Chelmer
Consultancy Services
'Groundbreaking Services'

Basement Impact Assessment

Site	55 Greencroft Gardens
	South Hampstead
	NW6 3LL
Client	Spencer Garcia
Date	July 2015
Our Ref	BIA/5352

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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 Chelmer Site Investigation Laboratories Ltd.

This report is specific to the proposed site use or development, as appropriate, and as described in the report; Chelmer Site Investigation Laboratories 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.

1.0 INTRODUCTION

1.1 This Basement Impact Assessment has been prepared in support of a planning application to be submitted to the London Borough of Camden (LBC) for construction of a single-storey basement beneath Flat 2, No.55 Greencroft Gardens, NW6 3LL. 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 (who has specialised in slope stability and hydrogeology), and Mike Summersgill, a Chartered Civil Engineer and Chartered Water and Environmental Manager with an MSc degree in Soil Mechanics (geotechnical and hydrology specialist). Both authors have previously undertaken assessments of basements in several London Boroughs.

1.3 A preliminary site inspection (walk-over survey) of the house was undertaken on Monday 1st June 2015. Photos from that visit are presented in Appendix A. Desk study data have been collected from various sources including geological data, environmental data and historic maps from GroundSure which are presented in Appendices D, E and F. 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.

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

- **SIMON GOLDSTEIN ARCHITECTURE (SGA):**

Drg No. 15001/JA12_P_AL_001 rev.A	Existing Layouts
Drg No. 15001/JA12_E_S_001 rev.A	Existing Rear Elevation
Drg No. 15001/G200_P_AL_001 rev.A	Proposed Layouts (whole building)
Drg No. 15001/G200_P_AL_002 rev.B	Proposed Layouts (Flat 1 only)
Drg No. 15001/G200_E_S_001 rev.A	Proposed Rear Elevation
Drg No. 15001/G200_S_AA_001 rev.A	Proposed Section AA
Drg No. 15001/G200_S_BB_001 rev.A	Proposed Section BB

- **S.R.Brunswick (Structural Engineer):**

  Calculation sheets, including preliminary(?) retaining wall analysis.
  Load takedown annotated on plan.

This report should be read in conjunction with all the documents and drawings listed above.

1.5 Instructions to prepare this Basement Impact Assessment (BIA) was by email with attached purchase order form on 8th May 2015.

2.0 THE PROPERTY, TOPOGRAPHIC SETTING AND PLANNING SEARCHES

2.1 Flat 2, No.55 Greencroft Gardens is a ground floor flat within the rear of a substantial, four-storey, semi-detached house built of brickwork beneath a clay tiled roof, situated within the South Hampstead Conservation Area, in the London Borough of Camden. Greencroft Gardens is located between Canfield Gardens to the north, and Aberdare Gardens to the south, and can be accessed at its eastern and western ends where it joins Finchley Road (the A41) and Priory Road respectively. As shown in Figure 1, No.55 is situated on the south side of Greencroft Gardens, slightly to the west of its junction with Fairhazel Gardens, between the adjoining No.57 to the west, and No.53 to the east (see also Photo 1 in Appendix A). To the south, No.55 is bounded by the rear gardens of No's. 71 & 73 Aberdare Gardens.

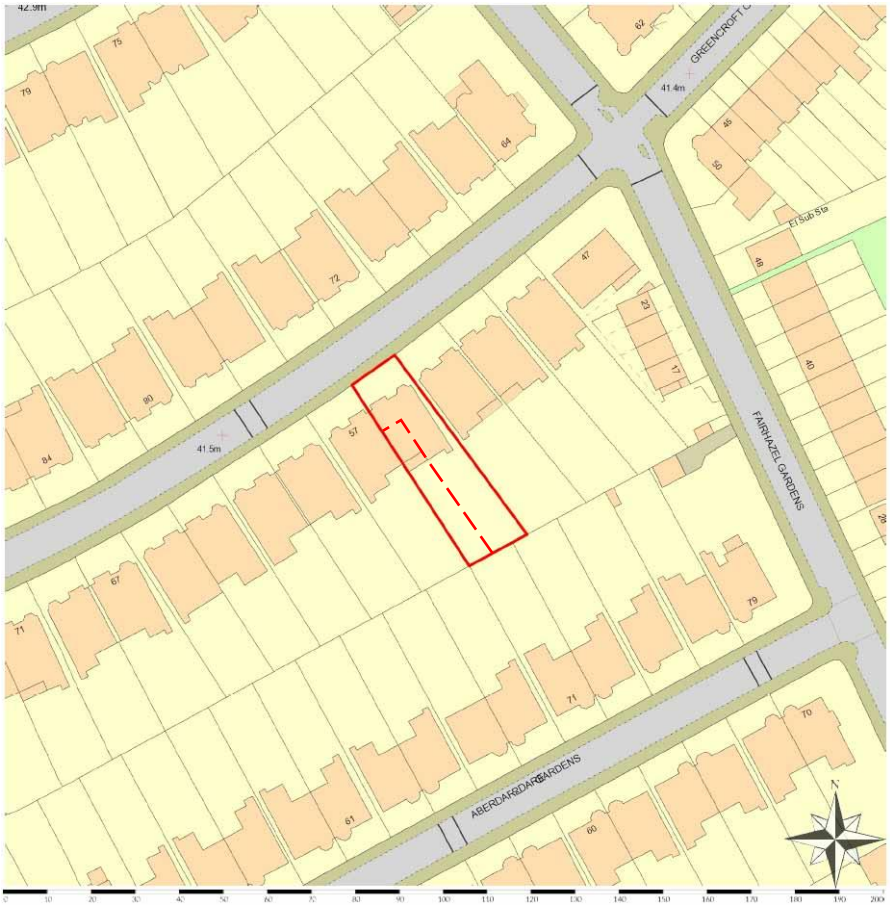


Figure 1: Extract from 1:1,250 OS map (not to scale) with No.55 outlined by the solid redline, and Flat 2 outlined approximately by the dashed red line.

2.2 Most of the houses in Greencroft Gardens are of a similar design. According to Elrington at al (1989) "*Ernest Estcourt and James Dixon, …, with T.K. Wells, built Canfield and Greencroft gardens, which by 1891 reached Fairhazel Gardens from its eastern junction with Goldhurst Terrace; some 68 houses and Rutland House flats were built in Greencroft Gardens, after 1891 extended to Priory Road, between 1886 and 1897*". Like the majority of properties on Greencroft Gardens, No.55 was subsequently divided into separate flats. There are two single-storey extensions to the rear of No.55, which form part of Flats 1 & 2 (see Photo 2), and beneath Flat 2 is a void which is currently in use as storage space (see planning search and Photo 4). Most of this void

has approximately 900mm of headroom, but at the northern end this increases to 1.77m (below the trap door entrance), and in the north-west corner increases again to 2.05m where a small bathroom has been installed.

2.3 Reference to the historic OS map dated 1871, shows the plot of No.55 Greencroft Gardens in the north-east corner of a field labelled No.413. The 1896 map shows that construction of the Greencroft Gardens carriageway had been completed prior to this date, however at that point in time No.55 had not been built. The map shows that construction of the houses on Greencroft Gardens began at its western end, and by the time the 1896 map was published No's 83 & 94 Greencroft Gardens had been completed. Similarly, construction on Aberdare Gardens was underway; however at this point in time, only those houses at the western end of the road had been constructed (up to No's. 21 & 23). By the time the 1915 OS map was published, all of the properties on Greencroft Gardens, Aberdare Gardens and Fairhazel Gardens had been completed.

2.4 Both the large and small scale historic OS maps show few significant changes in the area after this period of major development. The 1915 to 1965 OS maps show a greenhouse/conservatory where Flat 2's extension is now; that had been replaced with the extension by 1966, when the revisions for the 1971 map were undertaken.

2.5 The WW2 bomb map for the Borough of Hampstead shows that three high explosive bombs landed at the junction between Greencroft Gardens and Fairhazel Gardens to the east of No.55, and another landed to the west of the property, within the vicinity of No.75 Greencroft Gardens. There are no 'gaps' in bomb lines which might suggest that an unexploded bomb fell in No.55's garden, though this does not provide conclusive proof that the site is clear of unexploded ordnance. The London County Council Bomb Damage Map for this area indicates that No's 47 & 49 Greencroft Gardens, located at the junction between Fairhazel Gardens and Greencroft Gardens were 'Seriously damaged, but repairable at cost', however no other houses on Greencroft Gardens are indicated as having suffered any serious damage. This is reflected by the first available OS map after WW2 dated 1953, which showed the site of No.47 Greencroft Gardens as empty, before it was redeveloped prior to publication of the next available OS map dated 1965.

2.6 The front garden to No.55 consists of a small lawn area with a central pathway which slopes gently away from the property, and is bounded by low rendered walls, adjacent to which are small hedges. The eastern boundary wall continues southwards between No's 55 & 53, separating their side access paths. Because Flat 2 occupies only the rear part of the western side of No.55 (see Figure 1), the front garden is not considered relevant.

2.7 The rear garden to Flat 2 at No.55 Greencroft Gardens consists of a small patio area at ground floor level which adjoins the rear of the property, with a flight of steps leading down by approximately 0.9m to the rest of the rear garden, which extends southwards up to the boundary with No 71 Aberdare Gardens (Photos 2 & 3). The east and south boundaries were marked by wooden fences, however the west boundary consisted of a brick wall. The ground level within the adjoining rear garden to Flat 1 No.55 was lower than that of Flat 2, whereas the ground level in the rear garden to No.57 appeared to be slightly higher. Additionally, the ground levels at the southern ends of both the rear gardens to Flats 1 & 2 were observed to rise slightly, illustrated by the wooden fence which separates the two gardens (see Photo 3). This feature has also been observed within the rear gardens to properties on the north side of Aberdare Gardens, suggesting a small artificial ridge-like feature exists along the boundary between the properties along these two roads. Most of the rear garden to Flat 2 No.55 is surfaced with paving slabs, and several established trees were observed within the rear garden of No.71 Aberdare Gardens, adjacent to the wooden fence which forms the southern boundary.

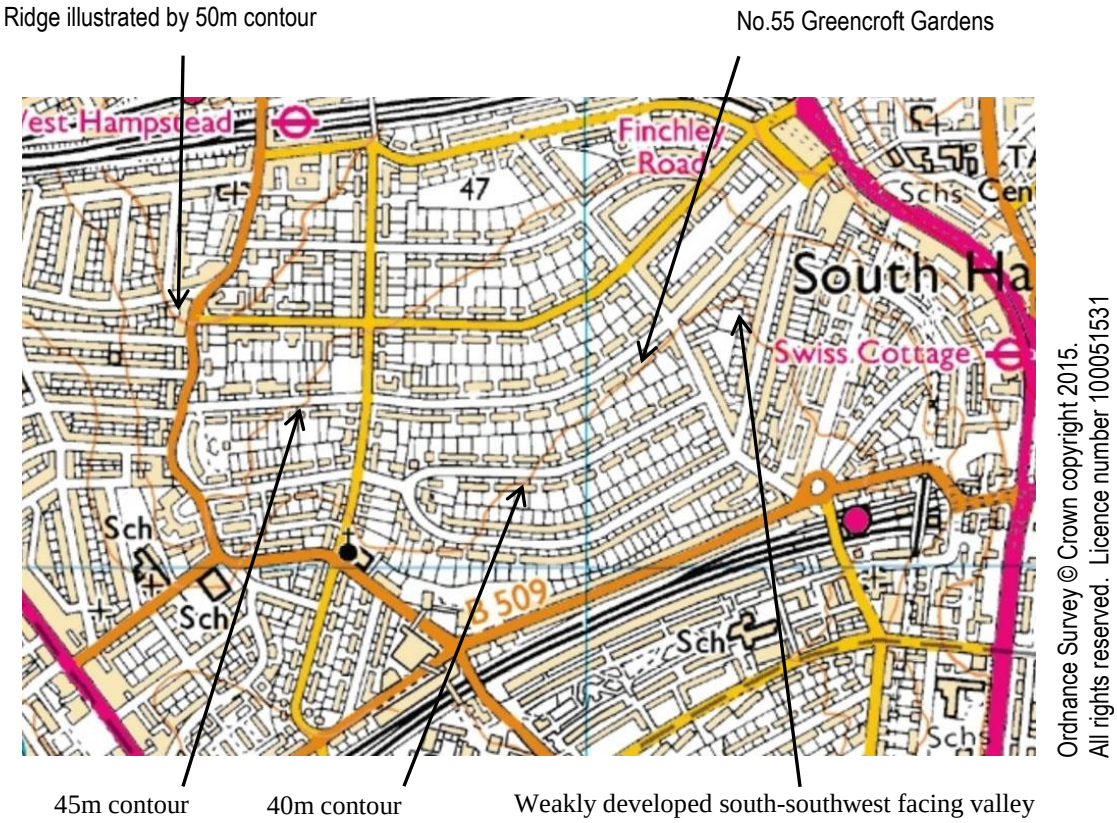


Figure 2: Enlarged extract from 1:25,000 Ordnance Survey map showing site location.

2.8 The topographic setting of the eastern part of Greencroft Gardens is the north-western side of a weakly developed SSW-facing valley, as illustrated by the contours in Figure 2. This valley was formed by one of the former tributaries to the River Westbourne, one of the 'lost' rivers of London (see paragraph 5.1). Between the 40m and 45m contours, which pass through and to the north-west of No.55 respectively, the overall slope angle has been calculated as around 1.0°; this overall slope angle reduces to less than 1° downslope of the 40m contour. The low point of Greencroft Gardens is thought to be where it crosses Fairhazel Gardens, slightly to the east of No.55. The speed hump which has been constructed at this junction obstructs the full width of both carriageways, so restricts surface water run-off from Greencroft Gardens into (and down) Fairhazel Gardens. However, double or even treble gullies have been provided alongside the speed hump in order to increase the drainage capacity at this low point.

2.9 The area around No.55's rear garden was observed to broadly follow this trend, although modified locally to give a predominantly eastwards fall from the slightly higher level of the rear garden to No.57 (to the west) to the lower level of the garden to Flat 1 No.55, to the east of Flat 2. To the west of this area, and beyond Priory Road, West End Lane can be seen to follow a prominent southwards-falling topographic ridge (see Figure 2).

2.10 A search was made of planning applications on the Camden Council's website, in order to obtain details of any other basements which have been constructed or are planned in the vicinity of the property. This search found:

- Flat 1 No.55 Greencroft Gardens: Application (2012/1274/P) involving "*Alterations to fenestration at basement and ground floor level on rear and side elevations and enlargement of lightwells to front and*

side elevations, all to ground floor flat" was granted planning permission on 18th May 2012. No documents relating to a ground investigation were found on the website.

- No.55 Greencroft Gardens: Application (9100061) involving the "*Erection of rear extension to provide extra residential accommodation at ground floor level and storage area at basement as shown on drawing no(s) 12/08a and 09 revised on 22.07.91 05.10.91 and 07.11.91*" was granted planning permission on 14th December 1991. No documents were found on the website.
- No.53 Greencroft Gardens: Application (9005133) involving "*Creation of additional floor space at basement/garden level to an existing maisonette. (Plans and photos submitted) Appeal received against the Council's failure to issue their decision within the appropriate period*" was registered on 2nd march 1990. It is unknown whether planning permission was granted or not. No documents were found on the website.
- No.49 Greencroft Gardens: Application (P9600275R2) involving "*Excavation at rear basement level and alterations to existing rear ground floor extension to create a two storey rear extension to flat 3, as shown on drawing nos. 579-01B, 579-03B*" was granted planning permission on 14th June 1996. No documents were available on the website. A later application (2009/2125/P) involving the excavation of a basement for the same address was registered on 9th July 2009, but was withdrawn, therefore it is unclear whether the works in the initial application were not carried out, or whether the application relates to a different flat.
- No.78 Greencroft Gardens: Application (2014/2979/P) involving "*Enlargement of existing basement and creation of lightwells to the front elevation of flats*" was granted planning permission on 17th October 2014. A Basement Impact Assessment (BIA) and site specific ground investigation were found on the website.
- No.65 Aberdare Gardens: Application (2013/1047/P) involving the "*Excavation of basement with two lightwells to the side, erection of a single storey rear extension and creation of rear first floor level roof terrace with associated balustrade (following demolition of existing single storey extension), alterations to fenestration of side elevation, and replacement of dormer windows at rear second floor level and replacement of french doors at rear first floor level all in connection with existing dwelling (Class C3)"* was granted planning permission on 2nd October 2013. A BIA and site specific ground investigation by Chelmer Consultancy Services were available on the LBC

3.0 PROPOSED BASEMENT

3.1 The proposed new basement for which planning permission will be sought, as shown in Simon Goldstein Architecture's drawings (see paragraph 1.4), will comprise:

- A single storey beneath the entire footprint of Flat 2, including beneath a new single-storey extension which will replace the existing extension and raised terrace at the rear of the house; the rear wall of the proposed extension and basement will line up with the rear wall of Flat 1's extension.
- To the rear of the extension and basement, a lower terrace area at basement level, with steps leading up to the rear garden, and an en-suite bathroom beneath a small upper terrace.
- Small lightwell at ground floor level, adjacent to the No.55/57 party wall, immediately to the rear of the original rear wall of No.55.

3.2 Simon Goldstein Architecture's 'Proposed Section AA' (Drg No. G200_S_AA_001) gives a finished floor level of 3.0m below the level of the existing ground floor. With allowance of 0.15m for insulation, cavity drainage and floor structure (also shown on Proposed Section AA), and allowance of 0.3m for the basement slab, the founding level (formation) of the proposed basement will be 3.45m below the existing ground floor level.

3.3 The depths of excavation required are expected to vary, approximately, from 3.3m below the external patio, to 2.5m below most of Flat 2, to 1.7m below the trap door, and reducing finally to 1.4m below the bathroom

4.0 GEOLOGICAL SETTING

4.1 Mapping by the British Geological Survey (BGS) indicates that the site is underlain by the London Clay Formation. 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 geology of the West Hampstead area.

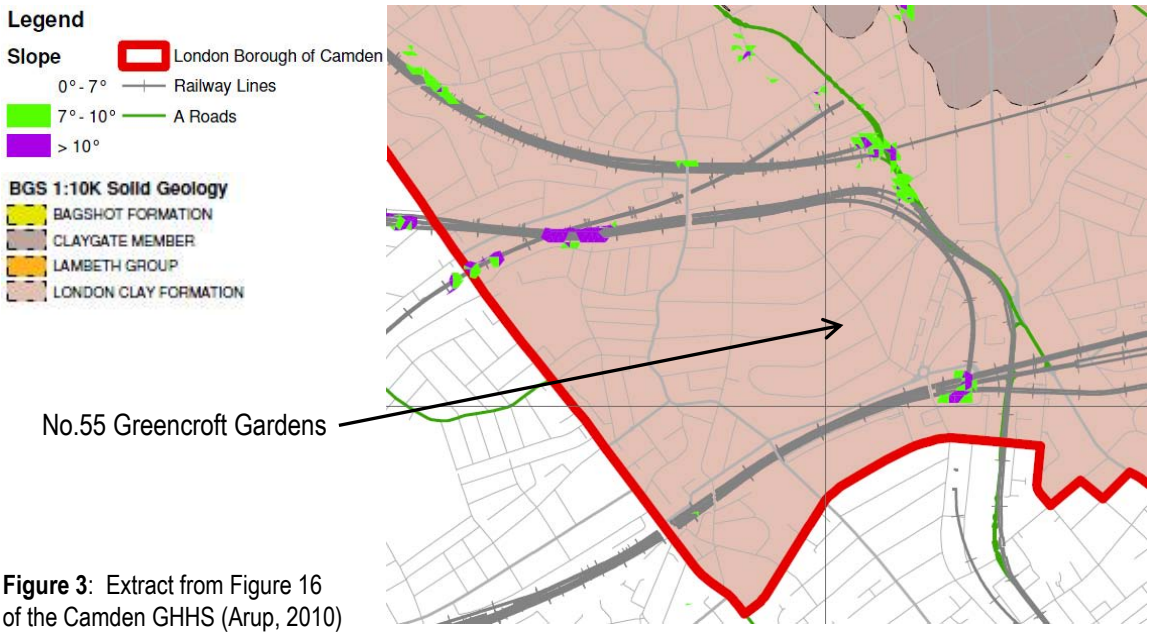


Figure 3: Extract from Figure 16 of the Camden GHHS (Arup, 2010)

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 D, Section 4); all except "shrink-swell clays" indicated “Negligible hazard” to “Very low hazard”. The shrink-swell clay hazard is classified as "Moderate-High" reflecting the presence of the London Clay Formation.

4.5 The GroundSure GeoInsight report (Appendix D, Section 3) records the presence of a number of historic 'mining' features within 1000m of the site, the closest of which is an 'Air shaft' located 388m to the north-east. The tunnel at the same location is recorded in the historic underground workings section of the GeoInsight report (Appendix D, Section 2). Both the air shafts and tunnels appeared to be associated with London Underground's Metropolitan line. No historical surface ground working features were identified by GroundSure within 250m of the site. These databases are based on mapping evidence, so inevitably will provide an incomplete record of underground workings.

4.6 The 1934 geological map (London IV.NE at 1:10,560 scale) also records "London Clay formerly dug" immediately to the east of Greencroft Gardens, though the lateral extent of those workings is not indicated.

4.7 A search of the BGS borehole database was undertaken for information on previous ground investigations and any wells in the vicinity of the site. As shown on the location plan in Appendix B, few BGS boreholes were available within close proximity to the site. The strata depths for the closest borehole available are presented in Table 1, together with a number of boreholes gleaned from the planning search (see paragraph 2.10).

4.8 The grey veining (gleying) above 2.0m in the borehole at No.78, close to the north-west of No.55, might be indicative of historic solifluction (downslope movement during periglacial climatic conditions), which means that weak shear surfaces with strengths only half the value of the clay's peak strength may be present in the uppermost 1.5-3.0m. Similar gleying was also present near-surface in some of the other boreholes.

4.9 At No.65 Aberdare Gardens, due south of the property of current interest, the two boreholes in the front garden recorded 1.8m of firm, moist, orange-brown, very silty CLAY with occasional gravel at 1.4-3.2m below ground level, beneath the Made Ground. These clays were attributed to a locally-derived Head deposit, whereas the boreholes drilled in the rear garden recorded only clays consistent with weathered London Clay Formation. Similar variability in the thickness of the Head deposits was also recorded at 17A Fairhazel Gardens (just north of the east end of Aberdare Gardens), where logging of initial excavations for a basement recorded Head deposits to depths of 0.8-1.5m (Ashton Bennett Consultancy, 2012).

Table 1: Summary of Strata in BGS Boreholes					
Strata (abbreviated descriptions)	**Depths (m) and levels (m AOD) to base of strata**				
	No.78 Greencroft Gardens	**17A Fairhazel Gardens**	**No.65 Aberdare Gardens**	**No.85 Greencroft Gardens**	**TQ28SE/276**
GL (mAOD)	Depth	Depth	Depth	Depth	Depth
Made Ground and/or Topsoil	0.70	0.60	0.4-1.4	0.38-1.40	0.76
Firm slightly gravelly orange/brown CLAY (Head Deposit)	2.0?	0.80-1.50	- / 3.2	-	1.52?
Firm or stiff, brown locally orange-brown, veined grey silty CLAY. (Soliflucted London Clay?)	-	0.80-1.50	- / 3.2	- / 2.50?	-
Brown silty CLAY (Weathered London Clay Formation)	>6.20	>2.40	> 6.0	>5.00	>7.62
Grey CLAY (London Clay Form'n)	-	-	-	-	-
Seepage/Strike	"Dry"	"None noted"	See Table 2	No records	"None"
Groundwater standing level	-	-	See Table 2	-	-

4.10 The groundwater readings from the boreholes at 65 Aberdare Gardens, both during drilling and from subsequent monitoring visits, are presented in Table 2.

Table 2: Groundwater records from boreholes at 65 Aberdare Gardens				
	BH 1	**BH 2**	**BH 3**	**Original BH 1**
Date drilled	26/04/2013	26/04/2013	26/04/2013	22/11/2012
	(m bgl)	(m bgl)	(m bgl)	(m bgl)
Water seepage	2.3	None	3.8 (slight)	1.4
Water seepage	3.2	-	-	3.2
Water standing level on completion of boring	Moist at base	Dry	Moist at base	Moist at base
Base of standpipe	5.0	3.5	5.0	
Groundwater levels in standpipes				
27/04/2013	0.86	0.39	Dry	
29/04/2013	0.52	0.39	Dry	
30/04/2013	0.52	0.39	Dry	

5.0 HYDROLOGICAL SETTING (SURFACE WATER)

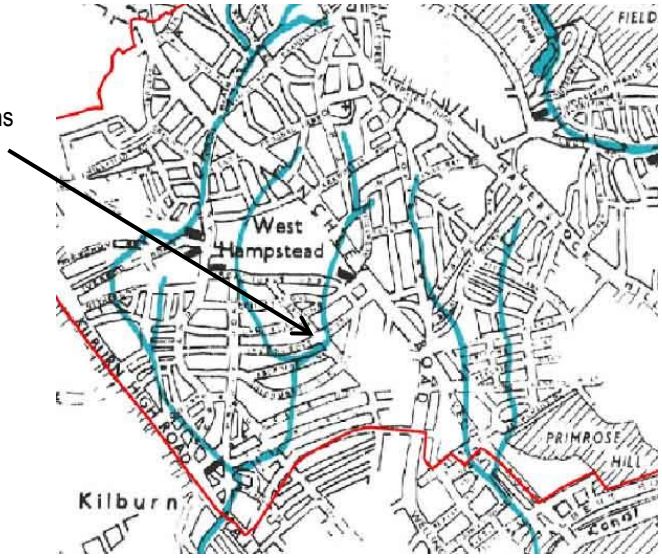


Figure 4: Extract from Figure 11 of the Camden GHHS (Arup, 2010) showing former watercourses, based on Barton (1992).

5.1 Barton's map of the 'lost' rivers of London (Figure 4) indicates that Greencroft Gardens is situated just to the north of the confluence of two branches to one of the former tributaries to the Westbourne. For the reasons set out in 5.2 below, the correct location of this confluence is now considered to lie further to the south, between Goldhurst Terrace and Belsize Road; however, despite this, one of the branches of this former tributary is still believed to pass very close to the site of current interest.

5.2 The 1871 Ordnance Survey map (1:2,500 scale) shows a ditch which, by comparison with one of the more modern maps, can be shown to pass immediately to the east of the south-east corner of the site, beneath the rear gardens to No.53 Greencroft Gardens and No.71 Aberdare Gardens on an alignment close to north-south. This ditch was probably the realigned Westbourne tributary. The 1871 1:2,500 and 1874 1:10,560 maps show a stream/ditch along the (irregular) northern boundaries of the properties on the north side of Belsize Road, to the south of Goldhurst Terrace. The 1934 geological map shows the same stream linked to the ditch immediately to the east of the site, and shows the western branch following the east side of Priory Road (and probably already in culvert). This layout of the tributary seems more plausible than that given by Barton.

5.3 By 1896 the OS map shows that the ditch immediately to the east of the site had disappeared and the Greencroft Gardens carriageway had been constructed, though none of the houses had been started at that end on the road. This suggests that the ditch flow had been culverted and/or diverted.

5.4 A map from SLR which illustrates the hydrology of the area was found on Camden Council's website, related to a planning application for the construction of a basement beneath No.85 Greencroft Gardens. This indicates that the ditch shown on the 1871 OS map immediately to the east of the site, attributed to the realigned Westbourne tributary, in fact passes directly through the site of No.55. The reason for the conflicting locations of this ditch between GroundSure's 1871 historic OS map in Appendix F, and SLR's map, which references both the 1871 OS map and the 1920 geological map, is unclear.

5.5 In order to find out more about the possible alignment of the suspected culverts, enquiries were made to Thames Water, then the Environment Agency, and finally to LBC's Asset Management and Highways teams. None of these organisations had any record of any culvert in the vicinity of Aberdare Gardens. The consensus

opinion was therefore that either the stream/ditch was diverted into the mains sewers beneath the road network, or it might still be in an old culvert which no organisation is now maintaining.

5.6 The natural surface water catchment upslope of No.55 was large, but has been substantially altered by development and now comprises:

i. Under all normal circumstances the catchment is expected to be restricted to the site itself. No run-off is expected from the rear garden of No 57 Greencroft Gardens provided that the masonry wall along the boundary between the rear gardens to No's 55 & 57 Greencroft Gardens is well maintained by those concerned. Surface water run-off is also not expected from the adjoining rear garden to Flat 1 No.55, due to its lower level, nor from the adjoining rear gardens to No's 71 & 73 Aberdare Gardens, downslope of No.55. All other surface water run-off upslope of No.55 is expected to be intercepted by the road network and discharged into the mains sewers, with the possible exception of flows which accumulate at the low point on Greencroft Gardens to the east of No.55; modelling of a 1 in 75 year storm by LBC is understood to have predicted overland flows from there heading approximately due south towards Aberdare Gardens, though neither of the new surface water models published in 2014 predicted any increased risk of flooding in that area (LBC's Strategic Flood Risk Assessment and the Environment Agency's detailed national model – see paragraphs 5.10 and 5.11).

ii. The front garden to No.55 is bounded by low rendered walls, and the concrete surfaced pathway slopes gently towards the carriageway, therefore the surface water catchment is likely to be restricted to direct rainfall and any run-off from the side access path (though the front garden has only an indirect relevance, because Flat 3 is located between the front garden and Flat 2).

iii. Infiltration is likely to be limited within the rear garden, as it is mainly surfaced with paving slabs; however the vegetation growing in-between the paving slabs may have increased the potential for infiltration. Infiltration is likely to occur within the front garden as it mostly laid to lawn.

The rise in ground level at the rear end of both gardens (Flats 1 & 2) has the potential to trap surface water run-off, though the lack of prediction of flooding in that area by the latest flood models indicates that the rise does not form a complete barrier.

5.7 Figure 5 shows that Greencroft Gardens was subject to surface water flooding in both the 1975 and 2002 flood events. The implications of those historical events are addressed in Section 10.6.

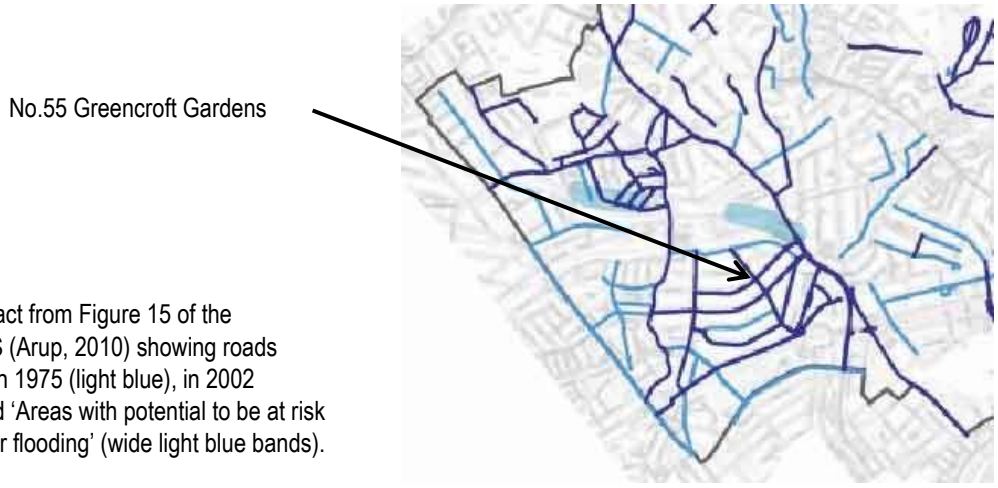


Figure 5: Extract from Figure 15 of the Camden GHHS (Arup, 2010) showing roads which flooded in 1975 (light blue), in 2002 (dark blue), and 'Areas with potential to be at risk of surface water flooding' (wide light blue bands).

5.8 Maps on the Environment Agency's website 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.

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

- There are no surface water features within 250m of the site and no 'Detailed River Network' entries within 500m (App.E, Sections 5.10 & 5.11).
- There are no surface water abstraction licences within 2000m of the site (App.E, Section 5.4).
- There are no flood defences, no areas benefitting from flood defences, and no flood storage areas within 250m of the site (Sections 6.2, 6.3 & 6.4).

5.10 Further flood modelling has been undertaken by the Environment Agency and was published on its website in early 2014, an extract from which is presented in Figure 6 below. 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 generally shows a 'Very Low' risk of flooding for all the properties on Greencroft Gardens, which is the lowest, national background level of risk. Two small localized areas at a 'Low' risk of flooding from surface water are shown on the Greencroft Gardens carriageway, the closest of which is at the topographic low point, adjacent to the junction between Greencroft Gardens and Fairhazel Gardens, to the east of the site where double highway gullies have been provided.

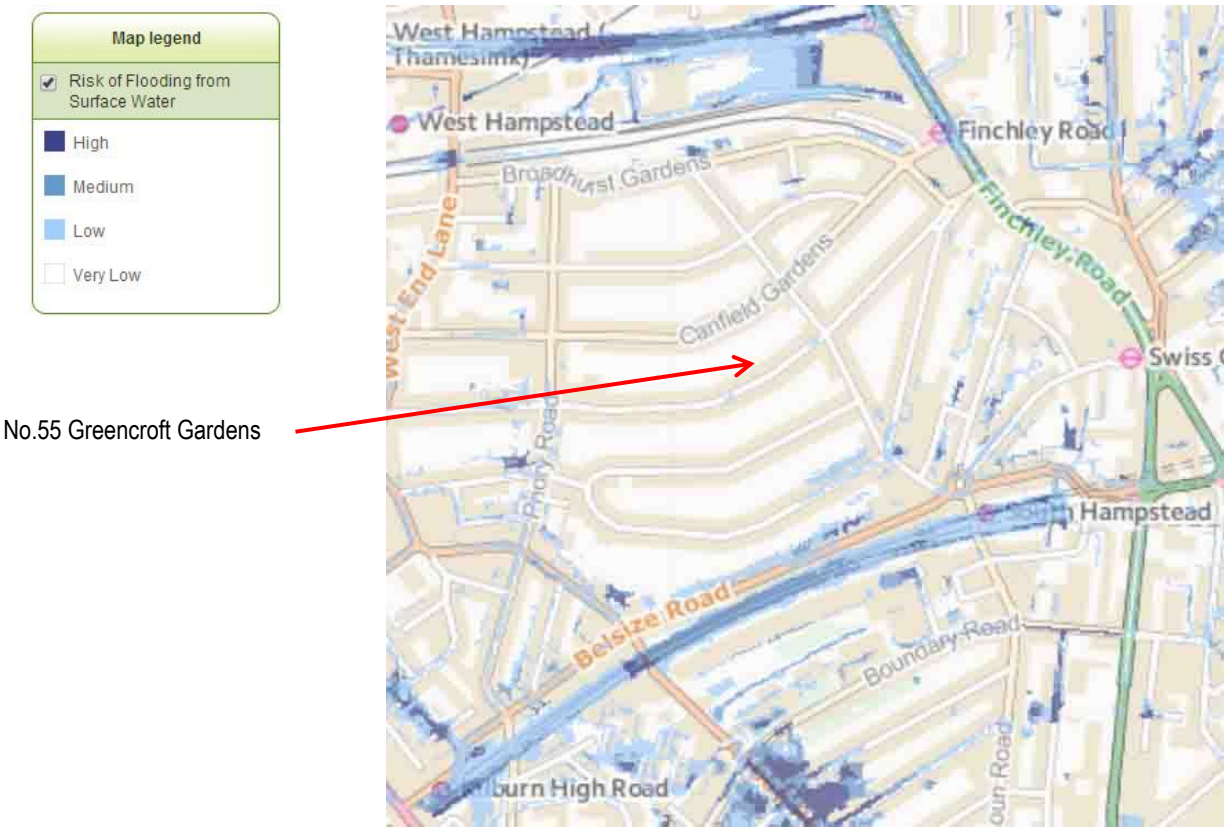


Figure 6: Extract from the Environment Agency's map of 'Risk of Flooding from Surface Water'.

5.11 More recently, surface water flood modeling has been undertaken by URS as part of a Strategic Flood Risk Assessment for the London Borough of Camden, and was published in July 2014; an extract from their model is presented in Figure 7. As per the Environment agency modeling, this map identifies the same four levels of risk (high, medium, low and very low), and shows a 'Very Low' risk of flooding for No.55 and most of the surrounding area. It should be noted however that this modeling does not show the same small, localized areas at a 'Low' risk of flooding from surface water within the Greencroft Gardens carriageway, as shown in Figure 6.

5.12 Figure 7 also shows that Greencroft Gardens falls within Critical Drainage Area Group3_010.

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

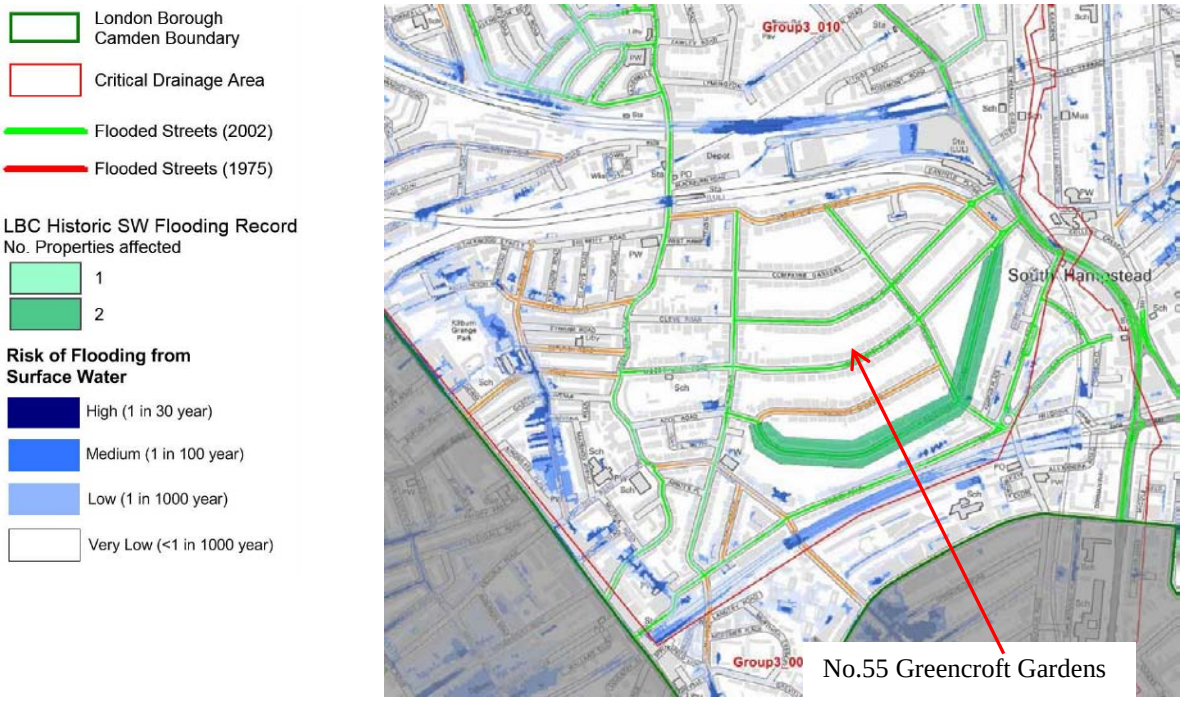


Figure 7: Extract from Figure 3v of the Camden Strategic Flood Risk Assessment (SFRA) (URS, July 2014) showing risk of flooding from surface water.

5.14 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.

6.0 HYDROGEOLOGICAL SETTING (GROUNDWATER)

6.1 The London Clay Formation is classified by the Environment Agency as an 'Unproductive Stratum', as indicated by Figure 8. Under the old groundwater vulnerability classification scheme, which now applies only to superficial soils, the area is unclassified.

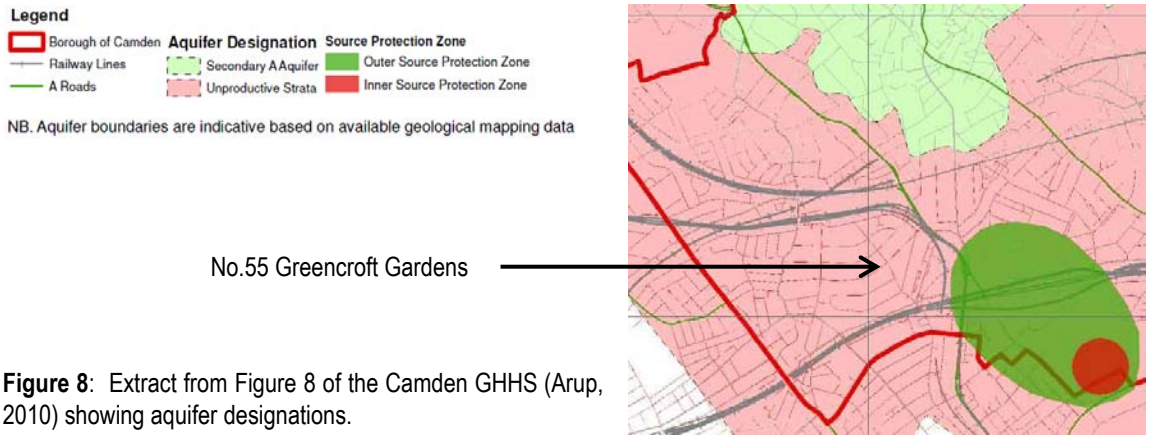


Figure 8: Extract from Figure 8 of the Camden GHHS (Arup, 2010) showing aquifer designations.

6.2 The Chalk Principal Aquifer which occurs at depth beneath the London Clay is not considered relevant to the proposed basement, so is not considered further.

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 in response to seasonal climatic changes and with other man-induced influences.

6.5 Details of what was found by the site-specific ground investigation in May 2015 are presented in Section 9.

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 limited infiltration within 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 potentially a 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 E) include:

- The nearest Source Protection Zone (SPZ) is a Zone 2, 'Outer catchment' located 478m to the east of the site (App.E, Section 5.6, and Figure 8 above); this is irrelevant to the proposed basement.
- The nearest groundwater abstraction licence is 648m to the east of the site at the Swiss Cottage Open Space Borehole (TQ28SE/1769) (App.E, Section 5.3) with a maximum permitted abstraction of 28.8 m^3/day. 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 1638m to the east of the site (App.E, Section 5.5), so will also be 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 6.5)

7.0 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 (Arup, 2010), historic maps and data obtained from GroundSure (see Appendices D, E & F) 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
1b	Will the proposed basement extend beneath the water table surface?	No, not beneath the water table in an aquifer, though it will extend below the phreatic surface of any perched groundwater in the Made Ground/Head Deposits overlying the London Clay.	8.2, Sections 10.2 & 10.3
2	Is the site within 100m of a watercourse?	No – There are no surface water features within 250m of site. The former culverted Westbourne tributary is possibly close to (or even beneath?) the site.	5.1 to 5.5, & 5.9
3	Is the site within the catchment of the pond chains on Hampstead Heath?	No – Site is approx 1.9km SW of Hampstead No.1 Pond	
4	Will the proposed basement development result in a change in the proportion of hard surfaced/ paved areas?	No – The rear garden to Flat 2 No.55 is already paved	2.7 & Section 3.
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; SuDS may be used, but volume of water discharged to ground will not increase.	
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 around 1km to NE (at London Clay-Claygate Member interface).	5.7 & 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 clays. 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 overall slope across the site is approximately 1.0°	2.8
2	Will the proposed re-profiling of landscaping at site change slopes at the property boundary to more than 7°?	No – No significant re-profiling is proposed.	
3	Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	No – Max. overall slope angle in the vicinity of the property is 1°; (and there are no railway cuttings in the vicinity of the site).	2.8
4	Is the site in a wider hillside setting in which the general slope is greater than 7°?	No – As Q3 above.	2.8
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, Sections 9, 10.4 & 10.5
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 close to the proposed basement.	(Photo 2)
7	Is there a history of seasonal shrink/swell subsidence in the local area, and/or evidence of such effects at the site?	Yes, in this area, though these houses appear to have suffered less than others in the area. No.55 showed minimal crack damage, though some parts have been re-pointed.	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).	4.1
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 1.9km from Hampstead No.1 Pond.	
12	Is the site within 5m of a highway or a pedestrian right of way?	No – Proposed basement is under the rear part of house and part of rear garden.	Section 3
13	Will the proposed basement substantially increase the differential depth of foundations relative to neighbouring properties?	Yes – but only relative to No.57, as the adjoining Flat 1 No.55 already has a full-footprint basement.	Carried forward to Scoping: 8.3, Section 10.4
14	Is the site over or within the exclusion zone	No – Re railway tunnels.	Carried forward to

	of any tunnels, eg railway lines.	Unknown - re other tunnels.	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 1.9km from the nearest part of the catchment (Hampstead No.1 Pond).	
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?	Unknown – Possibly, because the flat roof to Flat 2's small extension currently drains to the rear garden. A revised flow route may be required, potentially onto Flat 1's extension roof. Also, surface water from the new lower terrace area may have to be pumped into the drainage system.	Carried forward to Scoping: 8.4 & Section 10.7
3	Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?	No – The rear garden to Flat 2 No.55 is already paved.	2.7
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?	None significant – Run-off from front garden to adjacent properties is nil (and is not owned by Flat 2). Run-off to Flat 1's rear garden, if any, might reduce slightly. The historic natural watercourses downslope of the property have been culverted since the 1800's.	5.1 to 5.6
5	Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	No – There should be no significant change in surfaces generating run-off. None of the surface run-off from this property reaches a watercourse.	5.6
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 – Greencroft Gardens was subject to surface water flooding in both the 1975 and 2002 flood events, though the construction in 1994 of the NW Storm Relief Sewer should have been beneficial.	5.7, 5.10-5.12 & Figures 5 - 7. Carried forward to Scoping: 8.4 & Section 10.7

7.5 Non-technical Summary – Stage 1:

The screening exercise in accordance with CPG4 has identified six issues which need to be taken forward to Scoping (Stage 2); four are related to Ground Stability and two are related to Flooding potential. The presence of groundwater in the clays 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.

8.0 STAGE 3 – GROUND INVESTIGATION

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 Slope/ground stability scoping:

Issue (= Screening Question)		Potential impact and actions
5	Is the London Clay the shallowest strata at the site?	**Potential impact:** Continued seasonal shrink/swell below shallow foundations and heave following unloading by the basement excavations. **Action:** Ground investigation required, then 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 Flat 2 and the adjoining No.57 once the proposed basement has been constructed. **Action:** Review potential impact of any planned vegetation removal and future growth. Designer and contractor to take account of any weakening of the structure caused by past movements.
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 No.57 if basement excavations are inadequately supported. Possible long term differential movement. **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. **Action:** Undertake services search to check that there are no tunnels/services in the vicinity.

8.3 Surface flow and flooding scoping:

Issue (= Screening Question)		Potential impact and actions
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?	**Potential impact:** Increased discharge to the mains drainage system, leading to potential flooding of other locations. **Action:** Identify appropriate SuDS measures to ensure no increase in discharge to mains.
6	Is the site in an area known to be at risk from surface water flooding, such as South Hampstead, West Hampstead, Gospel Oak	**Potential impact:** Flooding of the basement. **Action:** Assess flood risk and potential. Identify

	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?	appropriate flood resistance measures.

8.4 Non-technical Summary – Stage 2:

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).
- Appropriate types of Sustainable Drainage System (SuDS) should be reviewed for the increased roof size and rainwater discharge route.
- 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.
- Consider the need for transition underpinning to mitigate differential foundation depths.
- Undertake a services search to ensure there are no deep tunnels/services.
- Owing to Greencroft Gardens being recorded as having flooded in 1975 and 2002, the future flood risk should be assessed.

With the exception of the arboricultural survey, all these actions are considered in Stage 4, or Stage 3 for the ground investigation.

9.0 STAGE 3 – GROUND INVESTIGATION

9.1 A site-specific ground investigation was undertaken by Chelmer Site Investigations (CSI) on 14th May 2015, and comprised one continuous flight auger borehole (BH1) drilled to a depth of 8.0m below ground level (bgl) within the rear garden to Flat 2 No.55. The findings from the investigation are presented in CSI's Factual Report (see Appendix C), including a site plan, borehole log, and laboratory test results.

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

- Clay of uncertain origin: Recorded immediately below 0.3m of paving slab and concrete bedding was a 0.3m thick horizon described as "Stiff, slightly pungent, dark brown, silty CLAY". The origin of this clay is uncertain.
- Weathered London Clay Formation: Recorded from 0.6m bgl, was "Stiff, brown, silty CLAY"; this became very stiff from 3.0m bgl, and continued to the base of the borehole at 8.0m bgl.

9.3 Hand vane measurements of shear strength were taken in-situ in the borehole. In the upper part of the Weathered London Clay, these tests gave averaged values of 102kPa at 1.0m, rising to 116kPa at 2.0m. At 3.0m and below, all readings were >130kPa. These values do not allow for the clay's fabric such as fissures, so typically over-estimate the soil's strength and should NOT be used for design.

9.4 No roots were observed in the borehole.

9.5 No groundwater entries were recorded in BH1, and it was described as 'dry' and open (ie: stable) on completion.

9.6 A standpipe was installed to the base of BH1 (8.0m), and water level readings were taken on 3rd and 15th June 2015. During this short period of monitoring, the water level in the standpipe rose from 2.28m to 1.10m bgl. This level may not have equilibrated fully with water pressures in the clay, so may not have been representative of the groundwater levels/pressures in the surrounding ground.

Laboratory Testing:

9.7 Laboratory tests were carried out by Chelmer Geotechnical Laboratories (CGL) and others on samples recovered from the borehole. The testing comprised classification tests, including moisture content and plasticity, and chemical testing to assess the potential for acid or sulphate attack on buried concrete. The results were presented in CSI's Factual Report (Appendix C).

9.8 Plasticity tests were performed on three samples of Weathered London Clay recovered from BH1 at depths of 2.0, 3.5, and 8.0m bgl, and on the clay of uncertain origin. The London Clay 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). In contrast, the clay of uncertain origin from BH1 at 0.5m bgl, was found to be of High Plasticity, and low volume change potential. It should be noted that 54% of this sample consisted of particles >0.425mm in size.

9.9 The moisture contents of the London Clay samples from BH1 were found to vary between 31% and 36%; the variation with depth has been plotted as a profile against depth in CGL's report. The moisture content of the sample recovered from BH1 at 0.5m was much lower than the other three samples at 18%. This was 6% below the Plastic Limit value from the same sample, which would generally be considered indicative of significant desiccation. Similarly, the moisture content of the sample recovered from BH1 at 2.0m bgl was

found to be just 2% above the Plastic limit value for the same sample, which would also generally be considered indicative of some desiccation.

9.10 The chemical tests were undertaken on three samples to assess the potential for acid or sulphate attack on buried concrete, with two of the tests carried out in accordance with BRE Special Digest 1 (2005). The following results were recorded.

pH value:	7.6 – 7.8
Water-soluble sulphate:	510 – 1290 mg/l
Total Sulphur:	413 - 3055 mg/kg
Water-soluble magnesium:	13 – 150 mg/l

Calculations following BRE Digest SD1 gave 'derived' values:

Total Potential Sulphate:	0.35 – 2.71%
Oxidisable sulphides:	0.31 – 2.40%.

These results indicated that the samples fell within the following Design Sulphate Classes, as defined by BRE Special Digest 1 (2005):

DS-2 to DS-3: Weathered London Clay and clay of uncertain origin, at level of proposed basement.

DS-5: Weathered London Clay at 8m bgl.

10.0 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 for the site characterised by:

- Made Ground (?): Made Ground was not recorded during the recent site investigation at No.55, however was recorded during the site investigations at other sites within the near area (see Table 1), and is commonly found in urban parts of London. As a result, Made Ground is still expected to be present on site, particularly beneath the house and raised patio area.
  Perched groundwater should be expected in any Made Ground during at least the winter and spring seasons. The seepage into the Flat 1's front lightwell is indicative of shallow groundwater on the up-slope side of the building, as would be expected.
- Head (?): Although Head deposits were not described during the recent site investigation at No.55, they were described during site investigations at other sites within the near area, including No.65 Aberdare Gardens to the south-west of the site and No.17A Fairhazel Gardens to the east (see paragraph 4.9 and Table 1). As a result, the presence of Head deposits on site should not be ruled out.
- Weathered in-situ London Clay: Stiff, to very stiff, brown, silty CLAYS were found directly below the paving slabs/concrete in the on-site borehole (see paragraphs 9.2 and 9.3). These clays are likely to be fissured and will undergo heave movements in response to unloading by the basement excavation. They typically contain selenite (a form of gypsum) which is aggressive to buried concrete. The "stiff" and "very stiff" consistency descriptions were probably based in part on the vane test results which are known to over-estimate the shear strength of fissured clays.
- London Clay Formation (un-weathered): Un-weathered London Clay was not encountered during the recent site investigation. Based on the logs of deeper boreholes in the area, the base of the Weathered London Clay can be found at depths ranging from 6.5m to 10+m bgl.
- Groundwater pressures are expected to be essentially hydrostatic within the depth of current interest in the London Clay. 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 (BH1 found no silt/sand layers of sufficient size to warrant separate identification).
- 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 10.2.6 for the recommended provisional design groundwater level.

10.1.3 No railway tunnels are known to pass below or close to the site, although the NW Storm Relief Sewer is understood (from Thames Water's drawings) to pass beneath No's 65/67 Greencroft Gardens. Other infrastructure (including tunnels) for 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 notably 'dry' conditions in the underfloor void suggested that there is minimal or no flow of groundwater at shallow depth below the house. The house foundations will also prevent most/all flow from front to rear of the site. Thus significant flow in the Made Ground is only likely to be feasible where service trenches or granular pipe bedding facilitates channelled flow. Groundwater in the backfill to footing trenches is typically static (until excavations are dug into/though the backfill).

10.2.2 The lack of any record of silt/sand horizons in the weathered London Clay in BH1 indicates that these silty clays are likely to be at the lower end of the permeability scale, so will permit little or no flow of groundwater. However, the lack of groundwater entries into the borehole during drilling 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 boreholes were backfilled, and any water in silt/sand partings was sealed in by smearing of clays during the drilling process. The rise in groundwater level to 1.10m bgl recorded in BH1 during the four week monitoring period is entirely consistent with this ground model; even higher groundwater levels have been recorded in the vicinity and must be allowed for in the basement's design.

10.2.3 The basement will be founded at approximately 3.45m below ground floor level. It will therefore extend down through any Head deposits (eg: as recorded by the ground investigation at No.65 Aberdare Gardens and No.17A Fairhazel Gardens) and into the underlying "stiff", silty clay of the London Clay Formation. This in-situ London Clay may contain thin partings of silt/sand; flow through these partings, if any, would only occur where the partings are sufficiently interconnected, which is generally rare, and even then is likely to involve very low flow rates and volumes. The proposed basement will not increase the width of the existing obstruction to flow (if any) in Made Ground beneath and to the front of the building so, given the anticipated negligible flow in the London Clay, the proposed basement is considered acceptable in relation to groundwater flow. The comparatively 'dry' conditions noted in the underfloor void also indicates that there has not been any diversion of groundwater flow around the west side of the basement to Flat 1, so no cumulative impact is anticipated from the construction of the proposed basement.

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 Head deposits or 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 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.

10.2.6 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 may rise to ground level, 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 allow long-term 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 the Eurocode 7 (BS EN 1997-1), then groundwater should be taken at ground level in both short-term and long-term situations.

10.2.7 The basement structure must be designed to resist the buoyant uplift pressures which would be generated by groundwater at ground level. For the founding depths currently proposed, the uplift pressures would be up to 35kPa, reducing to a maximum of 20kPa on the south side of the lower terrace (both un-factored).

10.3 Subterranean (Groundwater) Flow – Temporary Works

10.3.1 Groundwater entries may occur into the excavations for the basement, so groundwater control should be allowed for during the basement construction works. 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 formation level clays onto which the underpins and the basement slab will bear must be protected from water because they would soften rapidly if water gets onto these surfaces. Thus, the formation should be blinded with concrete immediately following excavation and inspection.

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.

10.3.5 Irrigation systems in neighbouring gardens can also contribute significantly to water entries so, if such systems are present in the adjoining gardens, then the owners should be asked to avoid excessive use during the basement construction period.

10.4 Slope and Ground Stability

10.4.1 With slope angles of approximately 1.0° upslope of this property the proposed basement excavation raises no concerns in relation to slope stability.

Basement Retaining Wall Construction:

10.4.2 The retaining wall design analyses provided by SR Brunswick show that the basement will be constructed using reinforced concrete (RC) underpinning techniques beneath the original building and 55/57 boundary wall, together with similar RC retaining walls for the rear lightwell. These RC retaining walls should be cast in-situ on the same traditional 'hit and miss' basis as used for the underpins. Both 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. The finished floor level (FFL) in the proposed basement will be about 0.3m deeper than the FFL in Flat 1's basement, so it is possible that minor underpinning will be required below the west wall of that basement; the founding level of Flat 1's basement must be determined during the detailed design stage.

10.4.3 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 use of best practice methods of temporary support 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 engineer before any underpinning is carried out.

10.4.4 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.

10.4.5 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.

10.4.6 For the proposed basement beneath Flat 2, No.55 Greencroft Gardens:

- It should be assumed that full support will be required to any Made Ground and any natural granular soils exposed in the excavations.
- Closely spaced support should be used where any firm clay is present at the top of 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 must also be installed to support 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.

All temporary support should use high stiffness systems installed in accordance with best practice in order to minimise the ground movements.

10.4.7 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 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.

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

Design Considerations:

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 paragraph 10.4.10 below);
- Dead and live loads from the superstructure, including loads from the adjoining flats and No.57 which are carried on the party walls;
- Loads from the free-standing wall on the boundary between No's 55 and 57;
- Normal surcharge allowances;
- Swelling displacements/pressures from the underlying clays;
- A provisional design groundwater level at GL/0.5m bgl (see paragraph 10.2.6);
- Precautions to protect the concrete from sulphate attack.

10.4.10 The following geotechnical parameters are applicable to the strata in this area, however, as the depth of any Made Ground and/or Head deposits is not known, it is recommended that the parameters for London Clay should be used when calculating earth pressures acting on the basement's retaining walls:

Made Ground (clays):	Unit weight, γ_b:	17.0 kN/m^3
	Effective cohesion, c':	0 kPa
	Angle of internal friction, φ':	25°
Head Deposit Clays:	Unit weight, γ_b:	18.0 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 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 and No.55's Flat 3, where they adjoin Flat 2, subject to agreement under the Party Wall Act negotiations.

10.5 Settlement/Heave and Damage Category Assessment

The settlement/heave assessment, including the results of PDISP analyses, and the damage category assessment will be presented as an addendum to this report.

10.6 Monitoring

10.6.1 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 Agreement and are beneficial to all parties concerned.

10.6.2 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 two (or more) levels at the following locations:

- internally, at the front, middle and rear of the 55/57 party wall;
- internally, at the front, middle and rear of the Flat 2/Flat 3 party wall;
- if underpinning of the Flat 2/Flat 1 party wall is required, then internally at the front, middle and rear of that wall;
- externally, on the rear wall to No.57 close to the 55/57 party wall;
- externally, at the east and west corners of the first floor rear projection above Flat 2;
- externally, at two locations on the 55/57 boundary wall;
- externally, at two locations on the Flat 2/Flat 1 boundary wall between the lightwells/terraces.

10.6.3 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.

10.6.4 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.

10.7 Surface Flow and Flooding

Flooding from Rivers, Sea & Reservoirs:

10.7.1 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;
- there are no flood defences, no areas benefitting from flood defences and no flood storage areas within 250m of the site.

Surface Water (Pluvial) Flooding:

10.7.2 There are no surface water features within 250m of the site (see paragraph 5.9).

10.7.3 The site is known to lie close to one of the former tributaries to the 'lost' river Westbourne (as described in Section 5 above). These tributaries have been culverted or diverted into the sewer system so they are no longer able to receive surface water run-off. Whether the culverts remain connected hydraulically to the perennial surrounding groundwater is unknown.

10.7.4 The *'Floods in Camden'* report (LBC Floods Scrutiny Panel, 2003) and LBC's CPG4 guidance document record that Greencroft Gardens did flood in both the 1975 and 2002 local pluvial flood events. These flooding events probably affected only a small section of the road (possibly in the area of lower topography to the east of No.55, as the extent or number of properties affected was not recorded. Construction of the NW Storm Relief Sewer in 1994 should have helped to prevent a repeat in 2002, although it became overloaded because it was only designed for a 1 in 10 year storm.

10.7.5 The latest flood modelling by the Environment Agency gives a 'Very Low' risk of surface water flooding, the lowest category, for No.55's site, for almost all of the Greencroft Gardens roadway, and the whole area between Greencroft Gardens and Aberdare Gardens (see Figure 6). This suggests that the historic flooding in Greencroft Gardens may have been predominantly sewer flooding. As Flat 2 is on the downslope side of the building, flood mitigation measures here may be restricted to:

- Installing a nominal upstand around the downslope side of the lower terrace to prevent surface water from the immediate adjoining surfaces draining into this sunken terrace (most will drain away southwards from the terraces).
- Installing raised thresholds to the external doors in the lower terrace and the lightwell.

Changes to Hard Surfacing & Surface Water Run-off:

10.7.6 The proposed new ground floor extension, with basement below, and the associated terraces will be built in areas which are already fully paved. Borehole BH1 also recorded concrete beneath the paving, so infiltration in this part of the garden is likely to be nil. Thus, the proposed basement and extension will not cause any change in the area of hard surfacing.

10.7.7 It was noted that roofwater from Flat 2's extension was simply discharged to surface downslope of the raised patio. The larger roof area would increase the localised flow, though not the overall volume. No direct connection to the mains drainage system is available at the rear of Flat 2. Consideration might therefore be given to requesting permission from the owners of Flat 1 for the discharge of Flat 2's roof water onto Flat 1's roof, subject to construction at appropriate levels. Any revised arrangement for discharge of surface water to mains drainage must be attenuated by use of a Sustainable Drainage System (SuDS). The options for SuDS are limited in this circumstance, but could include installation of a green (sedum) roof on the new rear extension, although these offer no additional storage once they become fully saturated in a storm situation. Some continued discharge to surface to the rear of the terraces, and/or use of a grey water system may therefore also be required. Figure 4c of the Camden SFRA (URS, 2014) classifies this area as "Opportunities for bespoke infiltration SuDS" (the least favourable category). This seems somewhat optimistic, given the low permeability of the London Clay, though consideration could be given to this possibility. These SuDS schemes will require formal design, including accurate quantification of the design run-off volumes.

Sewer Flooding:

10.7.8 Thames Water has no records of flooding from public sewers affecting No.55 (see 5.14). 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.

10.7.9 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.

10.7.10 Non-return valves and/or pumped above ground loop systems must therefore be fitted on the drains serving the basement, the lightwell and the lower terrace, 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 foul water (and any roof water). A battery powered reserve pump should be fitted to ensure that the system remains functional during power cuts.

10.7.11 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 lightwell, lower terrace 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, lower terrace and lightwell, and foul water) for the duration of the predicted surcharged flows in the sewer. If decking is used in the lower terrace then the area beneath the decking could be used for interception storage, deepened as necessary to provide adequate capacity, though it must be protected from backup of foul sewage. This temporary interception storage would require formal design to ensure satisfactory performance.

10.7.12 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.

10.8 Mitigation

10.8.1 The following mitigation measures should be implemented:

- 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 (10.4.3).
- Subject to Party Wall Award negotiations, transitional underpinning blocks should be included beneath the adjoining walls to No.25, except where existing cellars would provide sufficient transition (see paragraph 10.4.11).
- Provision of an upstand around the downslope side of the lower terrace in order to prevent surface water draining into the lower terrace, and installation of raised thresholds to the external doors in the lower terrace and the lightwell (see paragraph 10.7.5).
- One or more appropriate types of SuDS: installation of a green (sedum) roof on the new rear extension, and/or use of a grey water system (see paragraphs 10.7.6 and 10.7.7).
- Non-return valves and/or pumped above ground loop systems should be fitted to the drains serving the basement, lightwell and lower terrace, in order to ensure that water from the sewer system cannot enter the basement when the mains sewer is operating under surcharge (see paragraphs 10.7.10 to 10.7.12).

11.0 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 any Made Ground may only occur where facilitated by service trenches or granular pipe bedding. The relatively 'dry' conditions in the underfloor void indicates that there has not been any diversion of groundwater flow around the west side of the basement to Flat 1, so no cumulative impact is anticipated (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 (10.2.5). 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) ranging up to 20-35kN/m^2 (10.2.6, 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 10.4.7).

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

11.8 The basement is expected to be constructed using RC 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 10.4.6).

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.57 and No.55's Flat 3 which adjoin Flat 2 (10.4.11).

11.11 The PDISP heave analysis and damage category assessment will be submitted as an addendum (Section 10.5).

11.12 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 10.6).

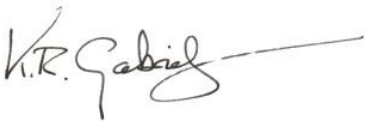
11.13 The Environment Agency's maps show that the site is at negligible risk of flooding from rivers or the sea, and at no risk of flooding from reservoirs (10.7.1).

11.14 While part of Greencroft Gardens is recorded as having flooded during both the 1975 and 2002 events, the latest flood modelling by the Environment Agency and Camden SFRA gave a 'Very Low' risk of flooding by surface water to No.55 and all the immediately surrounding area; this is the lowest, national background level of risk. Appropriate flood mitigation measures are recommended (10.7.5).

11.15 The basement and extension will not increase the area of hard surfacing. One or more appropriate, formally designed SuDS system should be implemented in order to control surface water discharge or store the water for re-use. The possibility of discharging roofwater via Flat 1's roof could also be considered, subject to appropriate permission (10.7.6, 10.7.7).

11.16 Non-return valves and/or pumped above ground loop systems should be fitted to the drains serving the basement, lightwell and lower terrace. Temporary interception storage may also be required for the predicted maximum volume of discharges (from all sources) via the protected outfall pipe, for the duration of the predicted surcharged flows in the sewer; formal design would be required (10.7.10 to 10.7.12).

11.17 The mitigation measures recommended in various parts of Sections 10.2 to 10.7 have been summarised in Section 10.8.



Keith Gabriel
MSc DIC CGeol FGS
UK Registered Ground Engineering Adviser

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Project:

55 Greencroft Gardens, London, NW6 3LL

16454

Photo 1: Street scene taken from the junction of Greencroft Gardens with Fairhazel Gardens (looking south-west). No.55 is a large, semi-detached house, situated on the south side of Greencroft Gardens.

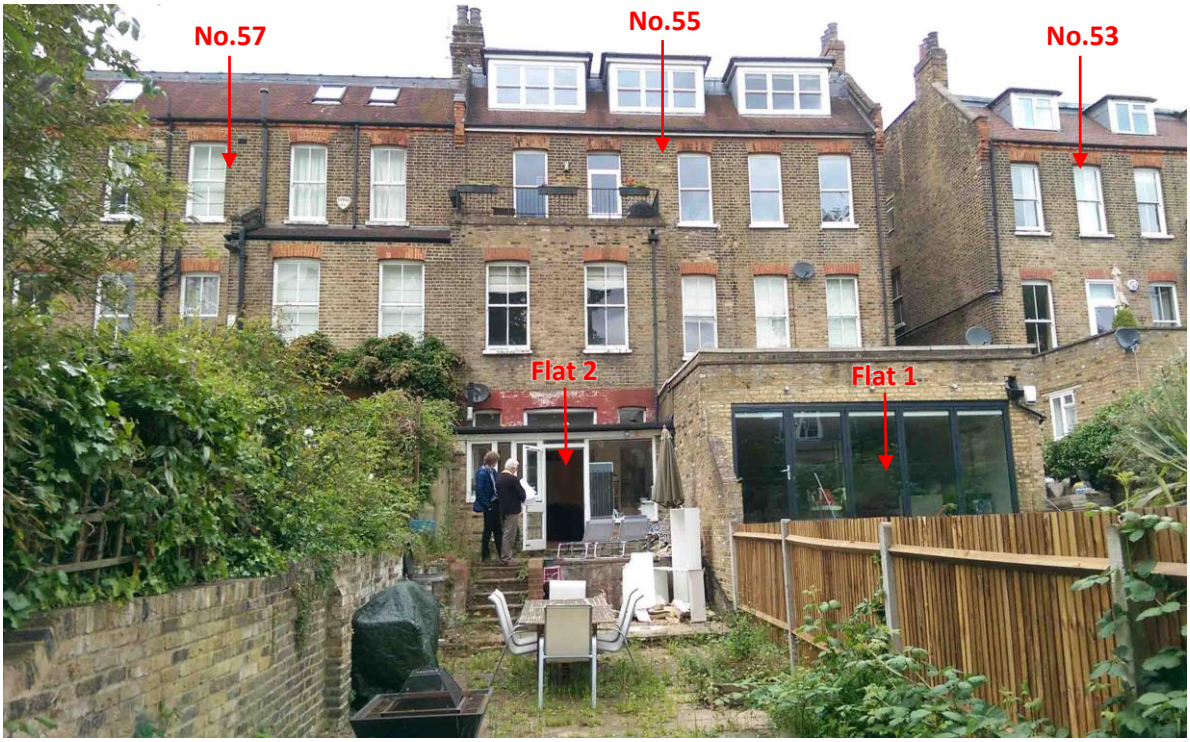

Photo 2: Rear Elevation. Flat 2 is a ground floor flat within No.55, located towards the rear of the house, on its western side. The Flat includes a small single storey extension, adjoining which is a raised patio area. Note the recent refurbishments to Flat 1, which included the construction of a basement.

Title:	**Photographs - Sheet 1**					Sheet	**A1**
Date:	1st June 2015	Checked:	AG	Approved:	KRG	Scale :	NTS

Project:

55 Greencroft Gardens, London, NW6 3LL

16454

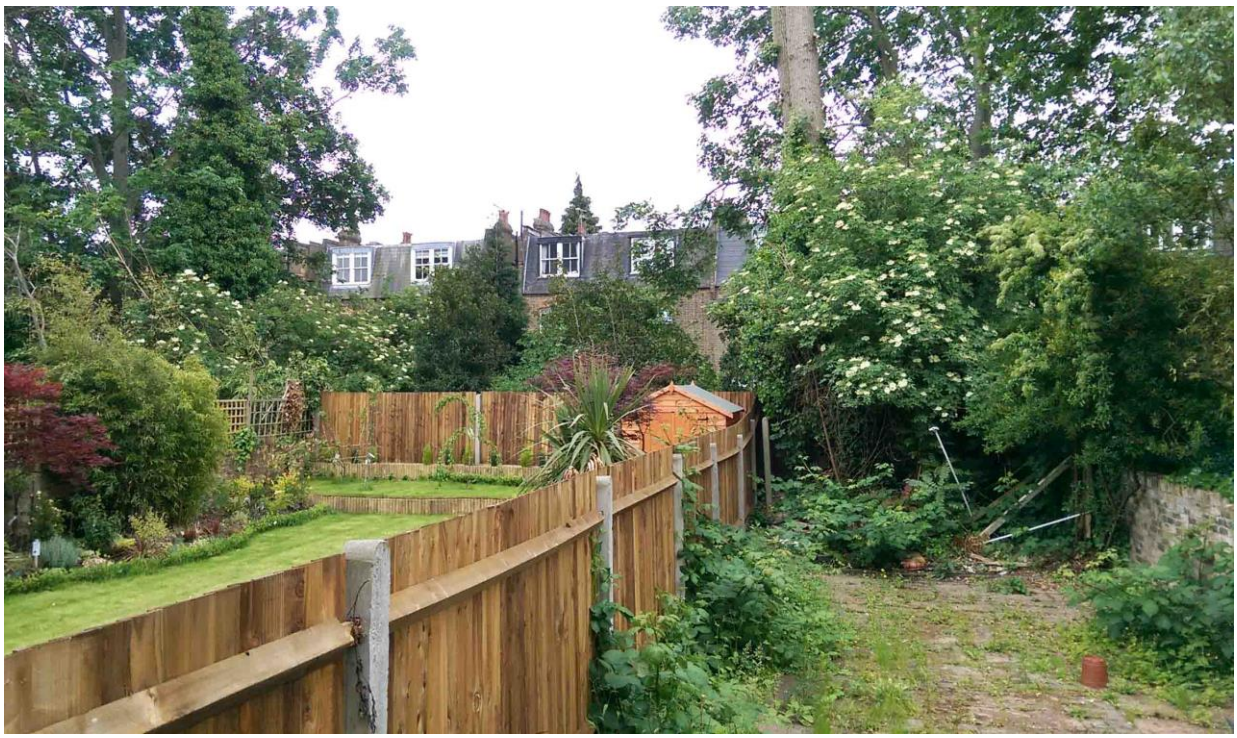

Photo 3: The rear garden to Flat 2 No.55 is surfaced with paving slabs, and is bounded by a brick wall to the west, and by wooden fences to the east and south. Overall the garden falls gently southwards, however a slight rise in level can be seen at its southern boundary with No.71 Aberdare Gardens.

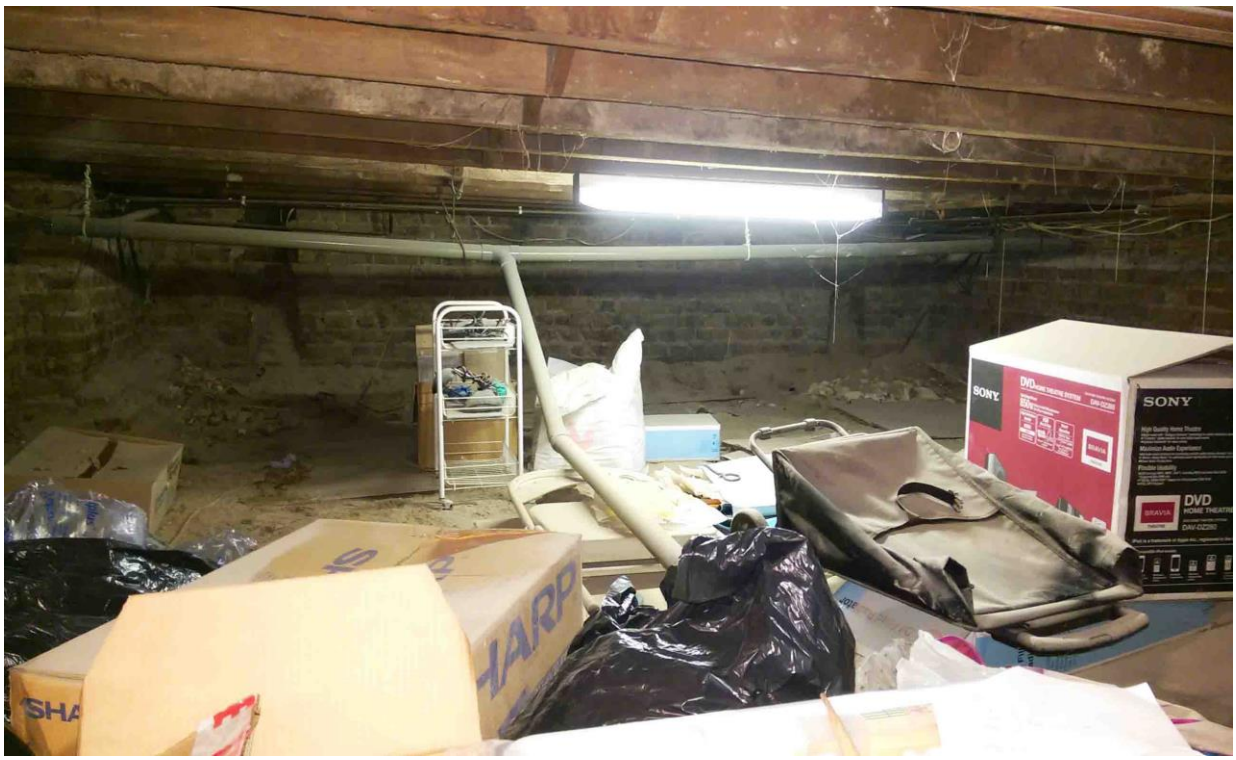

Photo 4: Beneath most of Flat 2 there is a void with approximately 900mm of headroom. The bathroom is located to the right of this photo, and extends deeper.

Title:	**Photographs - Sheet 2**					Sheet	**A2**
Date:	1st June 2015	Checked:	AG	Approved:	KRG	Scale :	NTS

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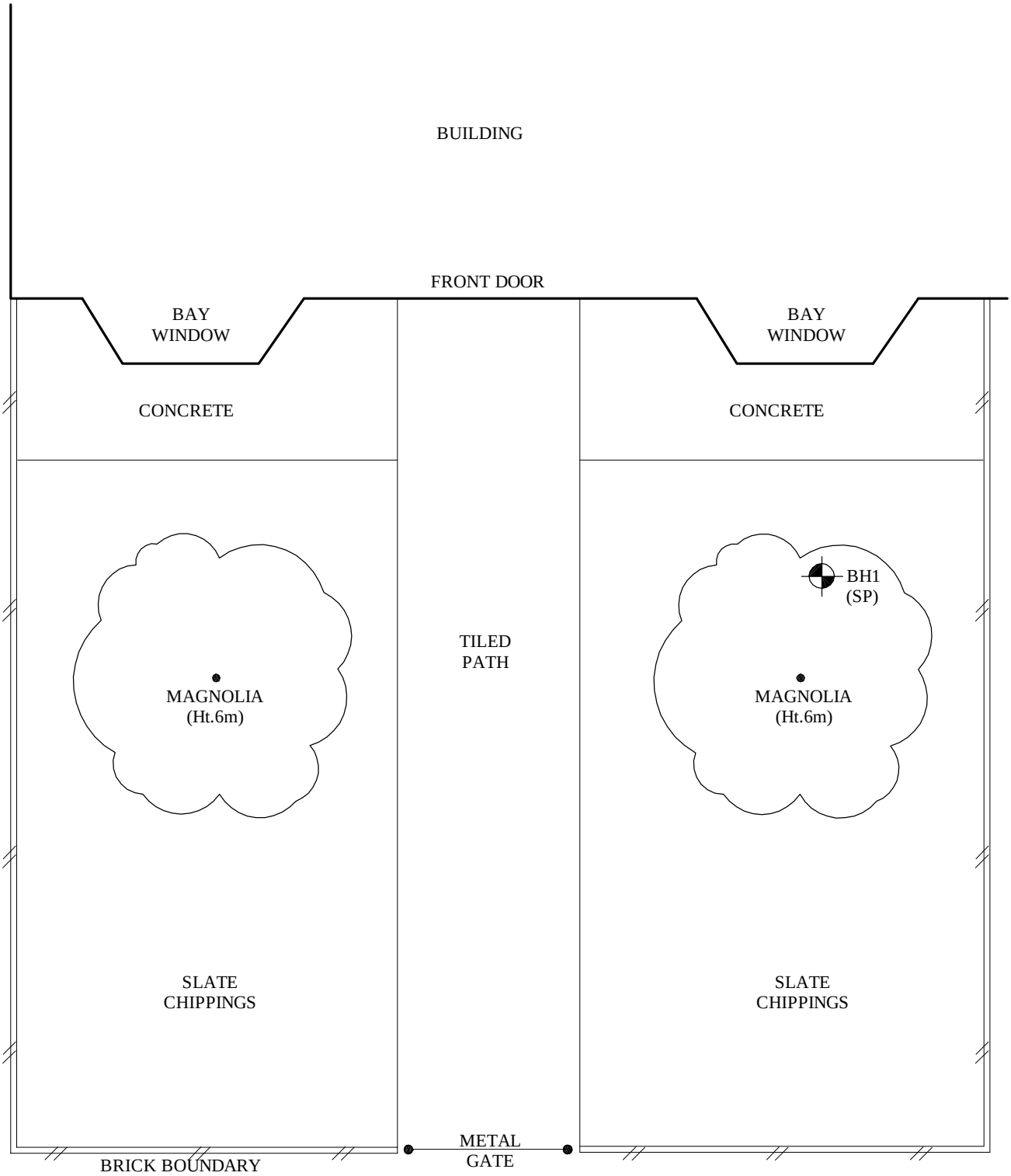
Client:	Basement Design Studio	**Scale:** N.T.S.	**Sheet:** 1 of 1	**Date:** 2.4.14	
Location:	78 Greencroft Gardens, London NW6	**Job No:** 4379	**Weather:** Overcast	**Drawn by: PL**	**Checked by: ME**



Notes:

On site tree identification for guidance only. Not authenticated.

Key:

Tree/Shrub | Borehole | Trial Pit | G Gully | Tree Stump | Rain Water/ Soil Pipe | MH Manhole

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Client: Basement Design Studios	**Scale:** N.T.S.	**Sheet No:** 1 of 1	**Weather:** Overcast	**Date:** 2.4.14	
Site: 78 Greencroft Gardens, London NW6	**Job No:** 4379	**Borehole No:** 1	**Boring method:** Secondman (100mm Ø) C.F.A.		

Depth Mtrs.	Description of Strata	Thick-ness	Legend	Sample	Test Type	Test Result	Root Information	Depth to Water	Depth Mtrs
G.L.									
0.1	SLATE	0.1					Roots of live appearance to 1mmØ to 0.6m.		
	MADE GROUND: medium compact, dark brown, sandy, silty clay, with brick fragments.	0.6		D			↓		0.5
0.7							Hair and fibrous roots to 1.0m. ↓		
	Firm, brown, grey veined, silty CLAY, with partings of orange and brown, silt and fine sand.	5.2		D	V	70 72	No roots observed below 1.0m.		1.0
				D					1.5
	.....becoming stiff from 2.0m.			D	V	88 92			2.0
				D					2.5
				D	V	120 124			3.0
				D					3.5
	.....becoming very stiff from 3.8m.			D	V	140+ 140+			4.0
				D					4.5
				D	V	140+ 140+			5.0
				D					5.5
5.9									
	CLAYSTONE	0.2							
6.1				D	V	140+ 140+			6.1
	Very stiff, brown, silty CLAY, with partings of orange and brown, silt and fine sand and selenite crystals.	0.1							
6.2	Borehole ends at 6.2m BH extended to prove thickness of claystone.								

Drawn by: PL **Approved by:** ME

Remarks: Borehole dry and open on completion.

Key: T.D.T.D. Too Dense to Drive
D Small Disturbed Sample J Jar Sample
B Bulk Disturbed Sample V Pilcon Vane (kPa)
U Undisturbed Sample (U100) M Mackintosh Probe
W Water Sample N Standard Penetration Test Blow Count

During the site reconnaissance, the basement excavation beneath No. 17A had been partially completed and it was possible to examine the in-situ soils for the full depth of the basement. The ground conditions were found to comprise:

- GL to 0.15m: Made Ground: Reinforced Concrete
- 0.15m to 0.3m: Made Ground: Dry dark grey black ash fill and broken asphalt.
- 0.3m to 0.6m: Made Ground: Dry dark grey dark brown slightly gravelly slightly cobbly CLAY with rootlets. Gravel comprised of fine to coarse sub-rounded to sub-angular flint together with brick and glass. Cobbles comprised of brick.
- 0.6m to 0.8m / 1.5m (variable): Moist soft to firm light grey light brown with black specks and occasional red staining slightly gravelly to gravelly CLAY. Gravel comprised of medium to coarse grained rounded flint. Red staining was associated with roots up to 8mm in diameter. Gravel became rare with depth. Head Deposit.
- 0.8m / 1.5m (variable) to 2.4m: Slightly moist firm brown fissured CLAY with some roots up to 25mm diameter close to the road and rootlets elsewhere. Occasional polished surfaces on boundary with overlying stratum. London Clay.

No groundwater seepage was noted in the basement excavation.

The boundary between the Head and the London Clay observed in the basement excavation varied as follows:

- 1.3m (west face)
- 0.9m (south west face)
- 0.8m (south east face)
- 1.5m (east face)

The Head deposits contained rounded flint gravel which is laid down naturally by rivers. The Head could therefore be a deposit formerly laid down by a watercourse, possibly in a flood-plain environment.

5.2 Hydrogeology

The above referenced geological map indicates the site to be underlain by the London Clay Formation, which is an aquiclude. The Environment Agency have designated the London Clay Formation beneath the site as being "Unproductive".

The natural soils underlying the site are likely to comprise a superficial covering of made ground (potentially absent) overlying weathered London Clay (clay soils). The London Clay soils have low permeability and do not readily permit the downwards transfer of surface water or percolating groundwater.

There is one groundwater abstraction licence within 1000m of the site. This abstraction licence relates to an abstraction 657m to the east of the site, which is used for direct spray

A Factual Report on the

Site Investigation undertaken for

London Basement

at

65 Aberdare Gardens
Hampstead
London NW6

CSI Ref: 3479

Dated: 22nd November 2012

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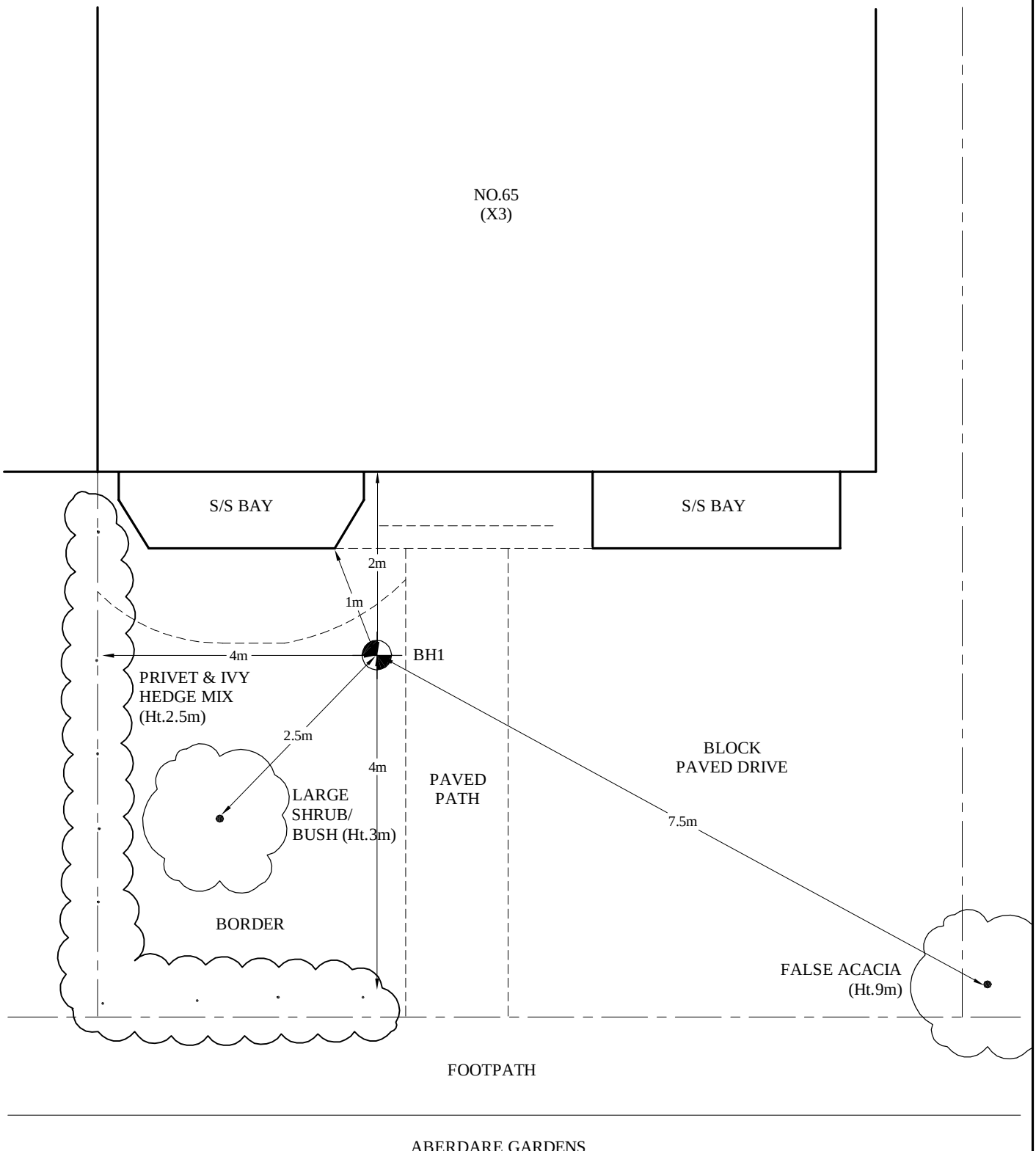
Client:	London Basement	**Scale:**	N.T.S.	**Sheet:**	1 of 1	**Date:**	22.11.12
Location:	65 Aberdare Gardens Hampstead, London NW6	**Job No:**	3479	**Weather:**	Overcast	**Drawn by: DB**	**Checked by: GW**



Notes:

On site tree identification for guidance only. Not authenticated.

Key:

Tree/Shrub | Borehole | Trial Pit | G Gully | Tree Stump | Rain Water/ Soil Pipe | MH Manhole

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Client: London Basement	**Scale:** N.T.S.	**Sheet No:** 1 of 1	**Weather:** Overcast	**Date:** 22.11.12	
Site: 65 Aberdare Gardens, Hampstead, London NW6	**Job No:** 3479	**Borehole No:** 1	**Boring method:** Hand auger		

Depth Mtrs.	Description of Strata	Thick-ness	Legend	Sample	Test Type	Test Result	Root Information	Depth to Water	Depth Mtrs
G.L.									
0.1	TOPSOIL	0.1							
	MADE GROUND: medium compact, brown, very silty clay, with frequent brick and carbon fragments.	1.3		D	M	14 18 21 23	Roots of live appearance to 2mmØ to 0.8m.		0.5
				D	M	20 24 28 31	Roots of live appearance to 1mmØ to 1.7m.		1.0
1.4								*1.4*	
	Firm, moist, orange-brown and grey veined, very silty CLAY, with partings of orange and brown silt and fine sand, with occasional gravel and carbon flecks.	1.8		D	V	78 86	Hair and fibrous roots to 2.1m.		1.5
				D	V	102 114 110	No roots observed below 2.1m.		2.0
				D	V	120 126			2.5
				D	V	134 140			3.0
3.2								*3.2*	
	Very stiff, brown and grey veined, silty CLAY, with partings of orange and brown silt and fine sand with occasional fine gravel and crystals. .....becoming stiff and moist from 3.80m.	1.2		D	V	140+ 140+			3.5
				D	V	140+ 140+			4.0
4.4									
	Very stiff, dark brown and grey veined, silty CLAY, with partings of orange and brown silt and fine sand with occasional fine gravel and crystals.	1.6		D	V	140+ 140+			4.5
				D	V	140+ 140+			5.0
				D	V	140+ 140+			5.5
6.0									
	Borehole ends at 6.0m			D	V	140+ 140+			6.0

Drawn by: DB **Approved by:** GW

Remarks: *Water seepage at 1.4m.*
Water seepage at 3.2m.
Borehole moist at base and open on completion.

Key: T.D.T.D. Too Dense to Drive
D Small Disturbed Sample J Jar Sample
B Bulk Disturbed Sample V Pilcon Vane (kPa)
U Undisturbed Sample (U100) M Mackintosh Probe
W Water Sample N Standard Penetration Test Blow Count

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REPORT NOTES

Equipment Used

Hand tools, Mechanical Concrete Breaker and Spade, Hand Augers, 100mm/150mm diameter Mechanical Flight Auger Rig, GEO205 Flight Auger Rig, Window Sampling Rig, and Large or Limited Access Shell & Auger Rig upon request and/or access permitting.

On Site Tests

By Pilcon Shear-Vane Tester (Kn/m^2) in clay soils, and/or Mackintosh Probe in granular soils or made ground and/or upon request Continuous Dynamic Probe Testing and Standard Penetration Testing.

Note:

Details reported in trial-pits and boreholes relate to positions investigated only as instructed by the client or engineer on the date shown.

We are therefore unable to accept any responsibility for changes in soil conditions not investigated i.e. variations due to climate, season, vegetation and varying ground water levels.

Full terms and conditions are available upon request.

TQ28SE/ 276
2623.8410
256

GROUND EXPLORATIONS LIMITED

BOREHOLE SECTION SHEET

Date December 19 55

CONTRACT NAME: Swiss Cottage. ORDER No.

Bored for : Messrs. Goodhart-Rendel & Partners.

Address : Kirkland House, Whitehall S.W1.

Address of Site : Coleridge Gardens

District or Town : Swiss Cottage County : London

Standing Water Level : - below surface Dia. of Borehole : 6 Inches.

Water Struck (1) None (2) (3)

Boring Commenced : 5.12.55 Boring Completed : 6.12.55

Special Remarks :

Jar Samples : 2871 2'0"; 2872 5'0"; 2879 9'0"; 2876 13'0"; 2878 17'0"; 2880 22'0";

Core Samples : 2873 5'6" - 7'0"; 2875 10'0" - 11'6"; 2877 14'6" - 16'0"; 2879 18'6" - 20'0"; 2881 23'6" - 25'0"

Sand/Gravel Samples :

DESCRIPTION OF STRATA	Thickness Feet	Thickness Inches	Depth Below Surface Feet	Depth Below Surface Inches
The descriptions are given in accordance with the Civil Engineering Code of Practice No. 1 "Site Investigations." No responsibility is accepted for these descriptions and clients should examine the samples submitted.				
No. 1 Boring				
Top soil	1	6	(0-9-1)	6
Loamy clay	3	6	(1-5-) 5	0
Brown clay	20	0	(21-25	0
TOTAL FROM SURFACE ...	25	0	25	0.

This form is to be returned to Head Office immediately the borehole is finished.

Foreman's Signature..... *Date*.....

P. & R. Ltd.—275

Borehole No: A

Sheet: 1 of 1

Job No:

Date: 06/02/2014

Ground Level mOD: -0.2m

S Chick Investigations

Site: 85 Greencroft Gardens

NW6

Work Carried out for: Chesters

Boring Method: C.F.A

Diameter: 100mm

Coordinates:

Depth (m)	Description of Strata	Thick-ness (m)	Sample	Test Type	Test Result	Depth (m)	Field Records/Comments	Depth to water (m)
GL	Block paving over sand	0.20					Roots of live appearance to 8mm to 1.2m	
0.20	Made ground, medium compact mid brown gravelly silty CLAY with pieces of rubble	1.20						
			D	M	14	1.00		
					14		Hair and fibrous roots observed to 2.2m	
1.40	Stiff mid brown grey veined silty CLAY with partings of brown silt/fine sand	1.10			16			
					18			
			D	V	122	2.00		
					132			
2.50	Very stiff mid brown silty CLAY with partings of brown silt/fine sand	2.50						
			D	V	140+	3.00		
					140+			
			D	V	140+			
					140+			
	BH Ends 5.0m		D	V	140+		BH dry and open on completion	
					140+			

Remarks:

X(Y) = X blows for Ymm penetration.

Key: T.D.T.D. Too Dense to Drive

D Small disturbed sample

B Bulk disturbed sample

W Water sample

J Jar sample

V Pilcon Vane (kPa)

M Mackintosh Probe

Logged: SC

Checked:

Approved:

Scale: NTS

Weather: