construction methods, as outlined in paragraphs 10.4.5 to 10.4.8, will be essential to ensure that the ground movements are kept in line with the above predictions.

10.7 Monitoring

10.7.1 Condition surveys should be undertaken of the neighbouring properties before the works commence, in order to provide a factual record of any pre-existing damage. Such surveys are usually carried out while negotiating the Party Wall Award and are beneficial to all parties concerned.

10.7.2 Precise movement monitoring should be undertaken weekly throughout the period during which the basement walls and slab are constructed with initial readings taken before excavation of the basement starts. Readings may revert to fortnightly once all the perimeter walls and the basement slab have been completed. This monitoring should be undertaken with a total station instrument and targets attached at the following locations:

- internally, on both party walls at three uniformly spaced positions;
- externally, at two levels on the front and rear walls to No's 53 and 57 on the centrelines of the party walls;
- at the client's discretion, since outside the Party Wall Agreement, it would also be sensible to monitor the middle of the front and rear walls to No.55.

10.7.3 The accuracy of this system of monitoring is usually quoted as +/- 2mm. Thus, if recorded movements in either direction reach 5mm, then the frequency of readings should be increased as appropriate to the severity of the movement, and consideration should be given to installing additional targets. If the recorded movements in either direction reach 7mm, then work should stop until new method statements have been prepared and approved by the appointed structural engineer.

10.7.4 If any structural cracks appear in the main loadbearing walls, then those cracks should be monitored using the Demec system (or similar) on the same frequency as the target monitoring.

10.8 Surface Flow and Flooding

<u>Flooding from Rivers, Sea & Reservoirs:</u>

10.8.1 The evidence presented in Section 5 has shown that:

- the site lies within the Environment Agency's Flood Zone 1 which means that it is considered to be at negligible risk of fluvial flooding (from rivers or sea);
- the area is not at risk of flooding from reservoirs, as mapped by the Environment Agency;
- there are no flood defences, no areas benefitting from flood defences and no flood storage areas within 250m of the site.

Change in Paved Surfacing & Surface Water Run-off:

10.8.2 The proposed lightwells will be wholly within areas which are paved with the exception of a very small area of flower bed in the front garden alongside the 53/55 boundary. Two surface water gullies were evident in the front garden of the property, so it is likely that water from some of the paved surfaces is already discharged to the combined sewer. This facility should be maintained.

10.8.3 Infiltration of surface water will be limited because the underlying soils are predominantly clays.

10.8.4 The slight loss of soft landscaping should be offset (mitigated against) either by permanently removing an equivalent area of paved surfacing elsewhere, or by the inclusion of one or more appropriate Sustainable Drainage Systems (SuDS) in the scheme, such as:

- Intervention storage;
- Rainwater harvesting;
- Use of permeable paving.

Surface Water (Pluvial) Flooding:

10.8.5 The evidence presented in Section 5 has shown that:

- there are no surface water features within 250m of the site;
- Ornan Road was affected by the surface water flooding during the 2002 event, but not in 1975, though this was probably downslope of No.55 in the area the Environment Agency's (2014) model predicts an increased risk of flooding;
- the only 'river' within 500m of the site is a culvert at 93m to the east of the site which is believed to carry the former river Fleet (one of the 'lost' rivers of London); that culvert is very unlikely to be relevant to the proposed basement;
- the latest flood modelling by the Environment Agency appears to show a 'Very Low' risk of surface water flooding (the lowest category, which represents the national background level of risk) for No.55 and the adjoining houses (see Figure 6).

10.8.6 In view of the 'Very Low' risk of surface water flooding predicted by the Environment Agency, only basic flood resistance measures will be required to protect the basement from local surface water flooding, including:

1. Provision of upstands around the proposed lightwells at the front and rear of the house;
2. Installation of suitably raised thresholds at the doorways into the basement from the lightwells.

Sewer Flooding:

10.8.7 Thames Water has no records of flooding from public sewers affecting No.55 (see 5.8). However, no drainage system can be guaranteed to have adequate capacity for all storm eventualities and all drainage systems only work at full capacity when they are properly maintained, including emptying gullies and regular checks of the sewers themselves for condition and blockages. Maintenance of the adopted sewers is the responsibility of Thames Water, so is outside both the Applicant's and the Council's control. The probability of future sewer flooding affecting No.55 is considered to be very low, provided that the sewer system is well maintained and appropriate flood resistance measures are implemented, as set out below.

10.8.8 Drainage systems are designed to operate under 'surcharge' at times of peak rainfall, which means that the level of effluent in the sewers may rise to ground level. When this happens the effluent can back-up into un-protected properties with basements or lower ground floors. During major rainfall events it is possible for some sewers to overflow at ground level, though this is rare.

10.8.9 Non-return valves and/or pumped above ground loop systems must therefore be fitted on the drains serving the basement and the lightwells, in order to ensure that water from the mains sewer system cannot enter the basement when the adjacent sewer is operating under surcharge. All drains which discharge via the same outfall as the basement must be protected, including those carrying roof water and foul water. A battery powered reserve pump should be fitted to ensure that the system remains functional during power cuts.

10.8.10 If non-return valves are used without an above-ground loop, then no effluent would at times be able to enter the mains sewer system when the flow in that sewer is sufficient to close the valves. The basement could then be vulnerable to flooding via the gullies in the lightwells and/or other low entry points on the drainage system within the basement. Sufficient temporary interception storage would therefore be required to hold temporarily the predicted maximum volume of water from all relevant sources which discharge via the valve-protected outfall (surface water from roof, paved areas and lightwells, and foul water) for the duration of the predicted surcharged flows in the sewer. This temporary interception storage would require formal design to ensure satisfactory performance.

10.8.11 If a non-return valve is fitted with an above-ground loop, then the loop must rise high enough above ground level to create sufficient pressure head to open the valve when the sewer flow is surcharged to ground level, otherwise the basement would once again be vulnerable to flooding while the surcharged flow continues. If it is not possible to achieve a sufficient rise of the loop above ground level, then temporary interception storage should be provided as recommended above.

10.9 Mitigation

10.9.1 The following mitigation measures have been recommended in Sections 10.2-10.8:

- In the unlikely event that the basement excavations encounter a local deposit of more permeable soils, of sufficient thickness to permit significant flow, then an engineered groundwater bypass should be provided (10.2.4).
- Cracks in load-bearing walls which have weakened their structural integrity should be fully repaired, in accordance with recommendations from the appointed structural engineers, before any underpinning is carried out (10.4.4).
- Subject to Party Wall Award negotiations, transitional underpinning blocks should be included beneath the adjoining walls to No.57 (10.4.12).
- Provision of upstands around the proposed lightwells, and the doorways into the basement in the lightwells should have raised thresholds (10.8.6).
- Non-return valves and/or above ground loop systems should be fitted to the drains serving the basement and lightwell, in order to ensure that water from the sewer system cannot enter the basement when the mains sewer is operating under surcharge (see paragraphs 10.8.9 to 10.8.11).

11. Non-technical Summary – Stage 4

11.1 This summary considers only the primary findings of this assessment; the whole report should be read to obtain a full understanding of the matters considered.

11.2 A services search should be undertaken for any tunnelled/deep utilities (10.1.3).

11.3 The proposed basement is considered acceptable in relation to the likely negligible groundwater flow in the natural strata, while flow in the Made Ground will only occur where service trenches or granular pipe bedding permits any perched groundwater to flow (10.2.1 to 10.2.3).

11.4 In the unlikely event that the basement excavations encounter a local deposit of more permeable soils of sufficient thickness to permit significant flow, then an engineered groundwater bypass would be required (10.2.4).

11.5 The basement will need to be fully waterproofed. Provisional design groundwater levels equal to ground level (short-term) and 0.5m below ground level (long-term) are proposed, which means that the basement must be able to resist buoyant uplift pressures (un-factored) of up to 385kN/m^2 (10.2.5 to 10.2.7).

11.6 Water entries into the basement excavations are likely to be manageable by sump pumping (10.3.1). The clays onto which the underpins and the basement slab will bear must be blinded with concrete immediately following excavation and inspection (10.3.3 and 10.4.11).

11.7 There are no concerns regarding slope stability (10.4.1).

11.8 The basement is expected to be constructed using underpinning techniques. A high quality of workmanship and best practice methods of construction and temporary support will be crucial to the satisfactory control of ground movements. Requirements for temporary support are summarised (10.4.2 to 10.4.7).

11.9 Various other guidance is provided in relation to the geotechnical design of the basement's perimeter walls (10.4.9, 10.4.10).

11.10 Transitional underpins should be considered, subject to agreement under the Party Wall Act negotiations, for all load-bearing walls in No.55 which adjoin No.57 (10.4.12).

11.11 Analyses have been undertaken using PDISP software of the likely heave/settlement in response to the net changes in vertical stress resulting from the construction of these basements. The perimeter walls were predicted to undergo 3mm to 14mm of heave (see Table 4). The soils beneath the basement floor were predicted to experience up to 13mm of heave, although the RC floor slabs will only experience the post-construction incremental heave of up to about 5mm (Section 10.5).

11.12 A preliminary damage category assessment indicated that, under the worst case scenario, damage to No.57 is likely to fall within Burland Category 0, 'negligible', owing to beneficial heave from the vertical unloading largely off-setting the settlements from relaxation of the ground alongside the excavations (Section 10.6).

11.13 Condition surveys of the neighbouring properties should be commissioned, and a programme of monitoring the adjoining structures should be established before the works start (Section 10.7).

11.14 The Environment Agency's maps show that the site is at negligible risk of flooding from rivers or the sea, and at no risk of flooding from reservoirs (10.8.1).

11.15 The proposed basement scheme will potentially result in a slight increase in paved surface area. Use of one or more SuDS system is recommended to mitigate this increase; suitable types of SuDS are listed (10.8.2 to 10.8.4).

11.16 While part of Ornan Road is recorded as having flooded during the 2002 event, it was probably restricted to a small area downslope of No.55, and the road did not flood in 1975 (10.8.5). The latest flood modelling by the Environment Agency gave a 'Very Low' risk of flooding by surface water to No.55's site; this is the lowest, national background level of risk. Appropriate flood mitigation precautions to thresholds/lightwells are recommended (10.8.6).

11.17 Non-return valves and/or above ground loop systems should be fitted to the drains serving the basement and the lightwell. Temporary interception storage may also be required (10.8.9-10.8.11).

11.18 The mitigation measures recommended in various parts of Sections 10.2 to 10.8 have been summarised in Section 10.9.

APPENDIX A

Photographs

Photo 1: Front elevation (street scene) looking south. No.55 Ornan Road is a two storey terraced house. No.51 was build at a latter date to No's 53-57, hence is not of similar character. Note the south-westwards fall of the Ornan Road carriageway.

Photo 2: Front elevation. Both No.55 and the adjoining No.57 originally had single storey garages, however in-fill extensions were constructed on top of these.

Project:

55 Ornan Road, London, NW3 4QD

15406

GabrielGeo Consulting

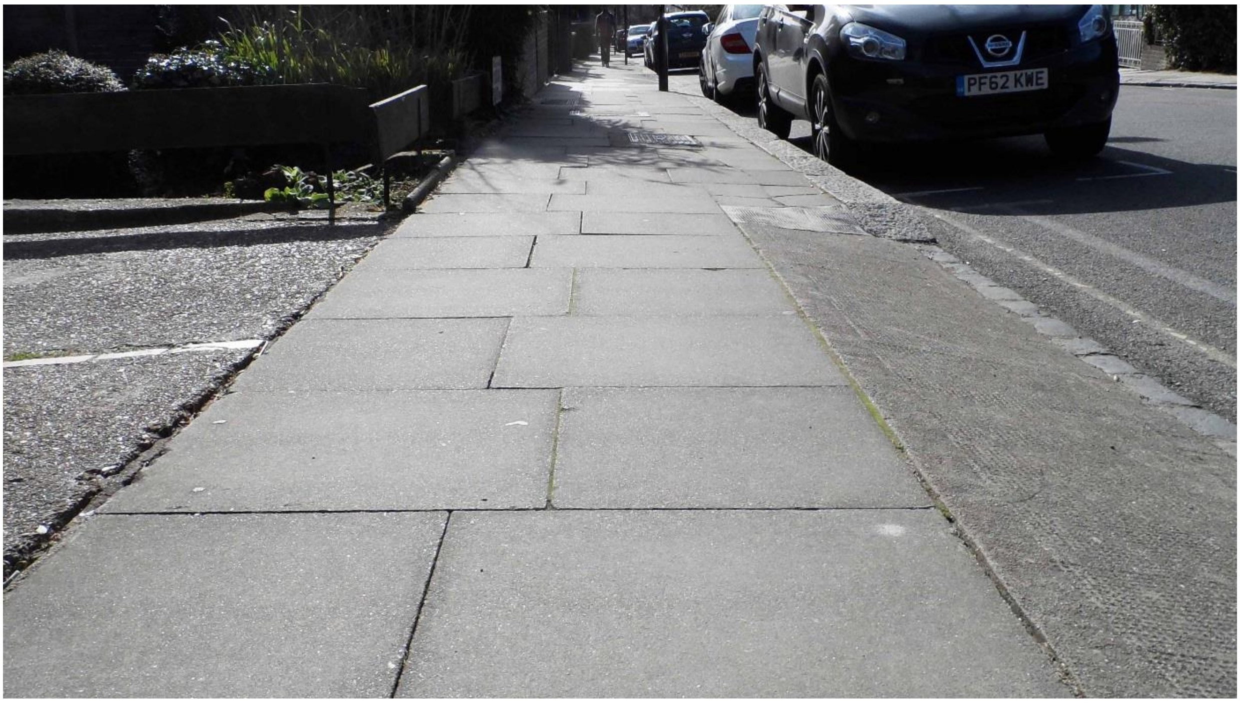


Photo 3: The footway falls gently towards the carriageway in front of the property, and falls more steeply towards the carriageway in front of the driveway.

Photo 4: The front garden to No.55 sits below the height of the footway and adjacent driveway. It is bounded by a low curb where it meets the footway, except at its access point.

Title:	**Photographs - Sheet 2**			Sheet	**A2**
Date:	10 March 2015	Checked: AG	Approved: KRG	Scale :	NTS

Project:

55 Ornan Road, London, NW3 4QD

15406

Photo 5: Concrete manhole cover within the front garden, indicating the possible position of a lateral sewer. Note gully in pebbled area near boundary.

Photo 6: The rear garden to No.55 is mostly laid to lawn with a small patio area adjacent to the house. Like the first floor extension above the garage, the rear conservatory is a latter addition.

Title:	**Photographs - Sheet 3**					Sheet	**A3**
Date:	10 March 2015	Checked:	AG	Approved:	KRG	Scale :	NTS

APPENDIX B

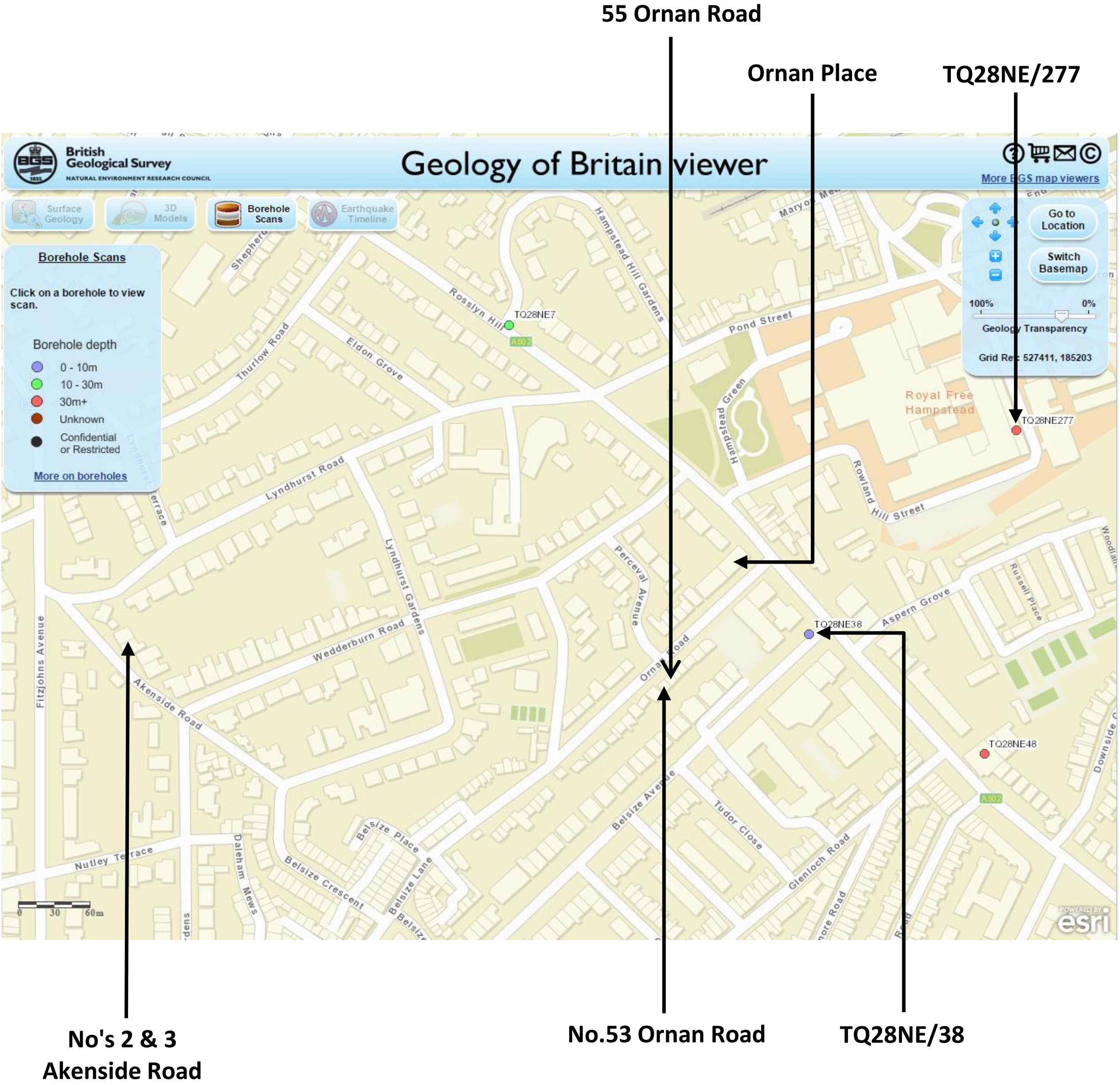
Desk Study Data – BGS Boreholes

Project:

55 Ornan Road, London, NW3 4QD

15406

GabrielGeo Consulting



Title:	**Location Plan of BGS and other Boreholes**			Sheet	**B1**
Date:	March 2015	Checked: AG	Approved: KRG	Scale :	NTS

Eastern-L.S. Thames E.A.

ROYAL FREE HOSPITAL 256 | TQ 28/198 | TQ28/NE277

Owner ROYAL FREE HAMPSTEAD NHT	Licence No.	Nat. Grid Ref. TQ 2739 8538		
Occupier " "	IGS Ref. No.	Status OBH		
Ground Level	m OD	ft. OD	Aquifer UPPER CHALK	
Level of Well Top 59.280	m OD	ft. OD		
Rest Water Level 95.65	m bwt	ft. bwt		
(Date 26/7/99)	m OD	ft. OD		

Summary of Geological Section

Summary of Geological Section	Thickness m	Depth m
LONDON CLAY	69	69
W&RB	21	90
Thanet Sands	11	101
UPPER CHALK	76	177

Construction

Depth bwt m	Dia. mm	Linings (below well top) From	To m	Dia mm	Type
114	300	0	114	200	plain
177	200				

Abstraction Rates — gph — gpd

Type of Pump

Chem./Bact. Anal. YES NO

Well Driller Soil Mechanics

If insufficient space has been allowed, continue in 'Notes' overleaf.

GEOLOGICAL SURVEY OF GREAT BRITAIN

RECORD OF SHAFT OR BORE FOR MINERALS

(For Survey use only)

6-inch Map Registered No. TQ28NE/38

Name of Shaft or Bore given by Geological Survey:

Name and Number given by owner: C16.

Nat. Grid Reference 2722.8520

For whom made

Town or Village Hampstead. County

Exact site Junction of Belsize Av. and Haverstock Hill. (Attach a tracing from a map, or a sketch-map, if possible.)

1" N.S.Map No.	1" O.S.Map No.	Confidential or not
256		

Purpose for which made

Ground Level at shaft/bore relative to O.D. 234' If not ground level give O.D. of beginning of shaft/bore

Made by Date of sinking 1900.

Information from LCC. Date received

Examined by

SPECIMEN NUMBERS AND ADDITIONAL NOTES

(For Survey use only) Geological Classification	DESCRIPTION OF STRATA	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
MGR	Made Ground	4	-		1.22
LC	Clay	16	-	20	- 6.10
	For Hampstead Tube Rly.				

(5412) Wt.32837/PS.154 2m 10/64 G.W.B.Ltd. Gp.863

3.0 EXISTING SITE INVESTIGATION DATA

3.1 Records of site investigations

Ground conditions at the site were investigated by Site Analytical Services Limited in December 2014 (SAS Report Reference 14/22714). The ground conditions revealed by the investigation are summarised in the following table.

Strata	Depth to top of strata (mbgl)	Depth to base of strata (mbgl)	Description
Made Ground	0.00	0.70 to 0.90	Surface layer of a stone slab or grass surface overlying silty gravelly fine sand and topsoil with brick and concrete fragments.
Claygate Member	0.70 to 0.90	4.00 to 4.60	Stiff to very stiff high strength becoming very high strength mottled orange/brown silty sandy clay.
London Clay Formation	4.00 to 4.60	8.00 (maximum depth of drilling)	Very stiff high strength becoming very high strength fissured silty clay with occasional partings of silty fine sand and scattered gypsum crystals

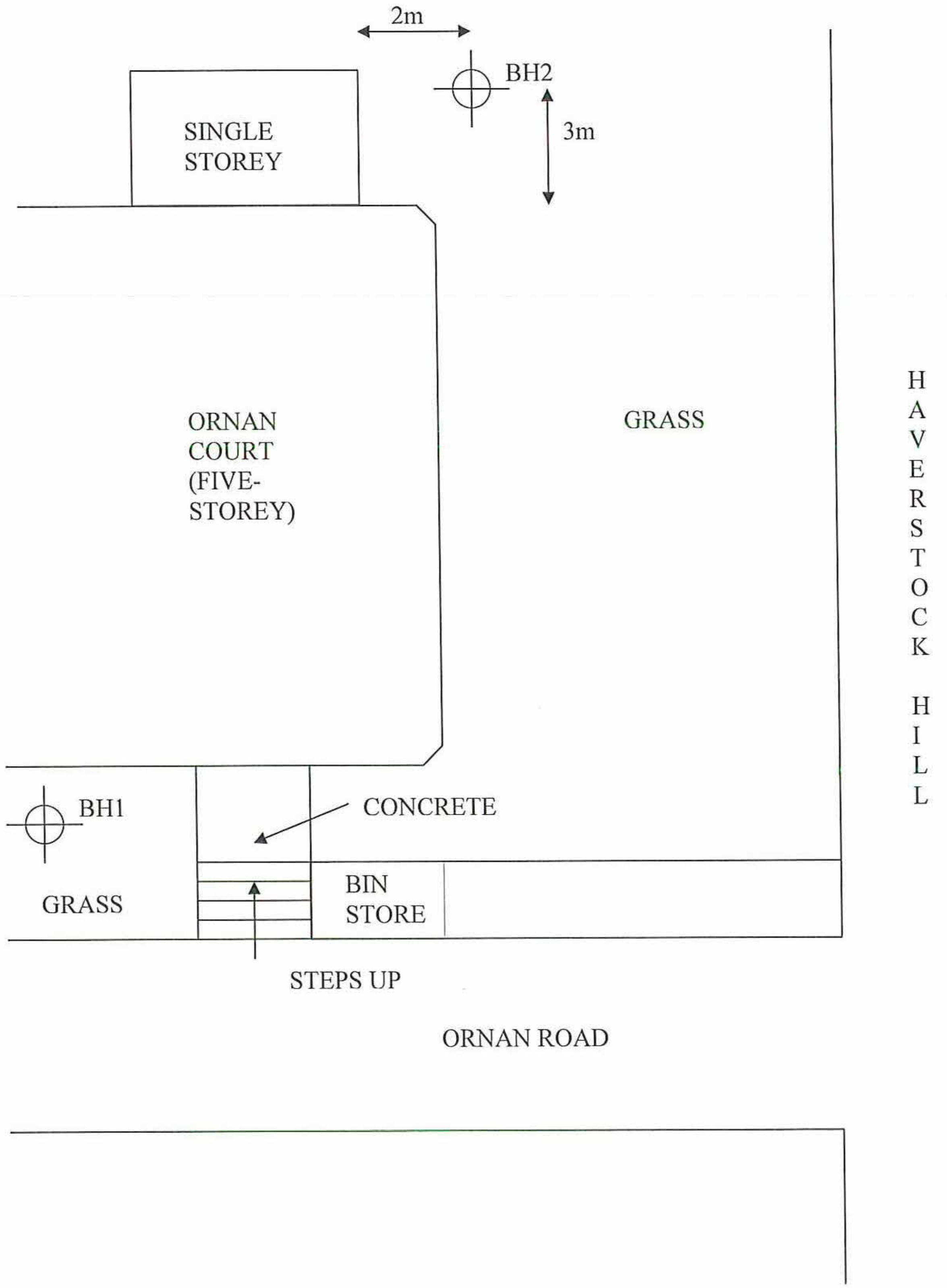
Groundwater was encountered as a seepage at a depth of 4.00m below ground level in Borehole 2, but was not encountered within Borehole 1.

Groundwater was subsequently found to have stabilised at respective depths of 2.68m and 1.85m below ground level in the monitoring standpipes placed in Boreholes 1 and 2 after a period of approximately five weeks.

In order to assess the soil infiltration characteristics of the natural superficial soils at the site, an in-situ rising head permeability test was carried out in Borehole 2 using the procedures recommended in BS 5930 (2007).

The results of the in-situ permeability test indicate an apparent permeability or soil infiltration rate of 6.29×10^{-6} m/sec. This soil infiltration rate lies within the range of published data for fissured and weathered clays and very fine or silty sands and is classed as being low permeability material with good to poor drainage characteristics.

Site Analytical Services Ltd.	REF: 11/17802
LOCATION: Ornan Court, 2 Ornan Road, London, NW3 4PT	FIG: 1
TITLE: Sketch Site Plan DATE: March 2011	SCALE: NTS



Site Analytical Services Ltd.

Site	Borehole Number
ORNAN COURT, 2 ORNAN ROAD, LONDON, NW3 4PT	BH1

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
CONTINUOUS FLIGHT AUGER	100mm cased to 0.00m		ORNAN COURT LIMITED	1117802
	Location	**Dates**	**Engineer**	**Sheet**
	TQ 271 852	31/03/2011	MARTIN REDSTON ASSOCIATES	1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
						(0.40)	MADE GROUND : grass over dark brown clayey silty sand with flint gravel and brick fragments		
0.25	D1					0.40			
0.50	D2					(0.40)	MADE GROUND : firm to stiff dark brown and orange brown silty clay with occasional flint gravel and brick fragments		
0.50	V1 80								
						0.80			
0.75	D3						Stiff becoming stiff to very stiff brown and mottled orange brown and veined blue grey silty CLAY with occasional partings of light brown silty fine sand, scattered small gypsum crystals, roots up to 2mm diameter above 1.30m depth and rootlets above 1.90m depth		
0.75-1.05	M1 40/300								
1.00	D4								
1.00	V2 81								
1.50	D5								
1.50	V3 140+								
2.00	V4 130								
2.00	D6								
2.50	V5 140+								
2.50	D7								
						(4.20)			
3.00	D8								
3.00	V6 140+								
3.50	D9								
3.50	V7 140+								
4.00	D10								
4.00	V8 140+								
4.50	D11								
4.50	V9 140+								
5.00	D12					5.00			
5.00	V10 140+			31/03/2011:DRY			Complete at 5.00m		

Remarks
Groundwater was not encountered during boring
D = Disturbed Sample
M = Mackintosh Probe - Blows/Penetration (mm)
V = Vane Test - Result in kPa

Scale (approx)	Logged By
1:40	APS

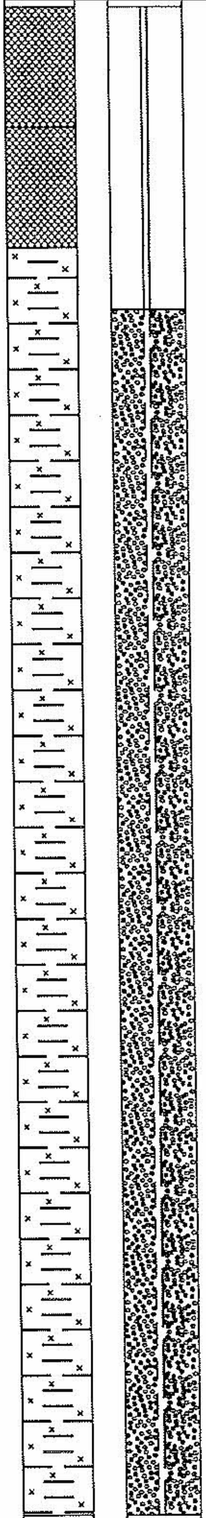
Figure No. 1117802.BH1

Site Analytical Services Ltd.

Site	Borehole Number
ORNAN COURT, 2 ORNAN ROAD, LONDON, NW3 4PT	BH1

Installation Type	Dimensions	Client	Job Number
MONITORING STANDPIPE	Internal Diameter of Tube [A] = 50 mm Diameter of Filter Zone = 100 mm	ORNAN COURT LIMITED	1117802

Location	Ground Level (mOD)	Engineer	Sheet
TQ 271 852		MARTIN REDSTON ASSOCIATES	1/1



Legend	Water	Instr (A)	Level (mOD)	Depth (m)	Description
					Bentonite Seal
				1.00	
					Slotted Standpipe
				5.00	

Groundwater Strikes During Drilling

Date	Time	Depth Struck (m)	Casing Depth (m)	Inflow Rate	Readings 5 min	10 min	15 min	20 min	Depth Sealed (m)

Groundwater Observations During Drilling

Date	Start of Shift					End of Shift				
	Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)	Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)
31/03/11				DRY			5.00		DRY	

Instrument Groundwater Observations

Inst. [A] Type : SINGLE STANDPIPE

Date	Instrument [A]			Remarks
	Time	Depth (m)	Level (mOD)	
06/04/11		2.35		Gas readings taken
12/04/11		2.39		Gas readings taken
20/04/11		2.31		Gas readings taken

Remarks
Lockable cover set in concrete
Gas valve fitted

Site Analytical Services Ltd.

Site	Borehole Number
ORNAN COURT, 2 ORNAN ROAD, LONDON, NW3 4PT	BH2

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
CONTINUOUS FLIGHT AUGER	100mm cased to 0.00m		ORNAN COURT LIMITED	1117802
	Location	**Dates**	**Engineer**	**Sheet**
	TQ 271 852	31/03/2011	MARTIN REDSTON ASSOCIATES	1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.25	D1					(0.60)	MADE GROUND : grass over dark brown silty sand with flint gravel and brick fragments		
0.50 0.50-0.80 0.75	D2 M1 36/300 D3					0.60 (0.40)	MADE GROUND : firm becoming firm to stiff dark brown and mottled orange brown and grey silty clay with occasional flint gravel, brick and concrete fragments		
1.00 1.00	D4 V1 82					1.00	Stiff becoming stiff to very stiff brown and mottled orange brown and veined blue grey silty CLAY with occasional partings of light brown silty fine sand, scattered small gypsum crystals and roots up to 1mm diameter above 1.10m depth		
1.50 1.50	D5 V3 140+								
2.00 2.00	V4 136 D6								
2.50 2.50	V5 140+ D7								
3.00 3.00	D8 V6 140+					(4.00)			
3.50 3.50	D9 V7 140+								
4.00 4.00	D10 V8 140+								
4.50 4.50	D11 V9 140+								
5.00 5.00	D12 V10 140+			31/03/2011:DRY		5.00			
							Complete at 5.00m		

Remarks
V = Vane Test - Result in kPa
M = Mackintosh Probe - Blows/Penetration (mm)
D = Disturbed Sample
Groundwater was not encountered during boring

Scale (approx)	Logged By
1:40	APS

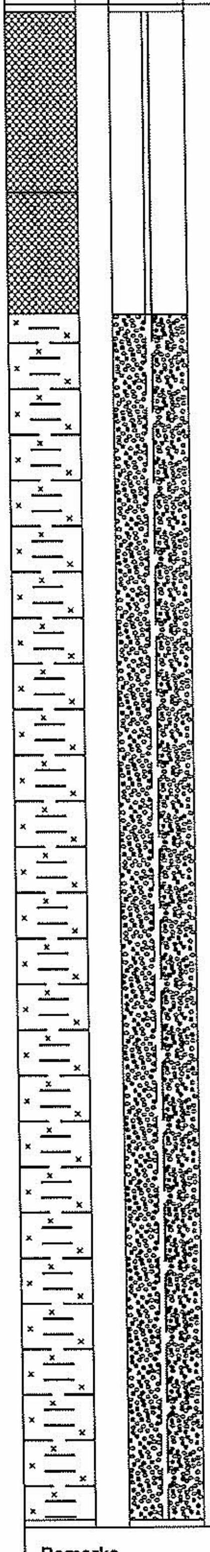
Figure No. 1117802.BH2

Site Analytical Services Ltd.

Site	Borehole Number
ORNAN COURT, 2 ORNAN ROAD, LONDON, NW3 4PT	BH2

Installation Type	Dimensions	Client	Job Number
MONITORING STANDPIPE	Internal Diameter of Tube [A] = 50 mm Diameter of Filter Zone = 100 mm	ORNAN COURT LIMITED	1117802

Location	Ground Level (mOD)	Engineer	Sheet
TQ 271 852		MARTIN REDSTON ASSOCIATES	1/1



Legend	Water	Instr (A)	Level (mOD)	Depth (m)	Description
				1.00	Bentonite Seal
				5.00	Slotted Standpipe

Groundwater Strikes During Drilling

Date	Time	Depth Struck (m)	Casing Depth (m)	Inflow Rate	Readings 5 min	10 min	15 min	20 min	Depth Sealed (m)

Groundwater Observations During Drilling

Date	Start of Shift					End of Shift				
	Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)	Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)
31/03/11				DRY			5.00		DRY	

Instrument Groundwater Observations

Inst. [A] Type : SINGLE STANDPIPE

Date	Instrument [A]			Remarks
	Time	Depth (m)	Level (mOD)	
06/04/11		3.49		Gas readings taken
12/04/11		3.40		Gas readings taken
20/04/11		3.49		Gas readings taken

Remarks
Lockable cover set in concrete
Gas valve fitted

APPENDIX C

Factual Report on Ground Investigation by Herts & Essex Site Investigations

HERTS & ESSEX SITE INVESTIGATIONS

The Old Post Office, Wellpond Green, Standon,
Ware, Herts, SG11 1NJ

Telephone : Ware (01920) 822233
Fax: Ware (01920) 822200

12th February 2015

Our Ref : MRS/12571

Neale & Norden Consultants
17 Dartmouth Park Avenue
London
NW5 1LJ

For the attention of N. Norden Esq.:.

Dear Sir,

Re: 55 Ornan Road, London NW3 4QD : Site Investigation

1.0 Introduction

1.01 In accordance with your instructions, we visited the above site during February 2015 .

1.02 The purpose of our visit was to carry out an investigation into the subsoil conditions with a view to foundation design.

1.03 The comments and opinions expressed are based purely on the conditions encountered and the subsequent laboratory testing.

1.04 Therefore, it is possible that some special conditions prevailing on site have not been encountered or taken into account.

1.05 All ground water recordings or their absence relate to short term observations and do not allow for fluctuations due to seasonal or other effects.

2.0 Description of Site

2.01 The site is situated at 55 Ornan Road, London NW3 .

2.02 At the time of our visit the site was generally flat.

3.0 Fieldwork

3.01 Two boreholes were sunk to a maximum depth of 5.00m by means of a window sampler drilling rig.

3.02 The location of the works is indicated on the site plan forming appendix one.

3.03 The various strata and details encountered were noted and are recorded on the borehole logs forming appendix two.

3.04 Insitu strength tests were carried out in the boreholes, the results of which can be seen on the aforementioned logs.

3.05 A full range of samples were recovered as noted and retained for subsequent laboratory testing.

3.06 The location, type and height of any trees should be taken from a survey for later use with NHBC Chapter 4.20, if required.

4.0 Laboratory Testing

4.01 All samples were tested in accordance with BS:1377:1990 Methods of Test for Soils for Civil Engineering purposes.

4.02 Selected samples were tested to determine their atterberg limits, triaxial strength, soluble sulphate content and pH value.

4.03 The results of all laboratory testing are summarised in appendix three.

5.0 Conclusions and Recommendations

5.01 By inspection of the borehole logs it can be seen that the subsoil consists of a Paving Slab or Topsoil over Sandy Claybound Brick FILL to between 0.50 - 0.75m where a Firm Becoming Stiffer With Depth Orange Brown CLAY is encountered and present to the base of the excavations.

5.02 No water was encountered upon excavation of the boreholes as described on the borehole logs, however a standpipes installed at 5m in borehole one.

5.03 No significant roots were encountered in the boreholes beyond 0.60m.

5.04 Laboratory testing proved the clays to be of high to very high plasticity (PI=38 - 48%) which indicates a high susceptibility to movement associated with moisture content change.

5.05 Triaxial testing proved the CLAYS to have cohesion values between 46 - 121 Kn/m² these values are generally seen to increase with depth.

5.06 Therefore when considering the information available we are of the opinion that a the basement can take the form of a reinforced raft with walls designed to take the pressure of the retained soil. The sandy granular material will need to be battered back to stop caving or alternatively a piled solution may be more appropriate if no room is available.

5.07 Further investigation may be required in order to locate existing foundations within the area of the site which may restrict any future works.

5.08 As the site contains less than 0.50g/L of soluble sulphate it can be categorised as a class 1 site in accordance with BRE Digest, and as such any concrete in contact with the subsoil needs no special precautions.

We hope that this is satisfactory, however if you should require any further information, please do not hesitate to contact us.

Yours faithfully,

M. R. Smith M.Sc
Principal Engineer

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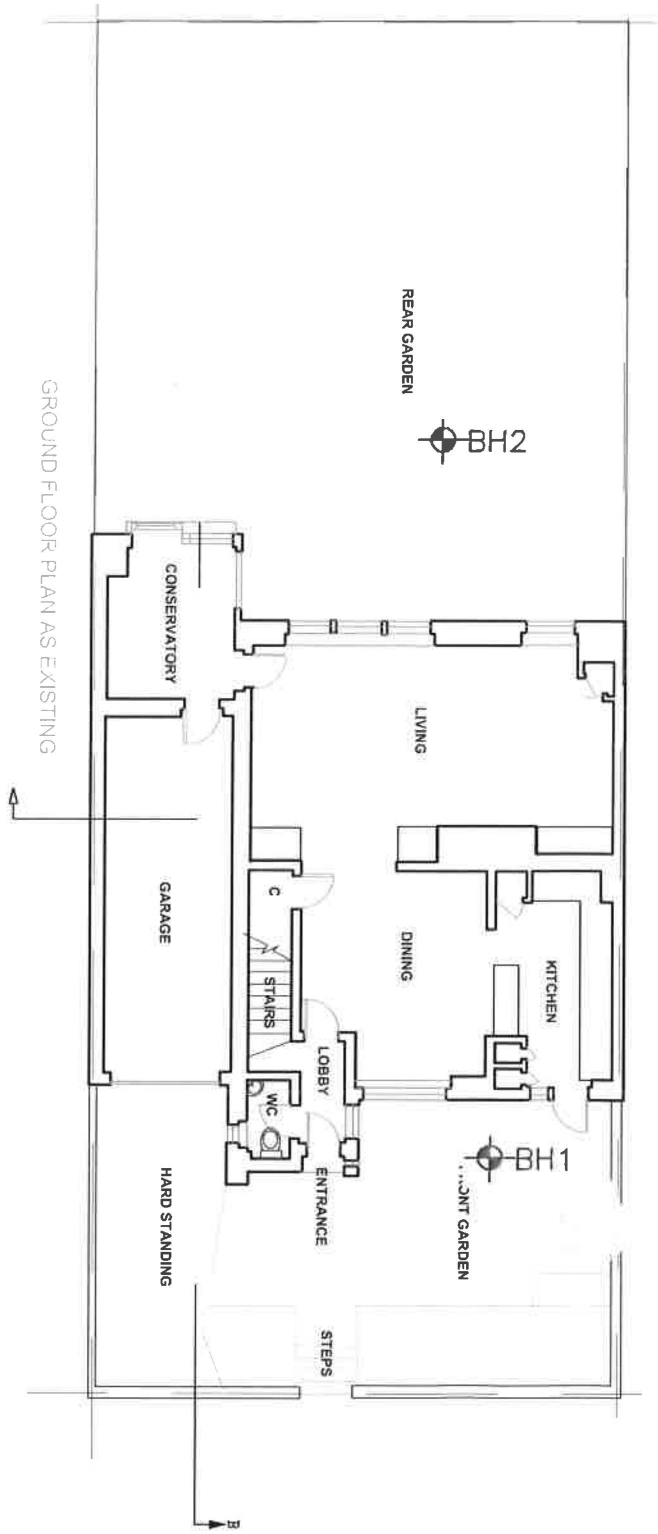
Appendix No. 1
Sheet No. 1
Job No. 12571
Date Feb 2015

55 Ornan Road, London NW3 4QD

Site Plan



Not to Scale

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Appendix No.	2
Sheet No.	1
Job No.	12571
Date	Feb 2015

55 Ornan Road, London NW3 4QD

Borehole One

Description of Strata	Depth	Reduced Level	Legend	Thickness (m)	Water Level	Samples No.	Samples Type	Samples Depth (m)	S.P.T N-Value or Vane Strength	Casing Depth (m)
Paving Slab Over Sandy Clay FILL	0.50			0.50	DRY	1	U	0.00		
Firm Becomming Stiff Orange Brown CLAY						2	U	1.00		1.00
						3	U	2.00		
				4.50		4	U	3.00		
						5	U	4.00		
	5.00					6	U	5.00		
Borehole Complete At 5.00m Standpipe Installed at 5.00m										

Remarks:

Scale 1:50

Key : U–Undisturbed Sample (100mm diameter) B –Bulk Sample ▼–Water Struck D –Disturbed Sample ▽–Water Standing W–Water Sample P–Piston Sample N–S.P.T. N–Value V–Vane Strength (kN/m²)

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Appendix No. 2
Sheet No. 2
Job No. 12571
Date Feb 2015

55 Ornan Road, London NW3 4QD

Borehole Two

Description of Strata	Depth	Reduced Level	Legend	Thickness (m)	Water Level	Samples No.	Samples Type	Samples Depth (m)	S.P.T N-Value or Vane Strength	Casing Depth (m)
Topsoil	0.25			0.25	DRY	1	U	0.00		
Sandy Claybound Brick FILL	0.75			0.50						
Firm Becomming Stiff Orange Brown CLAY				4.25		2	U	1.00		1.00
						3	U	2.00		
						4	U	3.00		
						5	U	4.00		
	5.00					6	U	5.00		
Borehole Complete At 5.00m										

Remarks:

Scale 1:50

Key : U–Undisturbed Sample (100mm diameter) B –Bulk Sample ▼–Water Struck D –Disturbed Sample ▽–Water Standing W–Water Sample P–Piston Sample N–S.P.T. N–Value V–Vane Strength (kN/m²)

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Appendix No. 3

Sheet No. 1

Job No. 12571

Date Feb 2015

LOCATION 55 Ornan Road, London NW3

LIQUID AND PLASTIC LIMIT TEST RESULTS

Borehole	Depth (m)	Sample	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Group Symbol	Desiccation Profile	Percentage Retained 425 Micron Sieve (%)
1	1.00	U	33	71	25	46	CV		0
1	3.00	U	32	72	25	47	CV		3
2	2.00	U	27	55	17	38	CH		0
2	5.00	U	34	73	25	48	CV		0

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Appendix No. 3

Sheet No. 2

Job No. 12571

Date Feb 2015

LOCATION 55 Ornan Road, London NW3

UNDRAINED COMPRESSION TEST RESULTS

Borehole	Depth (m)	Sample	Natural Moisture Content (%)	Bulk Density (Mg/m^3)	Lateral Pressure (kN/m^2)	Deviator Stress (kN/m^2)	Apparent Cohesion (kN/m^2)	Angle of Shearing Resistance	Remarks
1	1.00	U	33	1.96	20	114	57		
1	2.00	U	32	1.98	40	136	68		
1	3.00	U	32	1.99	60	130	65		
1	4.00	U	35	2.00	80	142	71		
1	5.00	U	32	2.03	100	242	121		
2	1.00	U	32	1.96	20	92	46		
2	2.00	U	27	1.98	40	160	80		
2	3.00	U	31	1.99	60	128	64		
2	4.00	U	36	2.00	80	136	68		
2	5.00	U	34	2.00	100	182	91		

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Appendix No. 3
Sheet No. 3
Job No. 12571
Date Feb 2015

LOCATION 55 Ornan Road, London NW3

SULPHATE ANALYSIS TEST RESULTS

Window Sampler	Depth (m)	Sample	Concentrations of Soluble Sulphate			Classification	pH
			Soil		Groundwater		
			Total SO_4 (%)	SO_4 in 2:1 water:soil (g/l)			
1	1.00	U		0.08			7.05
1	3.00	U		0.05			7.22
2	2.00	U		0.11			7.31

APPENDIX D

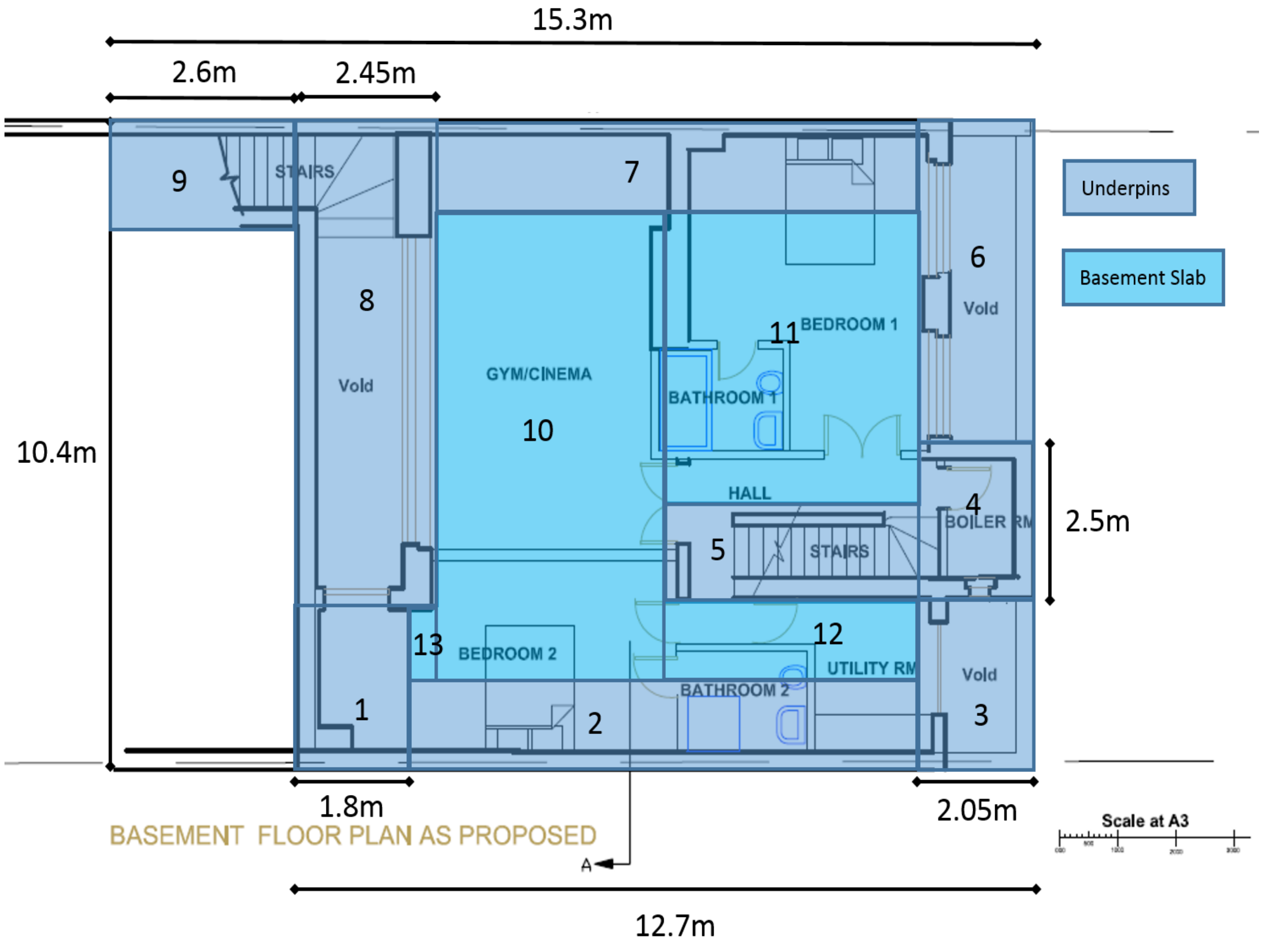
PDISP Heave/Settlement Analysis

Project:

55 Ornan Road, London, NW3 4QD

15406

GabrielGeo Consulting

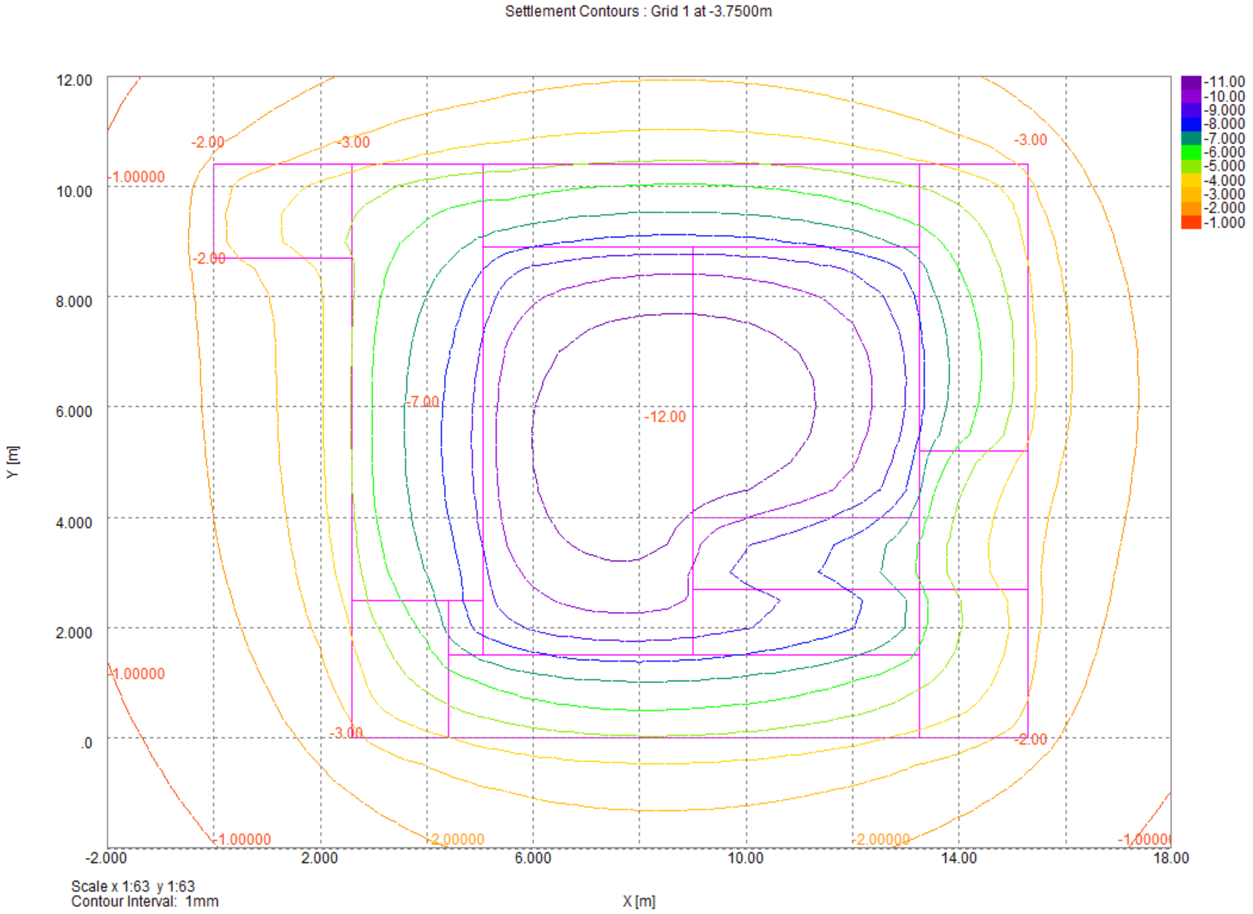


Title:	PDISP Zones			Figure:	D1
Date:	March 2015	Checked: AG	Approved: KRG	Scale :	NTS

Project:

55 Ornan Road, London, NW3 4QD

15406



Title: PDISP Contours - Stage 2

Figure: D2

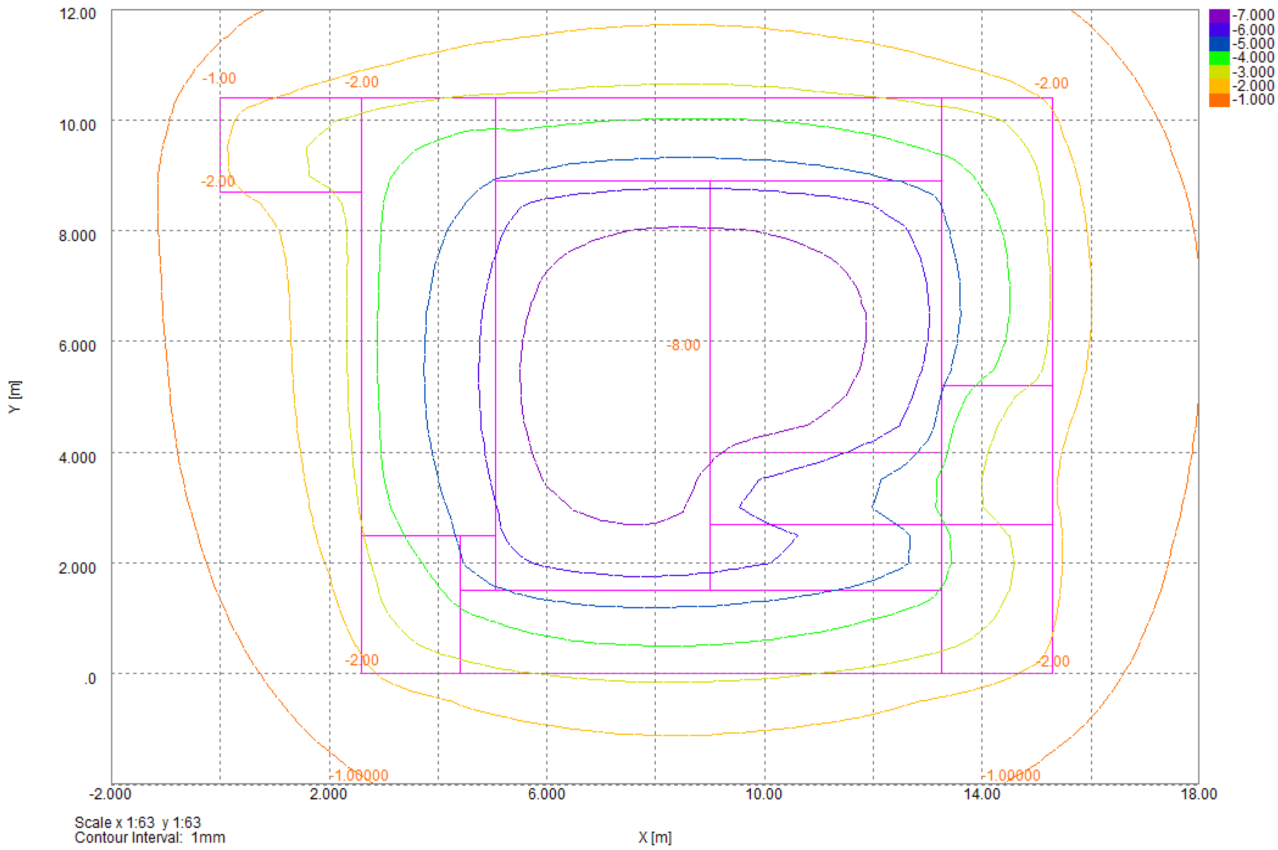
Date: March 2015 Checked: AG Approved: KRG Scale : NTS

Project:

55 Ornan Road, London, NW3 4QD

15406

Settlement Contours : Grid 1 at -3.7500m



Title: PDISP Contours - Stage 3

Figure: D3

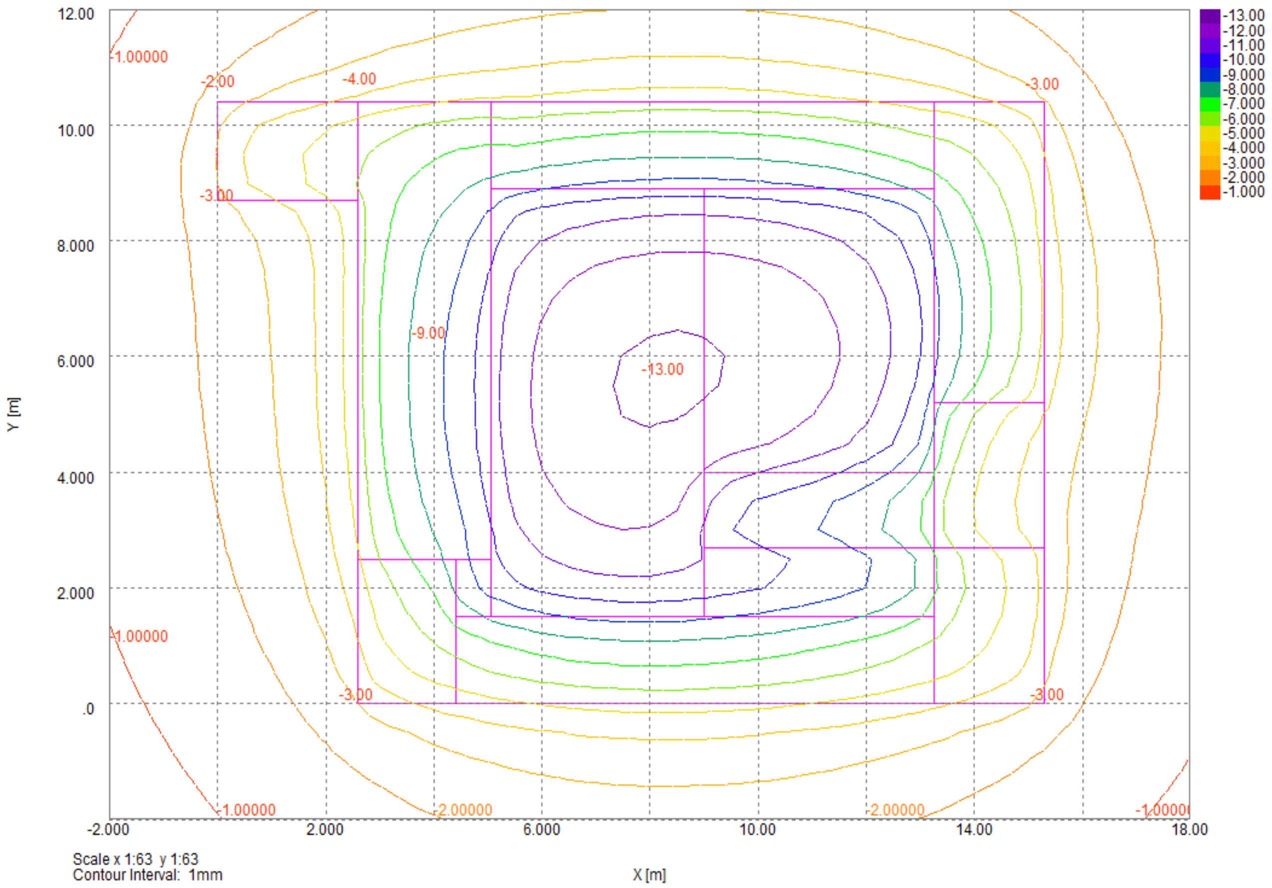
Date: March 2015 Checked: AG Approved: KRG Scale : NTS

Project:

55 Ornan Road, London, NW3 4QD

15406

Settlement Contours : Grid 1 at -3.7500m



Title: PDISP Contours - Stage 4

Figure: D4

Date: March 2015

Checked: AG

Approved: KRG

Scale : NTS