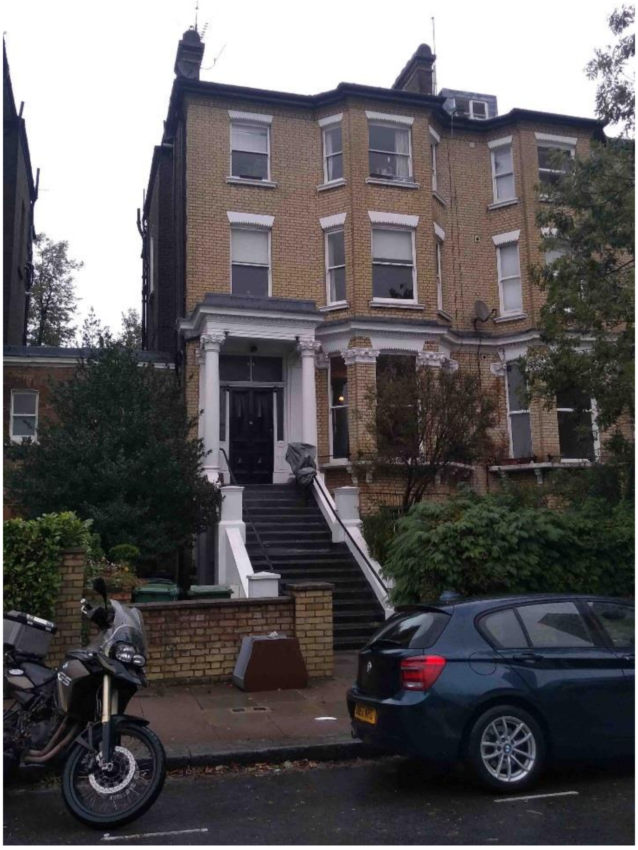
Report

Basement Impact Assessment

58A Fellows Road, London
NW3 3LJ

for

Mr Simon Wolanski



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Basement Impact Assessment

Site: **58A Fellows Road, London NW3 3LJ**

Client: **Mr Simon Wolanski**

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

Foreword

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

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

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

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

Contents Page

1. INTRODUCTION

1.1 This Basement Impact Assessment (BIA) has been prepared in support of a planning application to be submitted to the London Borough of Camden (LBC) for creation of a single-storey basement beneath the full footprint of No.58A Fellows Road, NW3 3LJ, including lightwells to front and rear of the house and an extension of the basement beneath part of the rear garden. Further details of the proposed works are given in Section 3. This assessment is in accordance with the requirements of the London Borough of Camden (LBC) Local Plan 2017, Policy A5 in relation to basement construction, and follows the requirements set out in LBC's guidance document 'CPG Basements' (March 2018).

1.2 This assessment has been undertaken by Keith Gabriel, a Chartered Geologist with an MSc degree in Engineering Geology (who has specialised in slope stability and hydrogeology), and reviewed by 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 many assessments of basements in several London Boroughs.

1.3 **Desk Study**: A site inspection (walk-over survey) of the property was undertaken on 2nd October 2020; photos from that inspection are presented in Appendix A. Desk study data have been collected from various sources including borehole/well logs from the area around the site (Appendix B), flood reports and flood modelling specific to the borough, historic maps (Appendices C & D), and environmental & geological data in Groundsure's Enviro+Geo Insight report (Appendix E). Relevant information from the desk study and site inspection is presented in Sections 2–6.

1.4 **Ground Investigations:** Sitework for the ground investigation (borehole and trial pits) was undertaken by GEA Ltd on 25th September 2020, the findings from which are presented in Section 9 and Appendix F.

1.5 The Screening, Scoping and basement impact assessments in accordance with CPG Basements, Stages 1-4, are presented in Sections 7, 8 & 10 respectively.

1.6 The following site-specific documents in relation to the proposed extension and planning application have been considered:

CAD Surveys Ltd:

- Drg No. 1099-S01 Existing Site Plan
- Drg No. 1099-S02 Existing Ground + First Floor Plans

Property Risk Inspection Ltd:

Arboricultural report on trees in the rear garden, prepared in in relation to a buildings subsidence claim (March 2020).

Brod Wight Architects (issued 11.12.2020)**:**

- Drg No. 1099-AP01 Proposed Site Plan
- Drg No. 1099-AP02 Proposed Basement Plan
- Drg No. 1099-AP03 Proposed Ground Floor Plan (& Section thr' Lightwell)
- Drg No. 1099-AP04 Proposed First Floor + Roof
- Drg No. 1099-AP05 Proposed Front Elevation
- Drg No. 1099-AP06 Proposed West Side Elevation
- Drg No. 1099-AP07 Proposed Rear Elevation
- Drg No. 1099-AP08 Proposed Section A-A
- Drg No. 1099-AP09 Proposed Section B-B

Michael Chester & Partners LLP (Structural Engineers):

- Drg No. 20078/01 rev.C Lower Ground Floor Plan
- Drg No. 20078/02 rev.C Ground Floor Plan
- Drg No. 20078/03 rev.A Sections A & B
- Drg No. 20078/04 rev.A Section C
- Drg No. 20078/05 rev.A Section D

- Drg No. 20078/SK01 rev.A Loads to Existing Walls
- Drg No. 20078/SK02 rev.D Sequence of Construction – Sheet 1
- Drg No. 20078/SK03 rev.D Sequence of Construction – Sheet 2
- Drg No. 20078/SK04 rev.D Sequence of Construction – Sheet 3
- Drg No. 20078/SK05 rev.B Sequence of Construction – Sheet 4
- Drg No. 20078/SK06 rev.D Sequence of Construction – Sheet 5
- Drg No. 20078/SK07 rev.B Sequence of Construction – Sheet 6
- Drg No. 20078/SK08 rev.B Sequence of Construction – Sheet 7
- Drg No. 20078/SK09 rev.B Sequence of Construction – Sheet 8
- Drg No. 20078/SK10 rev.B Sequence of Construction – Sheet 9
- Drg No. 20078/SK11 rev.B Sequence of Construction – Sheet 10
- '20078 Fellows Road - garden basement room foundation loads' (Permanent and Variable)

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

1.7 Instructions to prepare this Basement Impact Assessment were received by email from Jane Gleeson of Firstplan Ltd, on behalf of the client, on 17th August 2020.

2. THE PROPERTY, TOPOGRAPHIC SETTING AND PLANNING SEARCHES

2.1 No.58 Fellows Road is a four-/five-storey semi-detached house (see cover photo and Photo 1 in Appendix A), in the Belsize Conservation Area of the London Borough of Camden (LBC). Flat A occupies what would normally be considered as the lower ground floor of No.58, though it is referred to herein and on the Brod Wight drawings as the ground floor. Flat A also includes a small 'bridging' room over the side access path at 1st floor level (ground floor level in the main house) which is linked to a similar feature to the adjacent No.60; access to that room is via a staircase within the ground floor to the main part of the house.

2.2 No.58 is situated on the north side of Fellows Road, and is adjoined by No.56 to the east (the other half of this pair of semis) as shown on Figure 1. To the rear, No.58's garden adjoins the grounds of Sarum Hall School, which fronts onto Eton Avenue.

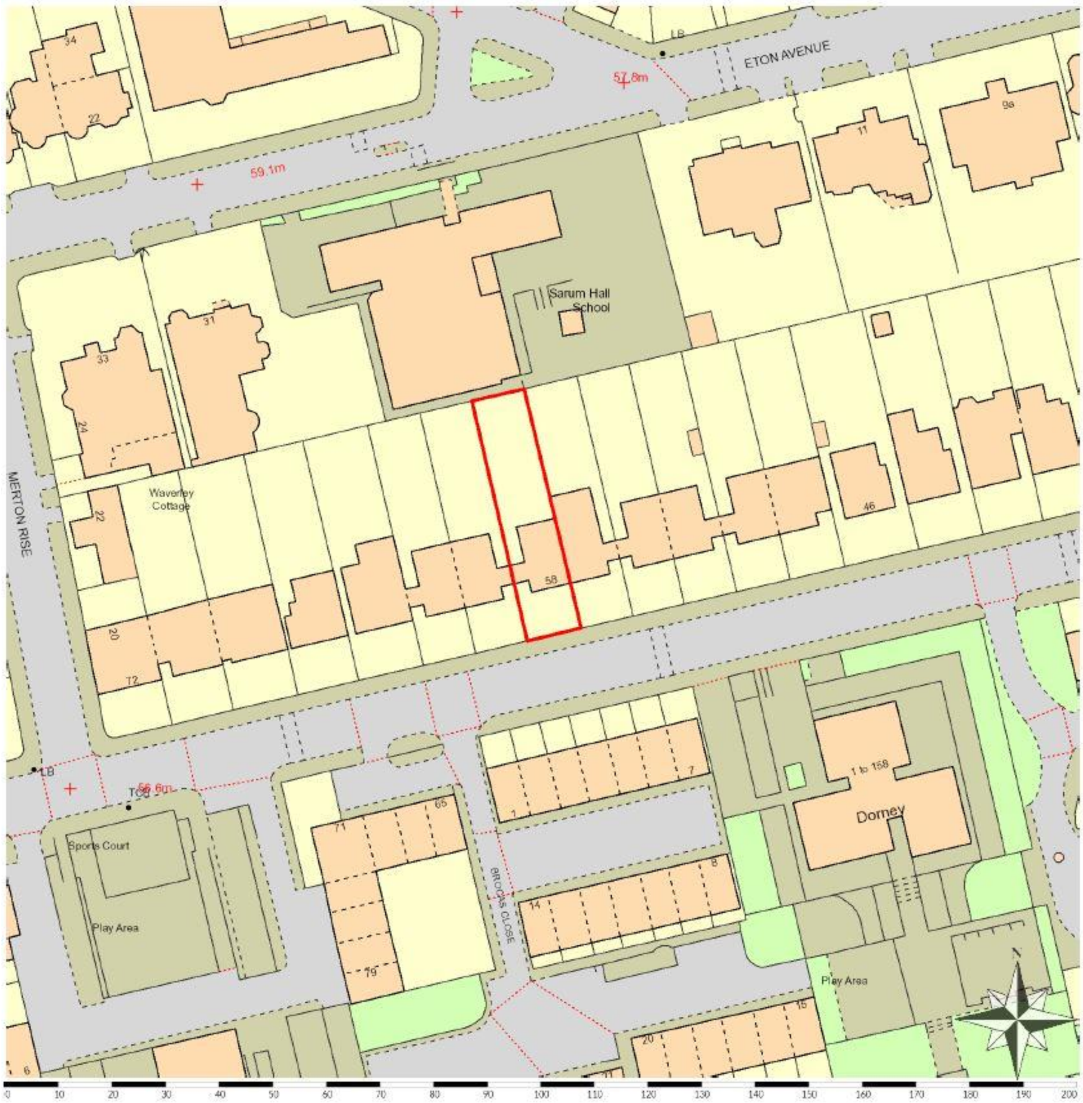

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Figure 1: Extract from 1:1,250 OS map (not to scale) with the site outlined in red.

2.3 Externally, No.58A's front garden is broadly level at 55.0-55.3m above Ordnance Datum (AOD). It includes a raised planter between the west boundary and the path to No.58A's front entrance, flower beds with shrubs and an unmade path in front of the bay, a small holly tree, a hedge immediately inside the front boundary wall and a substantial flight of 17 steps up to the porticoed main entrance to the upper levels of the house (cover Photo and Photos 3 & 4).

2.4 The rear garden is fully enclosed within brickwork boundary walls and rises gently away from the rear of the house, rising from 55.7-56.0m to 57.3m AOD near the rear boundary (Photo 6). Immediately alongside the rear wall of the house, excavations into the slope have allowed a slightly irregular concrete path to be constructed at 54.9-55.1m AOD (Photo 7). A conifer (TG1) and an Ash tree (TG2), which featured in the arboricultural report by Property Risk Inspection Ltd (March 2020) in relation to a buildings subsidence claim, both remained standing at the time of our inspection, together with three other trees at the rear end of the garden. Several stumps were also seen, which are understood to be from the self-seeded Ash trees (TG3) which have been felled this year.

2.5 The first available historical Ordnance Survey (OS) maps with coverage of this area, dated 1871 (1:1,056 and 1:2,500 scales, as presented in Appendix C), show that the area remained undeveloped farmland with five apparently natural ponds to the north, east and south-east. Adelaide Road was already present to the south and fully developed with pairs of semi-detached houses, while only the eastern part of Fellows Road, beyond Primrose Hill Road, existed at that time.

2.6 By 1896 Fellows Road had been completed, with all the housing along both sides fully built-out. The road network to the north of Fellows Road had also been completed and the area was in the process of being developed with residential housing and stables. A large saw mill was also present on the south side of Lancaster Grove.

2.7 By publication of the 1916 OS map (surveyed 1915), the area was almost fully developed with five large detached houses on the previously almost completely vacant land adjoining the rear of No's 40-72 (even) Fellows Road. The site for the Lancaster Grove Fire Station, located due north of No.58 on the north side of Eton Avenue, was shown as vacant (except for two tiny buildings near one corner) even though its Grade 2* listing records it as having been built in 1912-15.

2.8 The 1935 map shows a new building in the grounds of No.15 Eton Avenue, immediately alongside the rear boundary of No.58 (and half of No.56's rear boundary). That building remained until No.15 was demolished in 1994 to make way for the completely new Sarum Hall School building which was completed in 1995, as shown on the latest (2003) historical OS map.

2.9 Few other changes were evident from the historical maps in the immediately surrounding properties within the Conservation Area, with relatively little destruction by enemy bombing during WW2 in this area – the closest sites to be shown vacant on the first post-war 1:2,500 scale map (1953) were No's 71-77 (odd) Adelaide Road, some 150-200m to the south-west of No.58. The rear extension to No.56 is shown only on the current 1:1,250 scale map (see Figure 1). In contrast, between 1955 and 1985, all the Victorian semi-detached houses on the south side of Fellows Road were demolished and replaced by tower blocks and terraces of modern, 3-storey town houses with flat roofs.

2.10 The London County Council Bomb Damage Map for this area (London Topographical Society, 2005) shows No.66 Fellows Road as the nearest house to be affected by bomb damage, recorded as "*Seriously damaged; doubtful if repairable*". No's 72, 79 & 81 were also recorded as having suffered "*Blast damage, minor in nature*". The Hampstead bomb map shows no bombs in the area close to No.58. The combination of this evidence would suggest a relatively low risk for the presence of unexploded bomb(s), though this must not be taken as conclusive proof of the absence of unexploded ordnance (UXO). A specialist screening report has been obtained by GEA and is included in their report (see Appendix F).

2.11 Widespread crack damage was noted internally during the inspection on 2nd October 2020, including diagonal cracking in the two transverse walls indicative of relative settlement alongside the 56/58 party wall (see Photo 8 in App.A), cracking on both sides of the rear bay, cracks above both sides of the lintel over the kitchen window, cracks above the Hall-Kitchen doorway and various cracks at wall-ceiling junctions. Some door frames were distorted out of square (probably historic in part). Evidence of apparent rising damp was also noted in the 56/58 party wall in the front reception room. Externally there appeared to be less evidence of structural damage, though recent re-pointing and limited distortion of the brickwork lintels was noted in both the front and rear walls (in addition to older comprehensive re-pointing). This is not an exhaustive list of structural or other damage.

<u>Topographic Setting:</u>

2.12 No.58 is located on the south-south-easterly facing flank of a weakly developed ridge which falls in a south-south-westerly direction from the area around the Belsize Park underground station, as shown by the 55m and 60m contours in Figure 2. The maximum overall slope angle between those contours in the vicinity of the property is **1.8°**. The two headwater arms of the River Tyburn, one of the 'lost' rivers of London, pass to the west of this ridge (see Figure 5 and paragraph 5.1).

2.13 Spot heights on Eton Avenue (the next road to the north of, and parallel with, Fellows Road) on the 1:2,500 scale OS maps in Appendix C show that Eton Avenue falls both westwards towards the former River Tyburn and eastwards towards the former River Fleet. The high point (watershed) is at or near the **59.1m AOD** spot height which is adjacent to the west boundary of the Sarum Hall School's site and the Lancaster Grove Fire Station's site. From there, Eton Avenue falls at overall slope angles of **1.1°** eastwards to its junction with Primrose Hill Road and westwards at **0.5°** to the 58.2m AOD spot height (though becomes slightly steeper further to the west). Fellows Road probably follows a similar pattern, with No.58 on the eastward-falling section, although there are insufficient spot heights to confirm that.

2.14 Spot heights on 'Existing Site Plan' by CAD Surveys (Drg No. 1099-S01) indicate that the rear part of the rear garden slopes southwards at approximately **4.5°**; this reduces to approximately **2.5°**in the area of the garden where the proposed basement would be present.

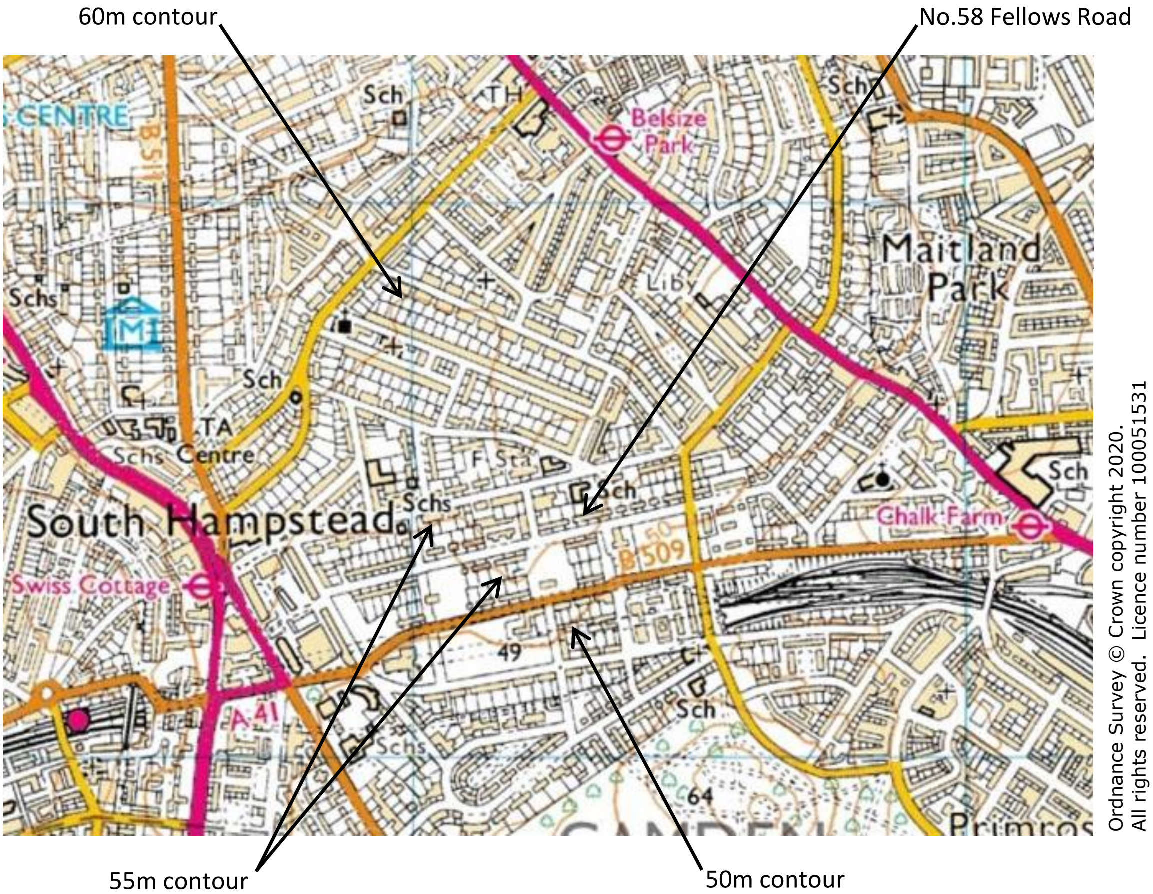

Figure 2: Extract from 1:25,000 Ordnance Survey map (not to scale) with contours.

<u>Planning Searches:</u>

2.15 Searches were made of planning applications on Camden council's website (between 24th and 29th September 2020) in order to obtain details of any other basements which have been constructed, or are planned, in the immediate vicinity of the property. Details of No.56A had already been made available to us by the client, but are included here for convenience and completeness. Plans of other the adjoining property, No.60, were also sought and were downloaded where available. These searches found:

- **Adjoining No.56A Fellows Road:**
    - Application (2009/4074/P) involving "Additions and alterations to include the e*rection of a full width single rear extension and excavation to include creation of a basement with rear and side lightwells…*" was granted planning permission on 3rd November 2009.

  - A subsequent non-material amendment (Application 2013/2251/P) allowed for "partial infilling of the lightwells to the rear and side elevation" and was granted consent on 15th May 2013.

- **Adjoining No.60 Fellows Road:**
  - Application 32322 for "*Change of use and works of conversion to sub-divide the existing maisonette on ground and basement floors into two self-contained flats"* was granted planning permission on 24th April 1981. Unfortunately the one file of drawings available on Camden's website belongs to some other completely different application. The "*basement*" floor is taken to be the lower ground floor, at the same level as No.58A.
  - Two applications (2014/2422/P & 2014/2424/P) involving extensions at second/third floor levels above the link to No.58A were both refused and the appeal for the former was dismissed. No plan of the lower ground floor was available.

- **Adjacent Sarum Hall School (No.15 Eton Avenue):** No relevant applications other than works to trees; the latest applications concerning trees in the rear garden were in 2007 for "*1 x Chestnut & 1 x Sycamore - Lift and cut back spread over play area by 25%*" and application 2020/2536/T for "*2 x Tilia cordata (Common Limes) (T20 & T21) - Clear branches from school by 2m*".

- **No.54 Fellows Road:** Application 2012/3816/P for "*Erection of single storey rear extension. External alterations to side elevation at lower ground floor level comprising of the installation of new entrance door and window. Internal alterations to flats 9 and 11 at lower ground floor level. Alterations to front elevation at lower ground floor level including replacing bay window with French doors and replacement of all front lower ground floor windows with timber sash windows. Part paving of rear and front gardens*" was granted consent on 18th October 2012. Copies of the supporting plans and elevations were obtained.

- **No.62 Fellows Road:** No relevant applications. Several applications for tree works have been approved or 'no objections raised', and an application for issue of an "*Established Use Certificate for use as three self- contained flats and one self-contained maisonette*" was granted in 1990.

- **Dorney Tower:** Plans of the existing basement car park were obtained from Application 2003/3489/P.

2.16 Planning consent has also been obtained recently (Application 2020/2736/T, granted 9th July 2020) for the felling of various trees in the rear garden of No.58.

3. PROPOSED BASEMENT

3.1 The proposed works at No.58A Fellows Road for which planning permission will be sought, as shown in the scheme drawings by Brod Wight Architects (see paragraph 1.6), will comprise:

- Single-storey ground floor extension, extending out to the same line as No.56's ground floor extension; level of ground floor reduced, with internal steps down from main entrance door in flank wall.
- Single-storey basement beneath the full footprint of the house (excluding the first floor bridging link to No.60) and continuing beneath the rear garden, to approximately 13.8m from the main rear wall of the house (about 9.6m to the rear of the ground floor extension).
- Internal lightwell in the rear part of the basement, positioned immediately to the rear of the western half of the ground floor extension, with staircase leading up to ground floor's sliding doors in rear wall.
- Lightwell at the front of the property, approximately symmetric on the front bay and spanning the full width between the 56/58 boundary wall and the flank wall of the steps up to the main front entrance.
- Ground level terrace and pergola alongside the rear lightwell.
- Re-profiled side access path.
- Removal of the floor to the bridging room and the staircase leading up to that in order to create a double-height space.
- Various internal alterations at ground floor level.

3.2 Brod Wight have advised us (email 6th October 2020) that the finished floor level (FFL) in the basement will be **51.17m AOD** and the structural slab level (SSL) will be **50.92m AOD** (which allows 250mm for cavity drainage, insulation and floor structure). The structural drawings by Michael Chester LLP show that the underpin bases will be **450mm thick**, while the central basement slab will be 225mm thick underlain by 225mm of void former, such that the excavation level (formation) for both the underpins and slab will be approximately **50.47m AOD**.

3.3 Excavation depths for the proposed basement are expected to range from **4.43m** below the lowest external ground level (= 54.90 – 50.47) to about **6.0m** at the rear end of the basement (= 56.5- 50.47).

3.4 Michael Chester LLP have also included 450mm diameter bored piles along the front wall of the front lightwell and around the basement beneath the rear garden, as far as access permits. Pile depths are usually determined by the contractor, as under standard UK practice the contractor designs the piles and provides a warranty for their performance.

4. 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 site geology of the Hampstead area.

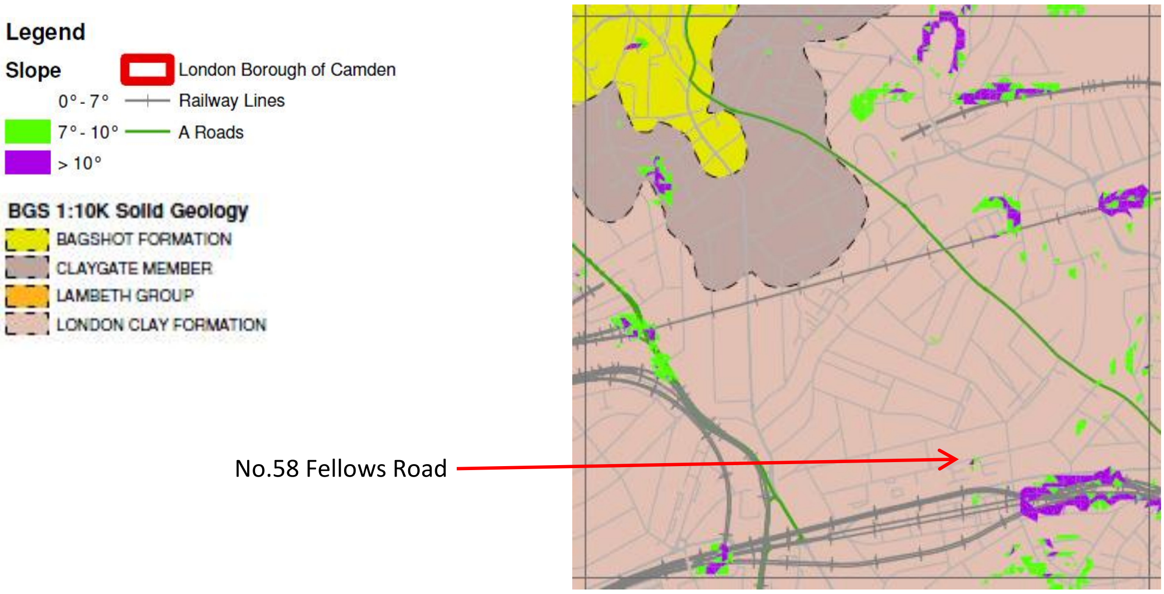

Figure 3: Extract from Figure 16 of the Camden GHHS showing geology and slope angles >7° (Arup, 2010)

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

4.3 The London Clay is well documented as being a firm to very stiff over-consolidated clay which is typically of high or very high plasticity and high volume change potential. As a result, it undergoes considerable volume changes in response to variations in its natural moisture content (the clay shrinks on drying and swells on subsequent rehydration). These changes can occur seasonally, in response to normal climatic variations, to depths of up to 1.50m and to much greater depths in the presence of the trees whose roots abstract moisture from the clay. The clay will also swell when trees are removed and 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 Enviro+Geo Insight report (Appendix E, Section 17); all indicated 'Negligible' or 'Very Low' hazard ratings with the exception of 'Shrink swell clays' for which a 'Moderate' hazard rating was given, which reflects the outcrop of the London Clay Formation at surface.

4.5 The Groundsure GeoInsight report (Appendix E, Sections 18) records:

- Historical surface ground working features, the closest of which were the excavations for the railway lines where they enter the three Primrose Hill Tunnels, located 246m to the south-east of the site (see App.E, Section 18.3).
- 69 records of historical underground workings within 1000m of the site, most of which relate to the Primrose Hill Tunnels to the south of the site (closest is recorded as 112m south of No.58). Other records concerned air shafts (two to south-east (closest at 296m) and two to south-west (closest at 359m) and tunnels more than 500m distant, which are completely irrelevant to the proposed basement (see App.E, Section 18.4,).
- No historical 'non-coal mining' features or 'mining cavities' within 1000m of the site (see App.E, Sections 18.6 & 18.7).
- No records of mining on site for five specific mineral deposits (see App.E, Sections 18.9 to 18.13).

It should be noted that these databases are based on mapping evidence so inevitably will provide an incomplete record of underground workings. For linear features, the distances quoted are to their centreline.

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

- BGS Boreholes TQ28SE/280: Unfortunately, the record for this borehole at the Fire Station site was not available.
- BGS Boreholes TQ28SE/2007-2016 (BH1-BH10) were all drilled as part of a ground investigation in 1962 for Hampstead Borough Council. These boreholes display similar information so Table 1 presents only the minimum and maximum depths. In three boreholes the two uppermost strata were absent, so these may have been drilled from lower, previously excavated levels; these boreholes are therefore presented separately.
- Claystone was recorded at 22.55-22.68m depth in BH TQ28SE/2013 (BH7).

Table 1: Summary of Strata in BGS Boreholes				
Strata (abbreviated descriptions)	**Depths to base of strata and Thicknesses (m)**			
	TQ28SE/2007-2013 (BHs 1-7)		**TQ28SE/2014-2016 (BHs 8-10)**	
	Depth	Thickness	**Depth**	Thickness
Made Ground (over concrete in BH2)	**0.15-1.37**	0.15-1.37	**-**	-
(Soft) brown/light brown CLAY (Head deposit?)	**1.82-3.05**	0.91-1.70	**-**	-
Brown/light brown CLAY with blue mottle. (Weathered London Clay Fm)	**4.27-6.10**	2.13-4.27	**3.05-4.27**	3.05-4.27
Brown CLAY. (Weathered London Clay Fm)	**8.53-11.58**	3.20-5.49	**7.62-8.53**	3.96-4.57
Blue CLAY (London Clay Fm)	**>24.4**		**>24.4**	
Seepage/Strike	**None**	-	**None**	-
Groundwater standing level	**-**	-	**-**	-

5. HYDROLOGICAL SETTING (SURFACE WATER)

Approximate location of No.58 Fellows Road

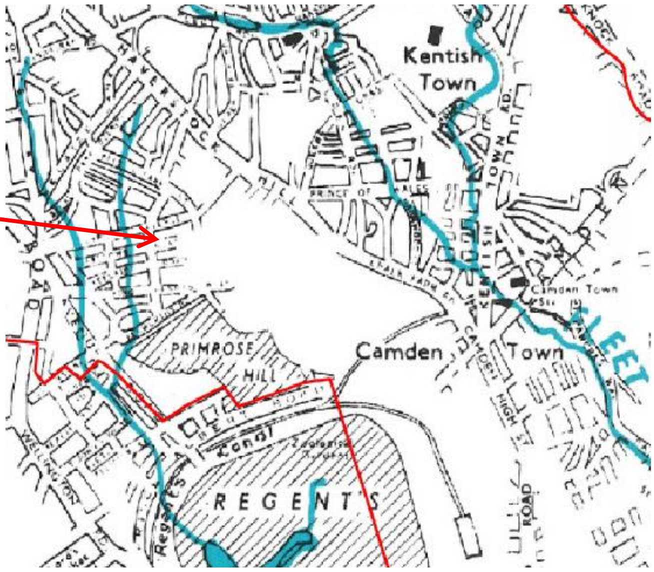

Figure 4: Extract from Figure 11 of the Camden GHHS (Arup, 2010) showing former watercourses, based on Barton (1992).

5.1 The site lies to the east of the two headwaters of the river Tyburn, one of the 'lost' rivers of London, as shown in Figure 4, though it is actually within the catchment of the river Fleet owing to its position to the east of the weakly developed ridge (see paragraph 2.12) which forms a hydrological watershed. Most of these 'lost' rivers now run in dedicated culverts or the sewer system. In the case of the eastern arm of the Tyburn headwaters, that culverting appears to have been done prior to the survey for the 1866/1874 historic OS map (1:10,000 scale, see Appendix D), because it is not on that map.

5.2 The cross-fall on the public footway towards the gutter (Photo 2 and levels on survey drawing), together with the gentle eastwards fall of Fellows Road, are expected to ensure that surface water drains away from the property's pedestrian access under normal conditions.

5.3 The front garden to No.58 is fully enclosed within brickwork walls, other than at the pedestrian access point. Spot heights within the front garden (see Drg No.1099-S02) indicated that the soft landscaped area to the east of the main flight of steps falls very gently towards the road, though, as that is largely soft landscaped with gravel and flower beds, run-off is expected to be minimal, if any. To the west of the main flight of steps is the path leading to the front entrance to No.58A; this path is slightly sunken in the middle so a channel drain has been installed to collect surface water (see Photo 4 in Appendix A). Infiltration is possible in the raised flowerbed alongside the 58/60 garden boundary wall. Therefore the surface water catchment for the front garden is expected to be restricted to the site itself.

5.4 No.58's rear garden is fully enclosed by brickwork walls, so its catchment will also be limited to direct rainfall into the site. Almost all of the rear garden is soft landscaped, with the exception of a narrow concrete path alongside the rear wall of the house (Photos 5, 6 & 7). Surface water is therefore able to infiltrate over the majority of the area of the rear garden (except when the ground is saturated or frozen), though the volume of infiltration will be limited by the presence of the underlying London Clay (and possible clayey Head Deposits; see Sections 4 & 9).

5.5 Figure 5 shows that Fellows Road was subject to surface water flooding during the 1975 flood event but not in the 2002 event. The implications of those historical events are addressed in Section 10.8. While the whole length of the road is recorded as having flooded, those floods generally affected only a short length (usually the 'low point') of the road which, in the case of Fellows Road, could have been at either the west or east end, or both, but was unlikely to be near No.58.

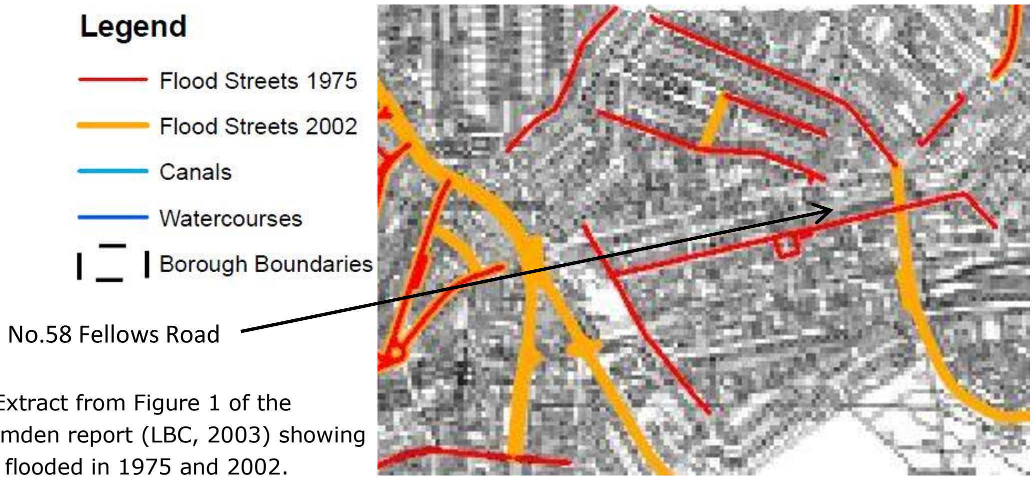

Figure 5: Extract from Figure 1 of the Floods in Camden report (LBC, 2003) showing roads which flooded in 1975 and 2002.

5.6 The Environment Agency's classifications for the risk of flooding from rivers and sea at Fellows Road (available on the GOV.UK website), has shown that the site is:

- Within Flood Risk Zone 1, so has less than 1 in 1000 annual probability of river or sea flooding (<0.1% in any given year), **not** taking into account the presence of any flood defences;
- Classified under the Environment Agency's Risk of Flooding from Rivers or Seas (RoFRaS) dataset, which **does** allow for the beneficial effects of any flood defences (though irrelevant in this part of Camden), with a 'Very Low' probability of flooding, which is once again defined as "*each year this area has a chance of flooding of less than 0.1%*" (<1 in 1,000).

These are all as expected, given the remote position of Fellows Road relative to the River Thames floodplain and the former course of the 'lost' river Fleet (see paragraph 5.1).

5.7 The Environment Agency's modelling also shows that this area does not fall within an area at risk of reservoir flooding; with the nearest potentially affected areas (the "maximum extent of flooding") being 720m to the south of No.58, on the south-west side of Primrose Hill, and just over 1km to the north, derived from the Hampstead Pond Chain.

5.8 Some hydrological data for the site has been obtained from the Groundsure Enviro+Geo Insight report (see Appendix E), including:

- An underground watercourse is recorded by the 'OS MasterMap' data at 112m to the west of the site (App.E, Section 6.1); this is believed to be the River Fleet, which is shown by Groundsure as a linear feature from Hampstead Pond No.1 to the Serpentine (with a slight bend close to Edgware Road), whereas in reality its course in the sewer system is far more complex and so this specific location is not reliable;
- No surface water features were identified within 250m of the site (App.E, Section 6.2);
- Under the EU's Water Framework Directive, the site is in the London Coastal Catchment, draining to the Thames, and does not fall within a 'River Water Body' catchment (App.E, Sections 6.3 & 6.4);
- There are two active surface water abstraction licences (for more than 20m^3 per day) within 2000m of the site, both from the Regent's Canal and so neither are relevant to the proposed basement (App.E, Section 5.7).
- The Environment Agency have no records of historical flooding within 250m of the site since 1946 (App.E, Section 7.2);
- There are no flood defences, no areas benefiting from flood defences, and no flood storage areas within 250m of the site (App.E, Sections 7.3, 7.4 & 7.5).
- Flood modelling by Ambiental Risk Analytics gives a 'Negligible' risk of surface water flooding affecting No.58 in all four rainfall event return periods modelled (1 in 30 years to 1 in 1,000 years) (App.E, Section 8).

5.9 The Environment Agency (EA) published a new map of 'Flood Risk from Surface Water' in January 2014, and a more detailed version has since become available on the 'Check your Long Term Flood Risk' pages of the GOV.UK website, an extract from which is presented in Figure 6 below. This map identifies four levels of risk (high, medium, low and very low), and is based primarily on topographic levels (from LiDAR data), flood depths and flow paths. The EA's definitions of these risk categories are:

'Very low' risk:	Each year, these areas have a chance of flooding of less than 1 in 1000 (<0.1%).
'Low' risk:	Each year, these areas have a chance of flooding of between 1 in 1000 (0.1%) and 1 in 100 (1%)
'Medium' risk:	Each year, these areas have a chance of flooding of between 1 in 100 (1%) and 1 in 30 (3.3%).
'High' risk:	Each year, these areas have a chance of flooding of greater than 1 in 30 (>3.3%).

Figure 6: Extract from the Environment Agency's 'Flood Risk from Surface Water'.
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5.10 The EA's modelling presented in Figure 6 shows that the majority of No.58's site and the adjoining properties all have a 'Very Low' risk of flooding from surface water; this is the national background level of flood risk. The exception is a narrow strip alongside the rear walls of these houses, where areas at a 'Low' and 'Medium' risk of flooding from surface water are shown; this is consistent with the levels on the topographic survey, which showed the path alongside the rear wall to be the lowest part of the site. The Fellows Road carriageway adjacent to No.58 and the adjoining houses have also been modelled with a 'Very Low' flood risk except for a narrow ribbon of 'Low' risk alongside the southern kerb, which supports the likelihood that the 1975 flooding affected only that lowest part of the road (see paragraph 5.5).

5.11 Surface water flood modelling has also been undertaken by URS as part of a Strategic Flood Risk Assessment (SFRA) 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's modelling, this map identifies the same four levels of risk (high, medium, low and very low). This modelling is less clear than the EA's, though also shows that the majority of No.58's site, the adjoining properties and the adjacent part of the Fellows Road carriageway are classified as being at 'Very Low' risk of flooding from surface water with a similar area of 'Low' and 'Medium' risk alongside the rear walls of these houses.

5.12 Figure 7 also shows that Fellows Road falls within the Group3_005 Critical Drainage Area, but it does not fall within any of the Local Flood Risk Zones (see SFRA Figure 6, Rev.2).

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

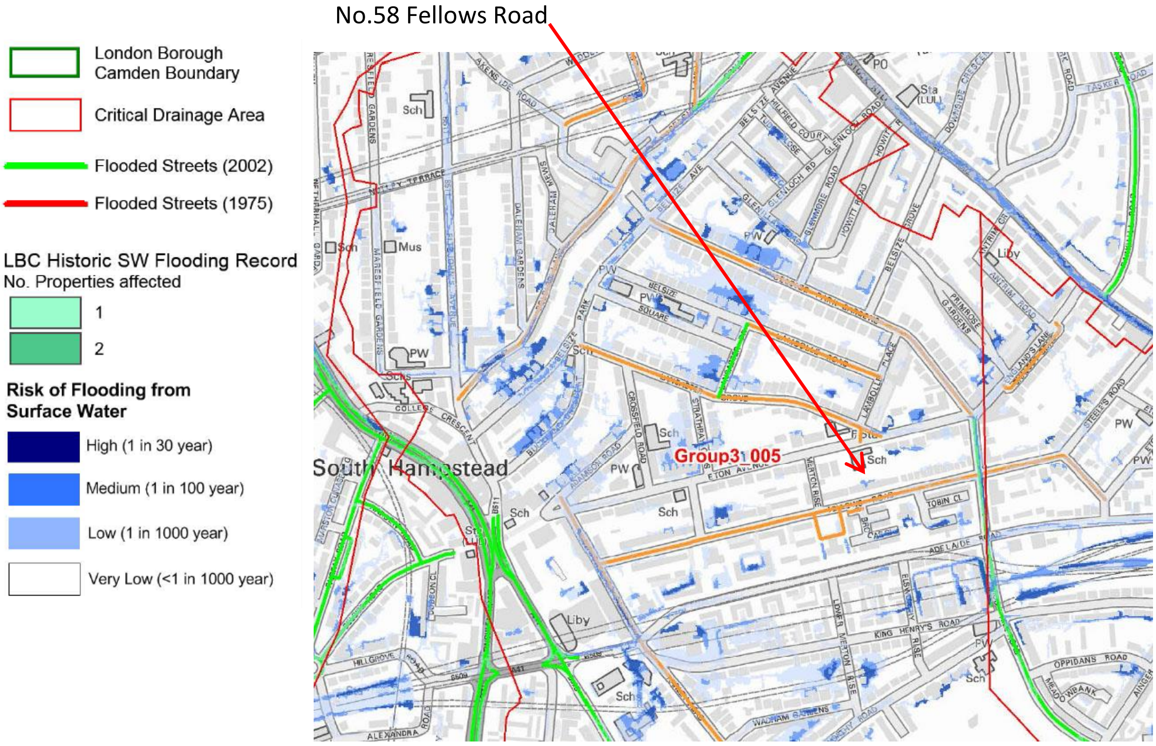

Figure 7: Extract from Figure 3v of the Camden Strategic Flood Risk Assessment (SFRA) (URS, July 2014) showing risk of flooding from surface water.

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5.14 Figures 5a & 5b of the Camden Strategic Flood Risk Assessment present historic records of internal and external sewer flooding respectively, based on Thames Water's DG5 Flood Register. These figures show that, when the Camden Strategic Flood Risk Assessment was written (July 2014), eight properties within the 'NW3 3' postcode area were recorded by Thames Water as having been affected by internal sewer flooding in the preceding 10 years, and none were recorded as having been affected by external sewer flooding in the preceding 10 years.

6. HYDROGEOLOGICAL SETTING (GROUNDWATER)

6.1 The London Clay Formation is classified by the Environment Agency as an 'Unproductive Stratum', as indicated by Figure 8. The site does fall just within the Outer Source Protection Zone (SPZ) for Thames Water's Barrow Hill abstraction on the south-west side of Primrose Hill. As that pumping station abstracts water from the Chalk principal aquifer at depth, the proposed basement is unlikely to have any impact on the SPZ.

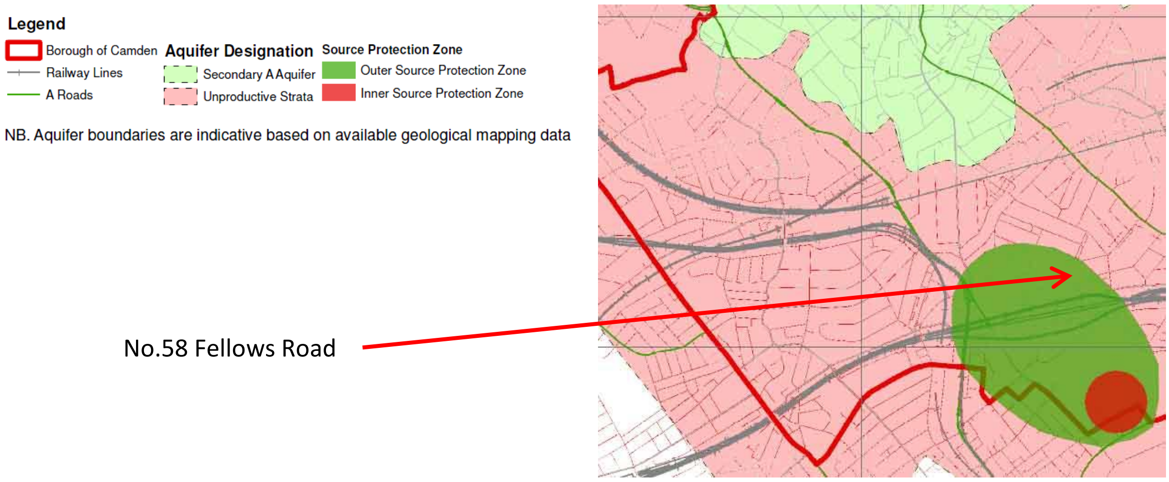

Figure 8: Extract from Figure 8 of the Camden GHHS (Arup, 2010) showing aquifer designations and SPZs. (Red = Zone I, Dark Green = Zone II).

6.2 New groundwater vulnerability mapping has been undertaken jointly by the BGS and Environment Agency; this mapping presents an assessment of the vulnerability of groundwater to a pollutant discharged at ground level based on the hydrological, geological, hydrogeological and soil properties within a one kilometre square grid. Groundwater vulnerability is described as High, Medium or Low based on the leachability and permeability of the soils concerned, with superficial and bedrock aquifers classified separately. The London Clay Formation is classified as having an 'unproductive' vulnerability with a 'Low' leaching class and infiltration value of 40-70% within 50m of No.58 (see Groundsure's Enviro+Geo Insight report in Appendix E, Section 5.3).

6.3 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.

6.4 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.

6.5 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.

6.6 The groundwater catchment areas upslope of No.58 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, 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 Enviro+Geo Insight report (Appendix E) include:

- There are no licensed groundwater or potable water abstractions (of greater than 20 cubic metres per day) within 500m of the site and none of the abstractions over 500m from No.58 will be relevant to the proposed basement (App.E, Sections 5.6 & 5.8).
- For No.58's site and an area within 50m of the site, Ambiental Risk Analytics has classified the susceptibility to groundwater flooding as '**Negligible'** for a 1 in 100 year return period (App.E, Section 9.1).
- Groundsure's report states incorrectly that are no Source Protection Zones (SPZs) for confined aquifers within 500m of the site (App.E, Section 5.10), whereas the site does fall within the SPZ for the Barrow Hill pumping station see (paragraph 6.1 and Figure 8 above).

6.8 Groundwater flooding incidents were presented on Figure 4e of the Camden SFRA (see Figure 9 below). Around 44 incidents have been reported in the entire borough, but none were close to Fellows Road (and some of those records were at sites underlain by London Clay, so may have been surface water flooding which was mis-identified as groundwater flooding).

6.9 Details of what was found by the site-specific ground investigation in September 2020 are presented in Section 9.

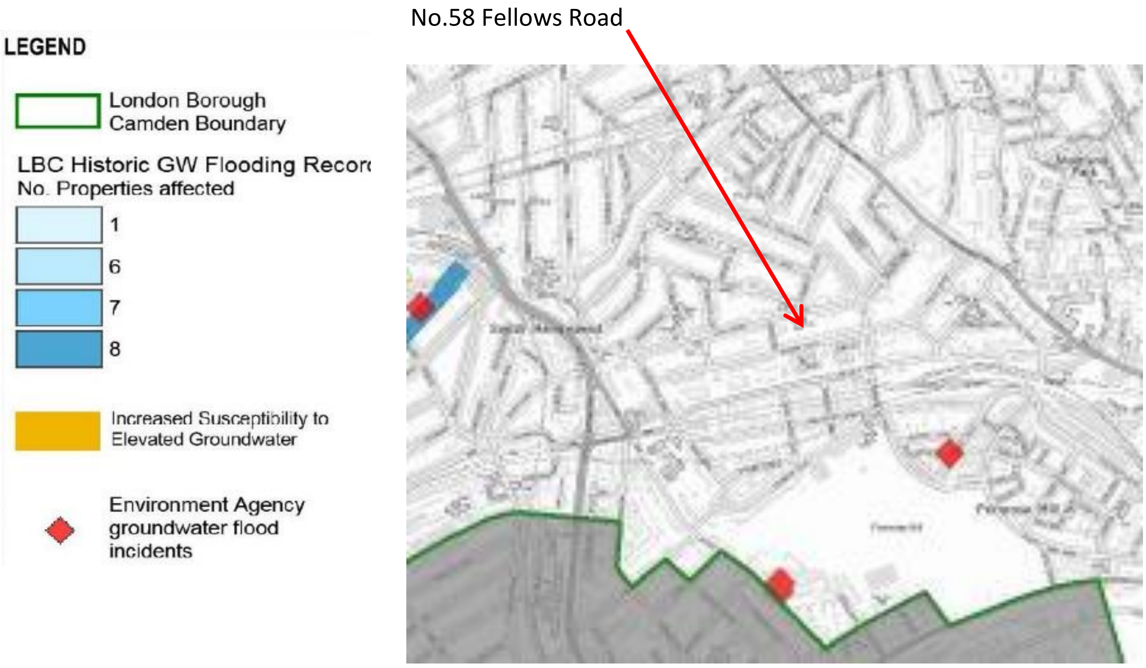

Figure 9: Increased Susceptibility to Elevated Groundwater – extract from Figure 4e of the SFRA.
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7. STAGE 1 - SCREENING

7.1 The screening has been undertaken in accordance with the three screening flowcharts presented in LBC's CPG Basements (2018) 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 C, D & E) and other sources as referenced.

7.2 Subterranean (groundwater) flow screening flowchart:

Question		Response, with justification of 'No' answers	Clauses where considered further
1a	Is the site located directly above an aquifer?	No – Site underlain by London Clay	4.1 & Figure 3
1b	Will the proposed basement extend beneath the water table surface?	No, not beneath the water table in an aquifer, though it may extend below the phreatic surface of the groundwater in the London Clay.	9.6, 9.7, and 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.	5.1 & 5.8
3	Is the site within the catchment of the pond chains on Hampstead Heath?	No – Site is approx 1km to the south of the nearest pond chain catchment (Hampstead Pond Chain).	
4	Will the proposed basement development result in a change in the proportion of hard surfaced/ paved areas?	Yes	Carried forward to Scoping: 8.2 & Section 10.2
5	As part of the site drainage, will more surface water (eg: rainfall and run-off) than at present be discharged to the ground (eg: via soakaways and/or SUDS)?	No – Soakaways would be inappropriate in London Clay.	
6	Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to, or lower than, the mean water level in any local pond (not just the pond chains on Hampstead Heath) or spring line?	No – There are no surface water features within 250m of the site. Nearest springs are likely to be around 750m to the north-west (at the London Clay-Claygate Member interface).	5.8 & Figure 3

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

7.3 Slope/ground stability screening flowchart:

Question		**Response, with justification of 'No' answers**	**Clauses where considered further**
1	Does the existing site include slopes, natural or man-made, greater than 7°? (approximately 1 in 8)	No – The rear garden slopes at approximately 2.5-4.5° and Figure 16 in the Camden GHHS shows no slopes greater than 7° in this property or the adjoining sites	2.14 and Figure 3
2	Will the proposed re-profiling of landscaping at site change slopes at the property boundary to more than 7°?	No – The rear garden will be reinstated over the basement.	
3	Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	No – Figure 16 in the Camden GHHS shows no land greater than 7° in the vicinity of this property.	2.12 & Figure 3
4	Is the site in a wider hillside setting in which the general slope is greater than 7°?	No – Maximum slope angle calculated from the contours is 1.8° and Figure 16 in the Camden GHHS shows no slopes greater than 7° in the vicinity of this property.	2.12 & Figure 3 (Note: area of green/purple to SE of site is u/ground car park for Dorney tower.)
5	Is the London Clay the shallowest strata at the site?	Yes, it is the shallowest strata mapped by the BGS (though it may be overlain by Head Deposits).	Carried forward to Scoping: 4.1, 8.3, Section 9
6	Will any tree/s be felled as part of the proposed development and/or are any works proposed within any tree root protection zones where trees are to be retained?	(Yes) – Some trees have already been felled in the rear garden.	Carried forward to Scoping: 8.2, Section 10.4
7	Is there a history of seasonal shrink/swell subsidence in the local area, and/or evidence of such effects at the site?	Yes.	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. No springs in the vicinity.	
9	Is the site within an area of previously worked ground?	No – See BGS map extract (Figure 3 herein) and Section 14.2 of the Enviro+ GeoInsight report (in App.E).	4.1 & Figure 3
10	Is the site within an aquifer? If so, will the proposed basement extend beneath the water table such that dewatering may be required during construction?	No – London Clay Formation is classified as an 'Unproductive Stratum'.	6.1
11	Is the site within 50m of the Hampstead Heath ponds?	No – Site is approx 1km south of the nearest pond chain (Hampstead).	
12	Is the site within 5m of a highway or a pedestrian right of way?	Yes (southern side of piled wall will be 4.6m from footway).	Carried forward to Scoping: 8.2, Section 10.4
13	Will the proposed basement substantially increase the differential depth of foundations relative to neighbouring properties?	Yes	Carried forward to Scoping: 8.3, Section 10.4
14	Is the site over or within the exclusion zone of any tunnels, eg railway lines.	No – Re. railway tunnels (but in HS2 safeguarding zone). Unknown re other tunnels.	Carried forward to Scoping: 8.3, 10.1.3

7.4 Surface flow and flooding screening flowchart:

Question		**Response, with justification of 'No' answers**	**Clauses where considered further**
1	Is the site within the catchment of the pond chains on Hampstead Heath?	No – Site is approx 1km south of the nearest pond chain (Hampstead).	
2	As part of the proposed site drainage, will surface water flows (eg volume of rainfall and peak run-off) be materially changed from the existing route?	No – Flow routes at surface should be unchanged. Only change to surface water flow route will be the lightwells (from where the surface water will have to be pumped into the drainage system)	
3	Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?	Yes	Carried forward to Scoping: 8.4 & Section 10.8
4	Will the proposed basement result in changes to the profile of the inflows (instantaneous and long-term) of surface water being received by the adjacent properties or downstream watercourses?	No – Brickwork boundary walls prevent any surface water run-off to the adjacent properties. There are no watercourses within 250m.	5.3, 5.4 & 5.8
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 run-off from this property goes to adjacent properties or directly to a surface watercourse.	5.3 & 5.8
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 – Fellows Road did flood in 1975 (though probably only a small part at the lower western or eastern ends of the road); modelling predicts localised surface water flooding within the site.	5.5, 5.10, 5.11 & Figures 5-7. Carried forward to Scoping: 8.4 & Section 10.8

7.5 <u>Non-technical Summary – Stage 1:</u>

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

8. STAGE 2 – SCOPING

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

8.2 Subterranean (groundwater) flow scoping:

Issue (= Screening Question)		Potential impact and actions
4	Will the proposed basement development result in a change in the proportion of hard surfaced/ paved areas?	**Potential impact:** Increased hard surfacing would decrease infiltration of surface water into the ground. **Action:** Review potential impacts of proposed changes, including appropriate types of SuDS for use as site-specific mitigation when relevant (ie: where reduced infiltration would be a problem).

8.3 Slope/ground stability scoping:

Issue (= Screening Question)		Potential impact and actions
5	Is the London Clay the shallowest strata at the site?	**Potential impact:** Heave in response to the unloading caused by the basement excavations, and as Q7 below. **Action:** Ground investigation required, followed by appropriate design.
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?	**Potential impact:** Heave from removal of trees (within area of root growth); slope(s) become less stable; damage to trees to be retained including possible loss of stability. **Action:** Obtain arboricultural assessment and review of potential impact on stability of buildings and/or slopes and/or the trees as relevant. Revise the scheme if required to prevent unacceptable impacts.
7	Is there a history of seasonal shrink/swell subsidence in the local area, and/or evidence of such effects at the site?	**Potential impact:** Weakened structures from past movement would be more susceptible to damage during works. Future differential movement between the building above the basement and the adjoining structures. **Action:** Review potential impact of future vegetation growth. Designer and contractor to take account of any weakening of the structure caused by past movements.
12	Is the site within 5m of a highway or a pedestrian right of way?	**Potential impact:** Construction of basement causes loss of support to footway/highway and damage to the services beneath them. **Action:** Ensure adequate temporary and permanent support by use of best practice underpinning methods.

13	Will the proposed basement substantially increase the differential depth of foundations relative to neighbouring properties?	**Potential impact:** Loss of support to the ground beneath the foundations to No.60 Fellows Road, 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. Piles or boreholes penetrating the tunnel**.** **Action:** Comply with HS2 safeguarding requirements. Undertake services search to check that there are no other tunnels / deep services in the vicinity.

8.4 Surface flow and flooding scoping:

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

8.5 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).
- Arboricultural advice to be obtained in relation to trees already felled and any others yet to be felled.
- Designer and contractor to take account of the 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, subject to Party Wall Act protocols.
- Undertake a services search to check whether there are any deep services/ tunnels which might be affected by the basement.
- Review and recommend appropriate types of Sustainable Drainage System (SuDS) in order to ensure that:
  - reduced infiltration does not result in detriment to the groundwater regime;
  - there will be no increase in surface water discharge rate to the adopted sewers, thereby mitigating the increased area of hard surfacing.
- Review flood risk and include appropriate flood resistance and mitigation measures in the scheme's design.

All the above review and recommendation actions are covered in Stage 4, or Stage 3 for the ground investigation.

9. STAGE 3 – GROUND INVESTIGATION

9.1 The ground investigation sitework was carried out by Geotechnical & Environmental Associates (GEA) on 25th September 2020, and consisted of two 'window' sampled boreholes (BH1 & BH2) drilled to a depth of 6.0m below ground level (bgl), and seven hand dug trial pits (TPs 1-6 & 5A). GEA's report from that investigation is presented in Appendix F, including factual findings from the investigation (site plan, borehole logs, trial pit logs, monitoring results and laboratory test results), a geoenvironmental desk study and geoenvironmental interpretation of the findings. Reference should be made to the logs for full details of the strata descriptions and footing geometries.

9.2 The trial pits were dug in order to investigate the foundations to the various walls which will be affected by the proposed works and to assess the nature and condition of the soils beneath the footings. The findings from those pits are presented with diagrams of foundation geometries in the Appendix to GEA's report, and a tabulated summary is presented in Section 4.6 of that report. TP5 was aborted because of a conflicting drainage pipe and replaced by TP5A. Where exposed, the foundations were all formed of brickwork, generally corbelled, and were founded between 0.41m and 1.20m below ground/floor level. All were underlain by Made Ground which generally comprised silty, slightly sandy, variably gravelly CLAY with a variety of artificial matter including fragments of brick, concrete, clinker and timber, half bricks rootlets and occasional ash. Frequent roots were found in TP4, alongside the rear bay, while whole bricks and concrete boulders up to 230mm across were found in TP6 (alongside the front end of the 58/56 party wall).

9.3 The geological sequence as found by the boreholes may be summarised as follows:

- <u>Made Ground:</u> 0.6m/0.9m of slightly clayey/silty, gravelly SAND with frequent brick, flint gravel and variable amounts of concrete fragments and roots/rootlets. Rare polystyrene was also noted between 0.3m and 0.9m in BH1. In BH2 (rear garden), 0.20m of silty, sandy TOPSOIL with roots and rootlets was present at surface.
- <u>Possible Head Deposits</u>: The "slightly gravelly" nature of the Stiff 'dry'/'very dry', light brown mottled grey, silty, slightly sandy CLAYS which underlay the Made Ground indicates that these clays could be a Head deposit, derived from the underlying clays and transported downslope, rather than in-situ Weathered London Clay. However, the gravel was recorded to depths of 3.80m/5.00m which is unusually deep for Head Deposits, so it remains possible that all the clays beneath 1.90m/2.00m are in-situ weathered London Clay. That interpretation is also supported by the presence of fissures in those clays and fine selenite crystals at 2.90m in BH1.

- Weathered London Clay Formation: As indicated above, at least the lower part of the stiff CLAYS which underlie the Made Ground comprise in-situ weathered London Clay, and it remains possible that the clays beneath 1.90m/2.00m depth are in-situ. The grey mottling down to 4.50m in both boreholes is a common feature in the weathering profile of London Clay.

9.4 Standard Penetration Tests (SPTs) were carried out in both boreholes at one metre intervals. The resulting 'N60' values (blows to drive the 300mm test length, after 150mm of 'seating' driving, corrected for test-related matters) are recorded at the relevant depths on the borehole log (in Appendix F), and have also been plotted as profiles against depth in Figure 10 below. The SPT values show an overall trend of increasing shear strength with depth, as is typically found in these strata.

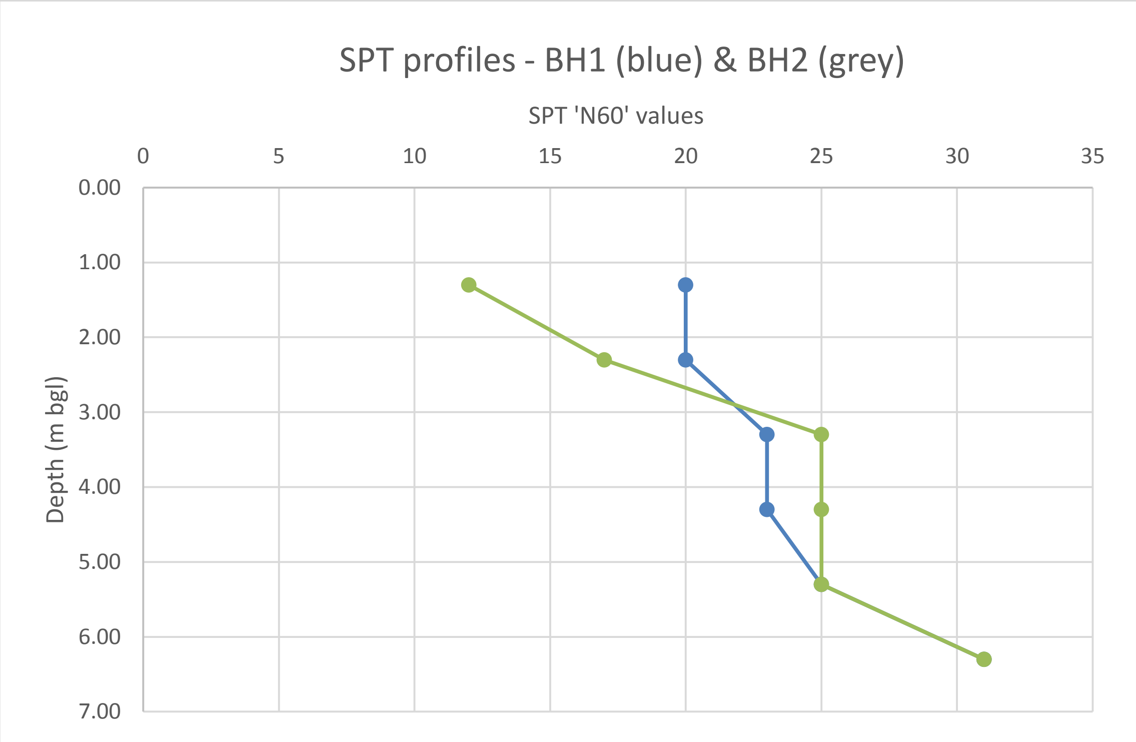

Figure 10: SPT 'N' values with depth

9.5 Undrained shear strengths of the clay material, which excludes the effect of any soil fabric such as fissures, were measured with a pocket penetrometer at 0.5m intervals (two levels within each run) starting at 1.0m. The readings are once again recorded on the borehole logs, and have been plotted as profiles against depth in the Appendix to GEA's report (page 34). Penetrometer readings are particularly sensitive to strength changes caused by varying water content and these profiles show clear evidence of desiccation to nearly 3.0m in BH1 and 4.0-4.5m in BH2.

9.6 Rootlets were recorded to a maximum depth of 4.0m bgl in BH1, and in all trial pits except TPs 5 & 5A. Frequent roots were recorded in TP4, alongside the rear wall of the house.

9.7 No groundwater entries were recorded in any of the exploratory holes (boreholes and trial pits) during drilling/excavation.

9.8 A standpipe was installed to 6.00m bgl in BH2, comprising 1.0m of plain pipe at top, then 5.0m of slotted pipe set in a granular response zone. Water level readings were recorded on two occasions; the results during this short monitoring period are presented in Table 2 below.

Table 2: Water levels from Groundwater Monitoring

Date	Depth to Water (m below ground level)	Water Level (m AOD)
16-10-2020	5.56	50.98
13-11-2020	3.84	52.70

<u>Laboratory Testing:</u>

9.9 Geotechnical laboratory tests were carried out by Geolabs Ltd on samples recovered from boreholes BH1 and BH2 and by i2 Analytical on samples from trial pits TP2 and TP4. The testing comprised classification tests (including water content and plasticity) and chemical testing to assess the potential for acid or sulphate attack on buried concrete. The test reports from Geolabs (Project No. GEO/31878) and i2 (Report No.20-32972) are presented in GEA's report in Appendix F.

9.10 Plasticity tests were performed on four samples of Head Deposits/Weathered London Clay. All four samples were both found to be of Very High Plasticity (see Figure 11 below), as classified by BS5930 (2015), and High Volume Change Potential, as defined by the NHBC (NHBC Standards, 2020, Chapter 4.2, Building near Trees).

9.11 The Water Contents of nineteen samples recovered from BHs 1 & 2 were found to vary from 21.9% to 30.5% and have been plotted against depth in the appendix to GEA's report. Particularly low values, at or below 25.0%, were obtained down to 1.5m/2.0m bgl, below which the Water Contents were all between 28.3% and 30.5% (with the exception of two slightly lower values).

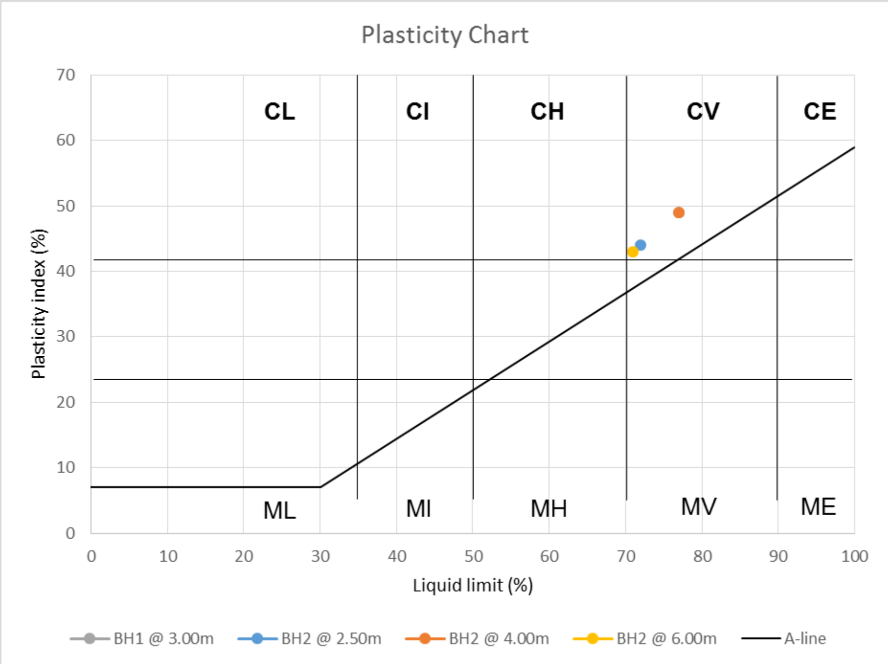

Figure 11: Plasticity chart for samples recovered from BHs 1 & 2.

9.12 The chemical tests were undertaken on a total of five samples in order to assess the potential for acid or sulphate attack on buried concrete. The samples tested included two samples of the natural clays and three from the Made Ground. The following ranges of results were recorded:

pH value:	8.1 – 8.9
Water-soluble sulphate:	120 - 1700mg/L

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

Made Ground:	DS-1 to DS-2
Head Deposits/Weathered London Clay:	DS-1

Non-technical Summary – Stage 3:

9.13 The site-specific ground investigation at No.58A Fellows Road found a limited thickness of Made Ground overlying natural clays. The maximum recorded thickness of the Made Ground was 1.20m in TP1, though the base was not found in that pit. The natural clays were stiff near surface, which was attributed to desiccation by tree roots, and became firm with depth. The presence of flint/chert gravel in the upper part of these clays indicates that they may be a Head deposit (see paragraph 4.2) while the clays below 3.80m/4.50m, and possibly up to 1.90/2.00m depth, were in-situ Weathered London Clay. This is broadly consistent with mapping by the British Geological Survey (BGS).

9.14 No groundwater entries were recorded in any of the boreholes or trial pits, though this does not mean that groundwater is absent. A standpipe was installed in BH2 in order to enable recording of groundwater levels/pressures. To date, two water level readings have been taken which showed the water in the standpipe rising very slowly to 3.84m below ground level; this indicates that the water level in the standpipe is unlikely to have equilibrated with (ie: matched) the water pressure in the surrounding clays. As the latest reading was taken seven weeks after the borehole was drilled, it also demonstrates the very low permeability of the surrounding London Clay.

10. STAGE 4 – BASEMENT IMPACT ASSESSMENT

10.1 Conceptual Ground Model

10.1.1 The desk study evidence, together with the ground investigation findings, suggest a conceptual ground model for the site characterised as follows. For further details of the geology found by the ground investigation, and the results of in-situ and laboratory testing, reference should be made to Section 9 and GEA's report in Appendix F.

- Made Ground: Made Ground was present in all the exploratory holes. The thickness in the boreholes was 0.60/0.90m with a locally greater thickness in TP1 where the base level was not proven at 1.20m below ground level (bgl). The Made Ground in the trial pits was generally described as "silty, slightly sandy, variably gravelly CLAY" with a variety of artificial matter (see paragraph 9.2 and the appended GEA report) and frequent roots in TP4; these clays may be disturbed in-situ soils rather than imported material. In contrast, the Made Ground found beneath the front and rear gardens comprised predominantly granular materials (silty, variably gravelly SAND) with artificial debris. Other materials, as well as other soil types and greater thicknesses/depths, are also likely to be present on site, owing to the inherent variability of Made Ground.
- Possible Head Deposits: Head deposits were not positively identified in the exploratory holes though the presence of gravel within the clays down to 1.90m/2.00m bgl indicates that those clays could be a locally-derived Head deposit (see paragraphs 4.2 and 9.3). Some gravel was recorded down to 3.80m/4.50m, however that would be unusually deep for a Head deposit and the presence of fissuring and selenite crystals below 1.90m/2.00m indicates that those clays are more likely to be in-situ Weathered London Clay. That interpretation is also supported by the plasticity test results from samples at 2.50m and 3.00m bgl, which gave broadly identical results as those from the underlying Weathered London Clay with no gravel (see paragraph 9.10 and Figure 11). The clays above 1.90m/2.00m were stiff and had significantly lower Water Contents than the underlying clays, while the penetrometer readings were notably higher than would be expected for London Clay at such depths; this evidence is all compatible with desiccation by plant roots.
- Weathered London Clay: Below 1.90m/2.00m the firm, fissured, light brown slightly sandy, silty CLAYS are attributed to the Weathered London Clay, despite the presence of some gravel, and are expected to underlie the whole site.
  The presence of fissuring within these clays reduces their shear strength, which makes such clays less stable in excavations than would otherwise be expected; the 'N' values from the in-situ Standard Penetration Tests should allow for the influence of the fissures and did indicate a progressive increase of shear strength with depth. Selenite (a form of gypsum, which is aggressive to buried concrete) was recorded at 2.90m bgl in BH1, and may be more widespread. These clays also often contain claystone nodules/horizons which can obstruct boreholes and

piles, and will undergo heave movements in response to net unloading by basement excavations.
The logs of other boreholes in the area indicate that the base of the Weathered London Clay was found at depths of 7.6-11.5m bgl (Table 1).

- London Clay Formation ('un-weathered'): Very stiff, grey CLAY of the London Clay Formation is expected to be present beneath the weathered brown clays and to underlie the whole site. These clays are likely to extend to a depth in excess of 50m. These clays are expected to be fissured, and will also undergo heave movements in response to net unloading by basement excavations.

- Hydrogeology
  - Perched groundwater should be expected in the granular Made Ground during at least the winter and spring seasons, though it may be present only locally. Local pockets of perched water may also be found in the clays of the Made Ground.
  - Groundwater pressures are expected to be essentially hydrostatic within the depth of current interest in the possible Head deposits and the London Clay, except where modified by tree roots and artificial impacts. 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. Occasional fine silt pockets and two sand pockets were recorded in BH1, but the minimal inflow into BH2's standpipe in the three weeks following drilling of that borehole provides good evidence for the very low permeability of these clays.
  - 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 10.2.8 for the recommended design groundwater level.

10.1.3 No railway tunnels are known to pass below or close to the site, though this must be verified. However, **the southern part of the site does fall within the Underground Safeguarding Zone for the HS2 railway**; the proposed basement works must therefore comply with any restrictions imposed which arise from this status. 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 Made Ground beneath the front and rear gardens comprised slightly clayey, silty SANDS with artificial debris. As these granular soils overlie clays, perched water should be expected in these soils during wetter periods of weather, even though none was found by the recent ground investigation. Local pockets of 'free' groundwater may also be present in the pockets/partings of granular soils within the possible Head deposits and Weathered London Clay, though the evidence from the boreholes indicates that such water is minimal or absent.

10.2.2 The common lack of groundwater entries into boreholes while drilling through the London Clay is caused by the low permeability of the clays and the temporary sealing of any slightly more permeable layers by the drilling process, rather than by an absence of water.

10.2.3 The low standing level of water in BH2's standpipe (in the rear garden) seven weeks after drilling the borehole, at 3.84m bgl, is considered to be unrepresentative of the water levels/pressures (phreatic surface) in the surrounding clays, so higher water levels/pressures must be expected and allowed for in the design of the proposed works.

Existing Basements:

10.2.4 The adjoining No.56A, which is also owned by the client, has a slightly smaller modern basement than the one currently proposed for No.58A. In particular, No.56A's basement has no front lightwell, does not extend forward of the front reception room's chimney breast, and does not extend as far into the rear garden as is proposed for No.58A.

Planning consent was granted in 2012 for a single-storey rear extension to No.54 at lower ground floor level (Application 2012/3816/P).

Dorney Tower, to the south-east of No.58, has a large underground carpark, but is considered to be sufficiently far from No.58 that it is irrelevant to the proposed basement.

Other Proposed Basements:

10.2.5 No applications were found on Camden's planning website for modern basements beneath the other adjoining and adjacent properties (No's 60 & 62 Fellows Road and Sarum Hall School at No.15 Eton Avenue).

Proposed Basement at No.58A:

10.2.6 Details of the proposed works are given in Section 3. The proposed basement is expected be founded at **50.47m AOD**, approximately **4.53m** below the FFL of the existing ground floor and 3.97m below the level of the proposed ground floor (see paragraphs 3.1 & 3.2). Based on the strata levels in boreholes, the basement's formation level will be in the Weathered London Clay. The basement will therefore obstruct any flows of perched groundwater in the granular Made Ground but it is not expected to create any significant impact, locally or cumulatively, because the existing footings and the underlying clays (the clayey Made Ground probably being disturbed in-situ soils rather than imported material) already block any downslope seepage/flow in the granular Made Ground, and because of the naturally very low permeability of the London Clay and associated Head deposits. The service trenches beneath the front garden and the carriageway/footway are also likely to provide flow paths with higher permeabilities than most of the surrounding natural ground. Thus, the proposed basement is considered acceptable in relation to groundwater flow.

10.2.7 In the unlikely event that the basement excavations encounter, and would completely obstruct, a local deposit of more permeable soils containing mobile groundwater which has remained undetected within the London Clay (or Head deposits), 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. Water-bearing claystone horizons in the London Clay can also permit significant seepage/flow and might require similar treatment if encountered.

10.2.8 Current geotechnical design standards require use of a 'worst credible' approach to selection of groundwater pressures. On sites such as this where high plasticity clays are present close to surface, the groundwater table (or phreatic surface) may rise to surface, or at least into the overlying Made Ground 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 design groundwater level at ground level is recommended for the whole basement, for both short-term and long-term situations (in accordance with Eurocode 7, BS EN 1997-1).

10.2.9 The basement structure should be designed to resist buoyant uplift pressure that would be generated by the 'worst credible' groundwater levels. For the design groundwater level(s) suggested above, the buoyant uplift pressures to be accommodated will range between up to **60kPa** at the upslope rear end of the basement and up to **45kPa** at the front of the basement (both un-factored).

10.2.10 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.

10.2.11 The National House Building Council published new guidance on waterproofing of basements in November 2014 (now NHBC Standards, 2020, Chapter 5.4). Compliance would be compulsory if an NHBC warranty is required, otherwise it may provide a useful guide to best practice.

10.3 Subterranean (Groundwater) Flow – Temporary Works

10.3.1 Local groundwater entries/seepages may occur into the excavations for the basement though, on current evidence, they are likely to be minor and should be manageable by sump pumping, provided that they are not being fed by defective drains or water supply pipes. It would be prudent to ensure the external isolation stopcock is both accessible and operational before the start of the works. An appropriate discharge location must be identified for the groundwater removed by sump pumping.

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

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

10.4 Slope and Ground Stability

10.4.1 With slope angles of <2° in the surrounding area and 2.5-4.5° in No.58's rear garden (see paragraphs 2.12 to 2.14), the proposed basement excavation raises no concerns in relation to slope stability provided that the slope angle is allowed for in the design and construction of the basement's rear retaining wall.

<u>Basement Retaining Wall Construction – Underpinning:</u>

10.4.2 Use of reinforced concrete (RC) underpinning is proposed for construction of the proposed basement, subject to agreement under Party Wall Act protocols, together with 450mm diameter bored piles where access permits in the front and rear gardens, as indicated on the drawings by Michael Chester & Partners LLP (MC&P; see paragraph 1.6). The estimated founding (formation) levels and excavation depths of the underpins, retaining walls and basement slab are explained in paragraphs 3.2 and 3.3.

10.4.3 Underpinning methods involve excavation of the ground in short lengths (not exceeding 1.0m is recommended) in order to enable stresses in the ground to 'arch' onto the ground or completed underpinning on both sides of the excavation. Loads from the structure above will similarly arch across the excavation, provided the structure is in good condition.

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

- the geology;
- the adequacy of temporary support to both the underpinning excavations and 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). The various cracks noted in No.58 and past repairs in load-bearing walls which have weakened their structural integrity should be repaired in accordance with recommendations from the appointed Structural Engineer, before any underpinning is carried out.

10.4.5 The minimum temporary support requirements recommended for the excavations for the proposed underpins and RC retaining walls, subject to inspection and review as described in 10.4.6 and 10.4.7 below, are:

- Full face support must be installed as the excavations progress for all excavations through the Made Ground and in any firm clay which is present in the Head deposits and at the top of the weathered London Clay.
- Closely-spaced temporary support may be adequate in the stiff clays of the Head deposits and weathered London Clay Formation, depending on the degree of fissuring.
- Temporary support must also be installed to support all the new underpins, 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.

10.4.6 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. The London Clay is 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 the extent of such fissuring and should assess what support is appropriate.

10.4.7 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.

10.4.8 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 in accordance with the recommendation given in paragraph 10.3.3.

10.4.9 The provisional construction sequence should be provided by the appointed Structural Engineer or a specialist basement contractor. That can only be preliminary because the appointed contractor will be responsible for the temporary works and preparation of the final Construction Phase Plan.

Geotechnical Design - Retaining Walls:

10.4.10 Design of the retaining walls for the basement 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 10.4.11 below);
- Dead and live loads from the superstructure, including loads from the adjoining No's 56 & 60 which are carried on the party walls;
- Loads from all adjoining/adjacent walls in No's 56 & 60 which are founded within the relevant active earth pressure zone, including the 58/60 boundary and party walls which is to be underpinned (for No.56, only the front wall is relevant owing to the existing basement);
- Normal surcharge allowances;
- Swelling displacements/pressures from the underlying clays;
- Design groundwater levels and hydraulic uplift forces on the basement structure, as described more fully in paragraphs 10.2.8 and 10.2.9;
- Precautions to protect the concrete from sulphate attack.

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

Made Ground (sands):	Unit weight, γ_b:	18.0 kN/m^3
	Effective cohesion, c′:	0 kPa
	Angle of internal friction, φ′:	30°
Made Ground (clays) & Head Deposits:	Unit weight, γ_b:	18.5 kN/m^3
	Effective cohesion, c′:	0 kPa
	Angle of internal friction, φ′:	23°
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: up to 2.5-3.0 where undisturbed (varies with depth); the extent to which this stress is released when the underpins are excavated depends on the stiffness of the temporary and permanent support, but might typically reduce to around $k_0 = 1.0$.

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

Geotechnical Design - Bearing Capacity:

10.4.12 The founding level (formation) of the underpins and slab will be **50.47m AOD** (approximately 4.4-6.0m bgl – see paragraphs 3.2 & 3.3). The Standard Penetration Test (SPT) 'N60' values, which reflect the presence of fissures in these clays, were 23 and 31 at that level (see Figure 10 and GEA's borehole logs in Appendix F). Using the lower value and converting that to undrained cohesion (Cu) using the relationship identified by Stroud (1974) gave a Cu value of **103kPa** just below the proposed founding depth for the basement.

10.4.13 Based on the derived undrained cohesion values given above, the minimum allowable bearing pressures for the underpins and retaining structures would be 175kPa for up to 25mm settlement (long-term) based on a bearing capacity factor, N_C = 5.2 (after Skempton, 1951, for a strip footing with no adjacent surcharge) and a factor of safety, F = 3. This allows for the temporary situation when the central area within the underpins is excavated prior to casting the central basement slab. A lower factor of safety could be justified for temporary works, though settlements could then be greater. However, settlements of up to 25mm are undesirable for attached properties so, in order to minimise differential settlements relative to the adjoining properties, it is recommended that bearing pressures should not exceed **125kPa**, and should be kept below that value if possible.

Transitional footings:

10.4.14 Normal good practice in foundation construction requires progressive stepping up between foundations of different depths beneath a single structure. Subject to agreement under the Party Wall Act negotiations, transitional underpins should be considered for all adjoining load-bearing walls in No.56 (front wall only) and No.60 where the differential founding depth exceeds 1.0m.

Trees:

10.4.15 An arboricultural report on trees in the rear garden was prepared by Property Risk Inspection Ltd in March 2020 in relation to a buildings subsidence claim. That report recommended felling of Ash trees TG1 & TG2, and all the self-set young Ash trees in the rear garden. TG1 and the Ash saplings had all been removed before our site inspection, whereas Ash TG2 remained. The Cypress tree in TG1 will need to be removed as part of the works, subject to appropriate permissions. The basement will be founded below the likely depth of influence of roots from those trees, though heave in response to these removals may cause damage to the garden boundary walls, so movement joints should be inserted where they abut the proposed works.

10.4.16 The pavement Ash tree outside No.56 is too remote to affect the proposed basement at No.58 but might impact the front wall to No.56.

10.5 PDISP Heave/Settlement Assessment

Basement Geometry and Stresses:

10.5.1 Analyses of the vertical ground movements (heave or settlement) have been undertaken using PDISP software, in order to assess the potential magnitudes of movements which may result from the changes in vertical stresses caused by excavation of the basement extension and front vaults.

10.5.2 Figure G1 in Appendix G illustrates the layout of the PDISP zones used to model the proposed bored pile walls, underpins, lightwells and basement slab (see Section 3) overlaid on the plan of the proposed basement (Brod Wight's 'Proposed Basement Plan', Drg No.1099-AP02). Where excavation depths will vary significantly within or across multiple zones, superimposed zones were used to allow for those variations, as shown in Figure G2. The loads from the internal load-bearing walls were also modelled as superimposed zones, including the additional concrete for the slab thickening but no extra excavation (Zones 31-37). The load takedown data for the existing building and the proposed sub-garden section of the basement have been provided by Michael Chester & Partners LLP (MC&P), as presented in Figures G3 & G4. The horizontal forces acting on the retaining walls have not been modelled, so the stress regime has been simplified.

10.5.3 The overall dimensions of the basement excavations are approximately 7.98m wide by 30.85m long. For the purposes of these analyses, the depth of the void beneath the existing suspended ground floor was assumed to be 0.3m, so the existing ground level within the building was assumed to be **54.70m AOD** which gave an excavation depth of **4.23m**. The depth of excavation in the rear garden increased to a maximum of **6.03m** (Zone 15). The bored piles were modelled using density difference and were assumed to extend to approximately twice the depth of excavation. MC&P's drawings show that the 225mm thick basement slab will be cast on an unspecified void former; for the purposes of these analyses it has been assumed that this will be Cordek Cellcore HXS 9/13, so a 13kPa load was modelled acting on Zones 23-30.

10.5.4 Table 3 presents the **net** bearing pressures which will result from the basement works for all the primary and superimposed PDISP zones at the end of construction and in the long-term (see 10.5.7 below for details), and the **gross** loading/unloading values for the superimposed zones. All applied pressures were calculated from MC&P's load takedown together with the self-weight of the basement structure.

Table 3: Bearing pressure changes for PDISP Zones		
ZONE #	TYPE	Change in vertical pressure - Stages 1 & 2 (kPa)
1	Bored pile wall	37.33
2	Bored pile wall	45.01
3	Bored pile wall	45.90
4	Bored pile wall	44.74
5	Underpin - Ret'ng wall	-2.33
6	Underpin - Bay & ret'ng wall	-23.89
7	Retn'g walls - Lightwell	-53.64
8	Retn'g walls - Lightwell	-47.39
9	Underpin - Bay & steps	-32.26
10	Underpin - Ret'ng wall	16.11
11	Underpin - Ret'ng wall	-3.58
12	Underpin - Ret'ng wall	-14.86
13a	Underpin - Ret'ng wall	-23.88
13b	Retn'g wall below Ext'n	-50.21
14	Retn'g wall - Rear lightwell	-80.02
15	Retn'g wall below rear garden	-56.84
16	Retn'g wall below rear garden	-11.32
17	Retn'g wall below rear garden	-38.77
18	Retn'g wall below rear garden	-64.47
19	Lining wall to No.56's bsmt	68.79
20	Lining wall to No.56's bsmt	62.79
21	Lining wall to No.56's bsmt	45.79
22	Lining wall to No.56's bsmt	73.23
23	Basement Slab	-69.49
24	Basement Slab	-69.49
25	Basement Slab	-69.49
26	Basement Slab	-69.49
27	Basement Slab	-69.49
28	Basement Slab	-69.49
29	Basement Slab	-97.76
30	Basement Slab	-97.77
31	Slab thick'g & wall loads	113.19
32	Slab thick'g & wall loads	34.20
33	Slab thick'g & wall loads	62.31
34	Slab thick'g & wall loads	47.49
35	Slab thick'g & wall loads	36.57
36	Slab thick'g & wall loads	29.15
37	Slab thick'g & wall loads	61.98
38	Additional excavation	-11.02
39	Additional excavation	-4.75
40	Additional excavation	-17.10

Table 4: Soil parameters for PDISP analyses				
Strata	**Level** (m AOD)	**Undrained Cohesion,** Cu (kPa)	**Short term, undrained Young's Modulus,** Eu (MPa)	**Long term, drained Young's Modulus,** E' (MPa)
Weathered London Clay & London Clay	50.6 34.0	100 224	50 112	30 67

Where:
For Weathered London Clay and London CLAY:

Undrained Shear Strength, Cu at top of stratum is based on the SPT N60 profile from BH 1.
Undrained Shear Strength within stratum assumed to increase at: 7.5 z kPa where z = depth below the top of the stratum.

Undrained Young's Modulus, Eu = 500 * Cu
Drained Young's Modulus, E' = 0.6 * Eu

Ground Conditions:

10.5.5 The ground profile was based on the site-specific ground investigation by GEA, as presented in Sections 9 and 10.1 above, and on the desk study information in Section 4. The interpreted base level of the possible Head deposits at 1.90m/2.00m bgl (53.12/54.64m AOD) is well above the proposed founding level for the basement, so those deposits did not need to be included in the soil profile.

10.5.6 The short-term and long-term geotechnical properties of the soil strata used for the PDISP analyses are presented in Table 4, based on this investigation and data from other projects.

PDISP Analyses:

10.5.7 Three dimensional analyses of vertical ground movements in response to construction of the proposed basement extension have been undertaken using PDISP software and the basement and ground floor geometries, loads/stresses and ground conditions outlined above. PDISP analyses have been carried out as follows:

- Stage 1: End of construction – Short-term (undrained) condition,
- Stage 2: As Stage 1, except – Long-term (drained) condition.

10.5.8 Stages 1 – 2 were analysed at formation level (50.47m AOD) although the ground profile was taken from 50.6m AOD, as the 200mm thick lining walls to No.56's basement will bear onto the heel to the reinforced concrete underpins to the party wall, which are founded at approximately 50.57m AOD.

10.5.9 The results of the analyses for Stages 1 & 2 are presented as contour plots on the appended Figures G5 & G6 respectively.

Heave/Settlement Assessment:

10.5.10 The proposed works will cause immediate elastic displacements (heave/settlement) in response to the stress changes, followed by long-term plastic deformations (swelling/consolidation) as the pore water pressures in the over-consolidated clays, which underlie the site, adjust to the stress changes. The rate of plastic swelling/ consolidation will be determined by the availability of water and the permeability of the soils concerned; the low permeability of the London Clay typically results in these adjustments taking many decades to reach full equilibrium. The underpins, RC retaining walls and basement slab will need to be designed so as to enable them to accommodate the swelling displacements/pressures developed beneath them and the resultant distortions.

10.5.11 The ranges of predicted short-term and long-term movements for each of the main parts of the proposed basement are presented in Table 5 below. The predicted displacements have been rounded to the nearest 0.5mm. These analyses predicted heave throughout the basement except for up to 1mm settlement affecting the bored pile wall at the rear end of the basement. The maximum heave predicted beneath an underpin base was 9mm under the rear lightwell, with slightly greater heave beneath the adjoining basement slab. However, as the 225mm basement slabs will be cast on void formers, the predicted post-construction heave displacements will be accommodated by those void formers.

10.5.12 The range of displacements quoted in Table 5 cover approximately the full range of predicted deflections, however the stiffness of the underpins and the anchoring effect of the bored pile walls are likely to reduce the range of displacements actually experienced by those structures and the retaining walls adjoining the bored pile walls.

Table 5: Summary of predicted displacements

Location	Stage 1 (Figure G5)	Stage 2 (Figure G6)
Front lightwell (inc. bored pile wall), front bay, front wall, portico & underpin to front end of party wall (Zones 1 & 5-10)	0 – 2.5mm Heave	0 – 4mm Heave
Flank wall (Zones 11-13a)	0 – 3mm Heave	0.5 – 5mm Heave
Rear single-storey extension, rear lightwell & rear terrace (Zones 13b, 14, 18 & 29)	1.5 – 5.5mm Heave	3 – 9.5mm Heave
Sub-garden basement retaining walls, inc. bored pile wall (Zones 2-4 & 15-17)	0.5mm Settlement to 4mm Heave	1mm Settlement to 5mm Heave
Central basement slab & internal pier in sub-garden basement (Zones 30 & 31)	1 – 5mm Heave	3 – 7.5mm Heave
Internal walls, basement slab beneath house & extension, and lining walls to No.56's basement (Zones 19-22, 23-28 & 32-37)	1 – 5.5mm Heave	1.5 – 9mm Heave
Existing underpins to 56/58 party wall	0 – 2.5mm Heave	0 – 4mm Heave

10.6 Damage Category Assessment

10.6.1 When underpinning, it is inevitable that the ground will be un-supported or only partially supported for a short period during the excavation of each pin, even when support is installed sequentially as the excavation progresses. This means the behaviour of the ground will depend on the quality of the workmanship and suitability of the methods used, so rigorous calculations of predicted ground movements are not practical. However, provided that the temporary support follows best practice as outlined in Section 10.4, then extensive past experience has shown that the bulk movements of the ground alongside a single-storey basement (typical depth 3.5m) should not exceed 5mm horizontally.

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

10.6.3 The potentially critical locations will be determined by the displacements predicted by the PDISP analyses and the geometries of the adjoining buildings. For these damage category assessments, we are interested in the ground movements at the foundation level of the neighbouring buildings, whereas the empirical data for ground movements alongside excavations presented in CIRIA Report C760 (Gaba et al, 2017) concerns movements at ground surface (and presents data for embedded retaining walls, but, as no equivalent data exist for underpins, this data is deemed the best available, though it must be interpreted very cautiously).

10.6.4 The existing basement beneath the adjoining No.56 is understood to be founded 0.1m above the founding level of the proposed basement and extends beneath the whole of the house except for the front wall. Thus, the front wall is the only wall in No.56 for which a damage category assessment is warranted.

10.6.5 Plans attached to planning application 2014-2824-P indicate that the adjoining No.60 originally had a very similar layout to No.58 with two transverse internal walls near the centre of the house. That planning application concerned only the upper floors, so it remains unknown whether any internal walls have been removed at lower levels. No.60's main east flank wall is approximately 4.0-4.9m to the west of No.58's flank wall. These houses are linked only via the small, two-storey high 'bridging' room over No.58's side access path at 1st floor level (ground floor level in the main house) which adjoins a similar feature in No.60. The heave predicted by the PDISP analyses is beneficial in reducing settlements caused by relaxation of the ground alongside the basement, so the critical damage category location will involve the least heave; that occurs at the front of this linking structure. The lack of any wall at ground floor level under the rear wall of the bridging room, also confirms the front parapet wall as the critical location for present purposes. The 4.0-4.9m separation between the main, four-storey parts of these houses also means that the deflection ratio will be much lower than for the adjoining two-storey walls, so no damage category assessment is warranted for the main part of No.60.

10.6.6 Separate damage category assessments have been undertaken for both of the locations identified above. These assessments considered:

- ground movements alongside the proposed underpins caused by relaxation of the ground in response to the excavations, using empirical data from monitoring of large retaining walls during construction, as presented in CIRIA Report C760 (see 10.6.3 above);
- ground movements arising from the vertical stress changes, as assessed by the PDISP analyses (see Section 10.5), including an allowance for the stiffness of the foundations. Only the post-construction displacements (between Stages 3 & 4 of the PDISP analyses) have been considered, because the CIRIA data includes all movements during construction.

Ground movements associated with the construction of retaining walls in clay soils have been shown to extend to a distance up to 3.5 to 4 times the depth of the excavation.

<u>Front wall of No.56 Fellows Road:</u>

10.6.7 The relevant geometries, based on information in Section 3, the ground investigation at No.58 (see Section 9 and Appendix F), and the relevant drawings (see 1.6) are:

Depth of excavation alongside front wall = **4.23m** (from ground below suspended floor in No.58A).

Width, horizontal movement = 4.23 x 4 = **16.9m**, so might extend just into No.52's site. Horizontal movements are typically linear, so generate no deflection.

Width of settlement zone = 4.23 x 3.5 = **14.8m**, so will extend well beyond the full width of No.56.

Width (L) of No.56 (beyond underpin) = **7.4m**

Depth of foundations to front wall (and party wall) = **approx. 0.43m** (TP6)

Height (H) = 12.9 (to eves) + 0.43 = **13.33m**

Hence L/H = **0.56**

10.6.8 The anticipated horizontal displacement value of 6.0mm has been obtained by adjusting pro-rata to the typical 5mm horizontal displacement for a 3.5m deep single-storey basement. Combining this with the geometry recorded above, indicates that the horizontal strain beneath No.56 is likely to be in the order of ε_h = 3.55 x 10^{-4} (0.036%).

10.6.9 The settlement caused by relaxation of the ground alongside the basement, in response to excavation of the retaining wall, can be estimated using the settlement profile for the worst case (low stiffness) scenario presented in Figure 6.15b of CIRIA Report C760. This CIRIA data should be combined with the long-term movements predicted by the PDISP analysis, between Stage 1 (short-term) and Stage 2 (long-term); the settlement profiles are then summed to find the maximum deflection, Δ.

Figure 13 presents these settlement profiles for the front wall of No.56, with allowance also made for the affected wall being shorter than the zone of influence of the ground movements. The maximum Δ = 0.66mm, which represents a deflection ratio, Δ/L = 8.92 x 10^{-5} (0.009%).

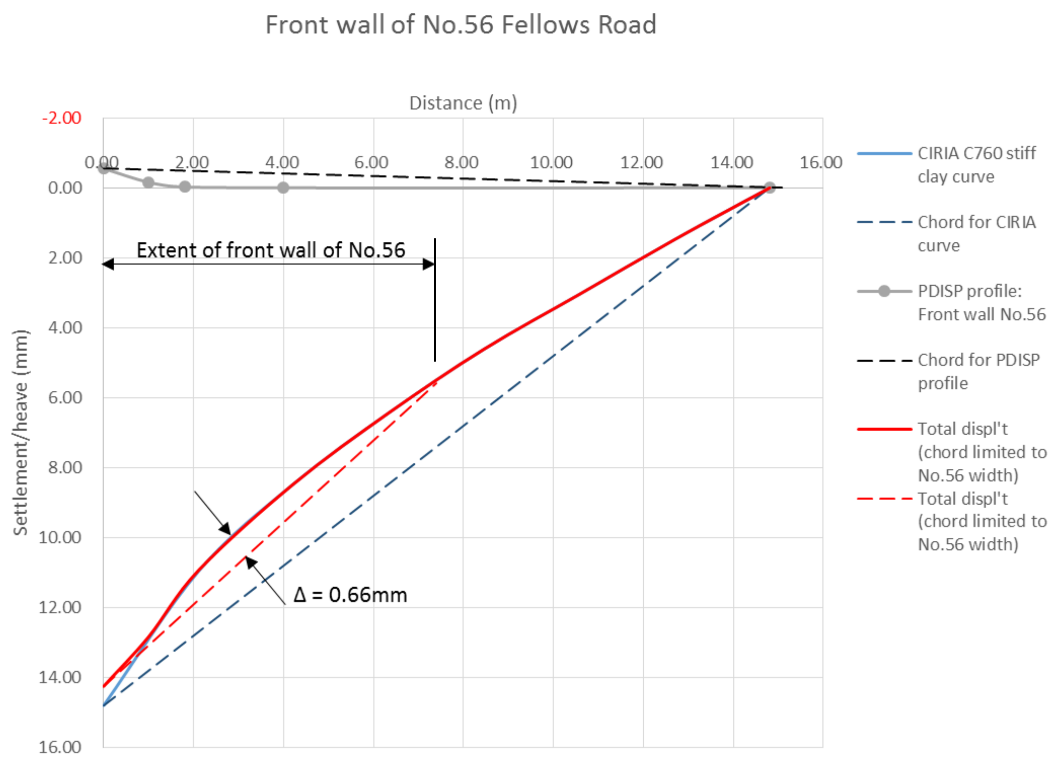

Figure 13: Displacement profile for front wall of No.56 Fellows Road.

10.6.10 Using the graphs for L/H = 0.5 these deformations represent a damage category of 'negligible' (Burland Category 0, ε_{lim} = <0.050%), as given in CIRIA SP200, Table 3.1, and illustrated in Figure 14 below.

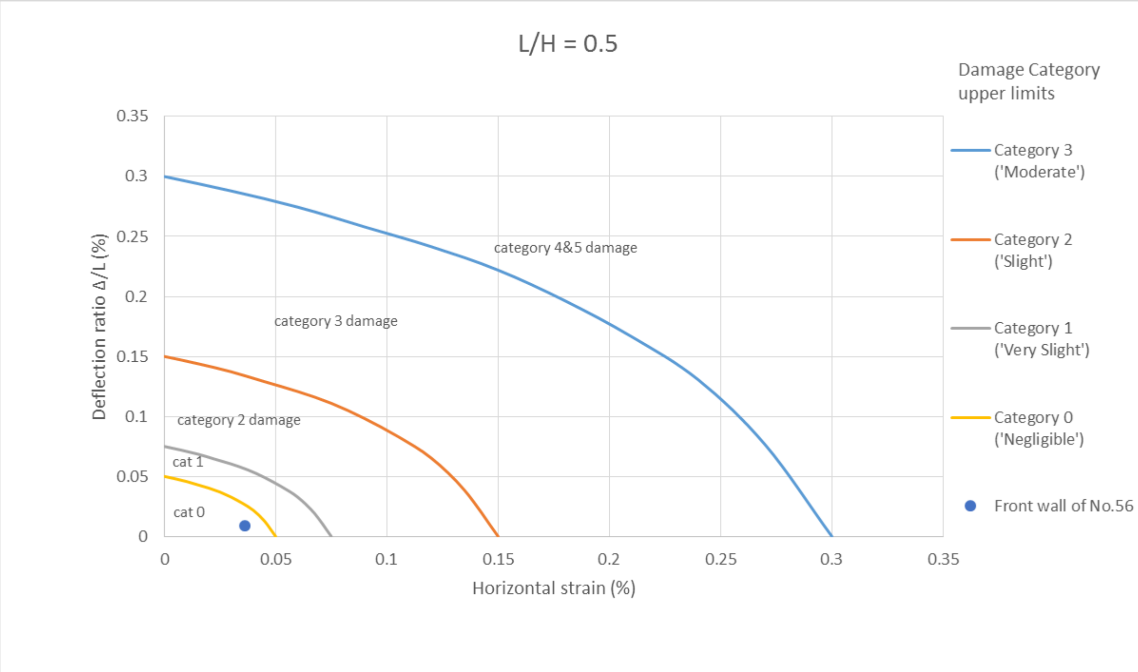

Figure 14: Damage category assessment for front wall of No.56 Fellows Road.

<u>Front wall of 2-storey link to No's 58 & 60 Fellows Road:</u>

10.6.11 This assessment has considered the parapet wall which straddles the boundary between No's 58 & 60, and adjoins PDISP Zone 11 (see paragraph 10.6.5). The relevant geometries for this 4.9m long wall, are:

Depth of excavation = **4.70m** ((55.03+55.3)/2 - 50.47m AOD), which allows for the slightly higher ground level in No.60's site.

Width, horizontal movement = 4.7 x 4 = **18.8m**, so will extend well beyond the wall of current interest.

Width of settlement zone = 4.7 x 3.5 = **16.45m**, so also extends well beyond the wall being analysed.

Width (L) of 2-storey wall = **4.9m**

Depth of foundations = **0.53m** (assumed same level as footing in TP5A), hence = (55.03 – (55.00 - 54.50))

Height (H) = 6.7 (to top of parapet) + 0.53 = **7.23m**

Hence L/H = **0.68**

10.6.12 Following the same procedure as before, with 6.7mm anticipated horizontal displacement, the likely strain beneath this two-storey wall would therefore be in the order of $\varepsilon_h = 3.56 \times 10^{-4}$ (0.036%).

10.6.13 Assessment of the maximum deflection also followed the same procedure as before, using the low stiffness settlement profile in Figure 6.15b of CIRIA Report C760 combined with the long-term movements predicted by the PDISP analyses between Stage 1 and Stage 2. The maximum deflection, Δ = 0.50mm, as shown in Figure 15, which represents a deflection ratio, Δ/L = 1.02 x 10^{-4} (0.010%).

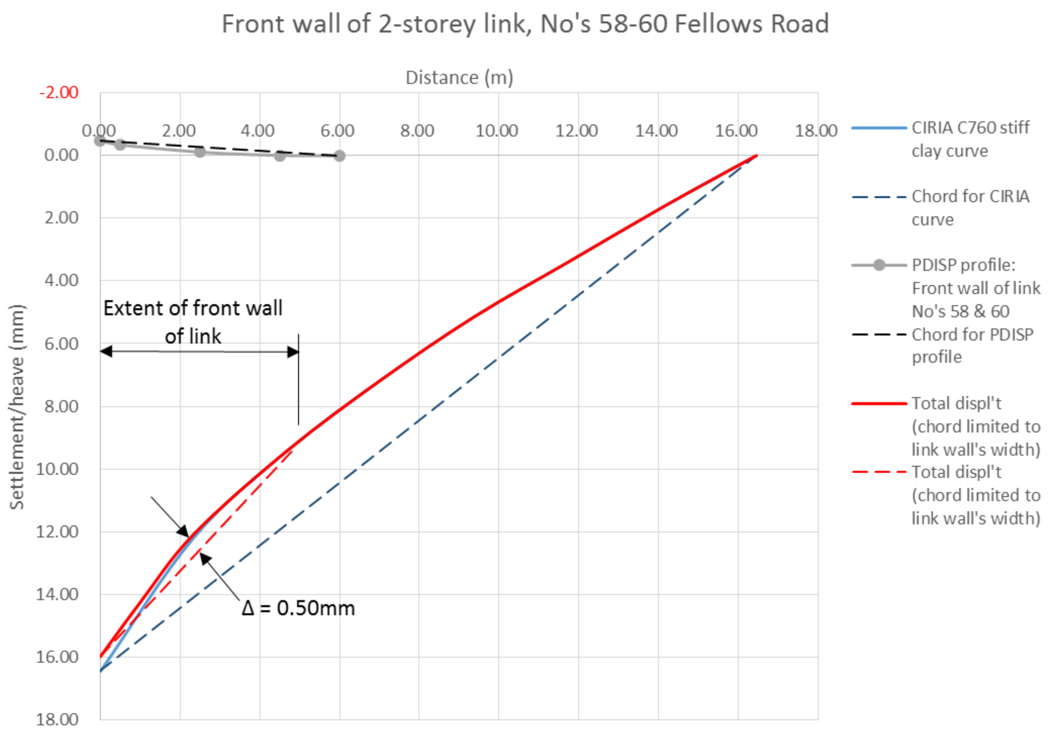

Figure 15: Displacement profile for the front wall of the 2-storey link to No's 58 & 60 Fellows Road.

10.6.14 Using the graphs for L/H = 1.0, which is slightly conservative, these deformations once again represent a damage category of 'negligible' (Burland Category 0, ε_{lim} = <0.050%), as given in CIRIA SP200, Table 3.1, and illustrated in Figure 16 below.

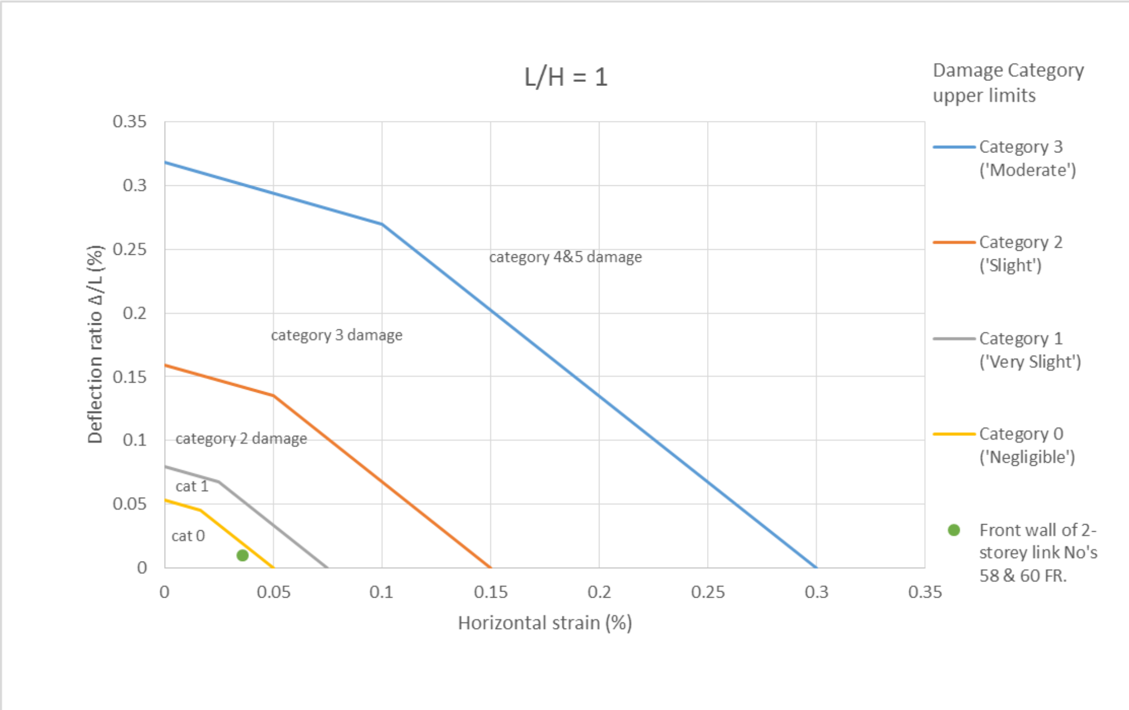

Figure 16: Damage category assessment for the front wall of the 2-storey link to No's 58 & 60 Fellows Road.

<u>Public Footway:</u>

10.6.15 The southern side of the bored pile wall alongside the front lightwell will be 4.6m from the public footway. The PDISP analyses indicate that very slight settlement, not exceeding 1mm would be expected in that area (and probably less than 0.5mm). For a 9.5m deep bored pile wall (double the lightwell excavation depth), CIRIA Report C760 predicts up to 1.9mm settlement from pile installation (0.02% of pile depth, see Figure 6.8 in C760) and up to 3.3mm of settlement in response to excavation of the lightwell provided that high stiffness support is used, as recommended in paragraph 10.4.5 above (0.07% of excavation depth, see Figure 6.15b in C760). This gives a maximum total potential settlement of 6.2mm at the nearest point to the centreline of the lightwell, reducing with gradually with increasing distance from the lightwell. This pattern of potential ground movements is unlikely to be a concern to the utility companies with services beneath the footway.

10.6.16 Use of best practice construction methods, as outlined in Section 10.4, will be essential in order to ensure that the ground movements are kept in line with the above predictions.

10.7 Monitoring

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

10.7.2 Precise movement monitoring should be undertaken weekly throughout the period during which the basement walls (underpins and piles) and slab are constructed. Ideally, three sets of initial readings should be taken before excavation of the basement starts in order to assess the extent of any pre-existing on-going movement. Readings may revert to fortnightly once all the perimeter walls, base slab and the new ground floor slab have been completed, and may terminate three months after the new slabs have reached working strength, the formwork has been struck and all temporary support has been removed, provided that there are no progressive on-going movements. This monitoring should be undertaken with a total station instrument and targets attached at a minimum of two levels at the following locations:

- internally, at three equally spaced locations on the 58/56 party wall;
- internally, at three equally spaced locations on No.58's main flank wall;
- internally, on any internal load-bearing walls which will remain in place;
- externally, on the front wall of No.56, on the centreline of the 58/56 party wall and on the front right corner of No.56;
- externally, on the main rear wall of No.56, on the centreline of the 58/56 party wall and on the rear right corner of No.56;
- externally, on the rear wall of No.56's single-storey rear extension, on the centreline of the 58/56 party wall;
- externally, on the front and rear walls of the two-storey link between No's 58A and No.60, on the centreline of the 58A/60 party wall;
- externally, on the main flank wall of No.60, at the front corner, middle and rear corner.

10.7.3 The wall movements detected by the monitoring exercise may be caused by rotation, flexing without cracking (especially for walls built using lime mortar, as may apply for a property of this age), or lateral movements transverse to the plane of the wall. Movements such as these which occur without cracking would all fall within Burland's Category 0, so a twin-track approach to the monitoring will be required, combining both the target monitoring as proposed above and visual observations. Daily inspections of the subject property and external walls of the adjoining buildings should be made and recorded by a member of the contractor's staff. If any new structural cracks appear in the main load-bearing walls, then the appointed Structural Engineer should be informed and those cracks should be monitored using the Demec system (or similar) on the same frequency as the target monitoring. Additional targets might also be installed, at the engineer's discretion, depending on the location of the cracks.

10.7.4 It will be important to ensure that the pre-existing cracks in the affected load-bearing walls, which have weakened their structural integrity, should be repaired in accordance with recommendations from the appointed Structural Engineer before any underpinning is carried out (as recommended in paragraph 10.4.4). The structural adequacy of the recent external repointing above the ground floor windows should also be reviewed.

10.7.5 While monitoring readings from this system are typically presented to the nearest 0.1mm, the accuracy (repeatability) is usually quoted as +/-2mm or +/-1.5mm. Thus, if recorded movements in either direction reach 5mm (amber trigger level), 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 recorded movements in either direction reach 8mm (red trigger level), then work should stop until new methods statements have been prepared and approved by the appointed structural engineer. Local temporary backfilling of the excavation adjacent to the movement of concern may be required.

10.8 Surface Flow and Flooding

Flooding from Rivers, Sea & Reservoirs:

10.8.1 The evidence presented in Section 5 has shown that:

- the site lies within the Environment Agency's Flood Zone 1, which means that it is considered to be at negligible risk of fluvial flooding (from rivers or sea), and is classified as having a Very Low risk of fluvial/tidal flooding under the Environment Agency's Risk of Flooding from Rivers or Seas (RoFRaS) dataset (paragraph 5.6);
- the site is not at risk of flooding from reservoirs, as mapped by the Environment Agency (paragraph 5.7);
- 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:

10.8.2 There are no natural surface water features within 250m of the site. The linear underground watercourse which is recorded by the 'OS MasterMap' data at 112m to the west of the site is believed to be a diagrammatic simplification of the course of the western arm of the River Fleet (from Hampstead Pond No.1 to the Serpentine), whereas it actually flows through the sewer system following a far more complex route, so this location is not reliable (paragraph 5.8).

10.8.3 The *'Floods in Camden'* report (LBC Floods Scrutiny Panel, 2003) and Arup's 2010 guidance document (Camden GHHS) record that Fellows Road was flooded in the 1975 local pluvial flood event, but not in 2002 (see Figure 5 above), although the extent of the road affected was probably limited to the low points towards the west and/or east ends of the road, whereas No.58 is close to the highest point on Fellows Road.

10.8.4 The Camden Strategic Flood Risk Assessment (SFRA, by URS, 2014) shows that Fellows Road is within Critical Drainage Area 'Group3_005'. However, Fellows Road was not in any of the Local Flood Risk Zones which were identified in the same SFRA (see paragraph 5.12 and Figure 7). CDAs include both source areas and flood-prone areas; the evidence presented above and below indicates that No.58 is in a source area for flooding elsewhere (as might be expected given its position close to the high point on Fellows Road) and is **not** in a flood-prone area.

10.8.5 The current risk of surface water (pluvial) flooding within the sites of No.58 and the adjoining properties is indicated to be mostly 'Very Low' by the Environment Agency's latest modelling (see Figure 6 herein) and 'Negligible' according to modelling by Ambiental Risk Analytics (see paragraph 5.8). These are the lowest categories which represent the national 'background' level of risk. A limited area of increased 'Low' and 'Medium' flood risk is mapped alongside the rear wall of these properties, which is plausible as that is the lowest part of No.58's site. Surface water flood risk on the adjacent part of Fellows Road is also shown as mostly 'Very Low', with a ribbon of 'Low' risk alongside the southern kerb, which is irrelevant for the proposed basement.

10.8.6 Flood resistance measures will be required in order to protect the basement and the lowered ground floor from the modelled risk of surface water flooding, although the proposed re-profiling of the side access path will be beneficial in eliminating the low area where 'Low' to 'Medium' flood risk has been predicted at the rear of the house. These measures are based on the assumption that the adjacent surface water sewer might run under 'surcharge' during a design rainfall event (see 10.8.9 below):

- Provision of upstands to the retaining walls around the rear lightwell (beneath the glass balustrades) and adjacent to the steps and flower beds alongside the ground floor terrace, of sufficient height to prevent surface water draining into the lightwell and terrace. Ramped paving could be used as an alternative to an upstand at the top of the steps in order to avoid creating a trip hazard.
- Provision of an upstand to the retaining wall which will form the front wall of the front lightwell, as already shown on the scheme drawings, in order to prevent surface water draining into the lightwell. The height of this upstand could be nominal (say 50mm).
- Provision of either watertight doors which will provide access to the two lightwells from the basement, and to the terrace from the ground floor, or sufficient temporary interception storage capacity within each lightwell in order to hold the amount of rainfall falling directly into the lightwells and terrace during a design storm. This storage capacity could be achieved with dedicated tank(s) or lowered slab levels within the lightwells (to create raised thresholds) and decking.
- Provision of either a watertight door or a ramped approach rising to the main entrance door in the flank wall.

<u>Change to Hard Surfacing & Surface Water Run-off:</u>

10.8.7 The proposed rear extension, rear terrace, lightwells, extended side access path and steps up to the rear garden will all occupy areas which are currently soft landscaped with the exception of the narrow concrete path alongside the rear wall of the house. The resultant potential increase in surface water run-off from the net increase in paved surface area must be mitigated by use of one or more suitable Sustainable Drainage Systems (SuDS), selected following the hierarchy given in Policy 5.13 of the London Plan (where applicable to this site – infiltration SuDS would not be suitable because of the underlying London Clay):

- Storage of rainwater for later use (rainwater harvesting), such as use of a grey water system;
- Installation of a green roof over the ground floor extension in order to attenuate run-off, as already included in the scheme. These also provide beneficial treatment of run-off water quality, another requirement of SuDS, though they are less effective at attenuating flows once saturated or frozen.

- Temporary attenuation storage and controlling the rate of gradual discharge from that storage; this could be combined with the interception storage recommended above.

These SuDS schemes would require formal design, including accurate quantification of the net change in paved surface area and of the design run-off volumes.

Sewer Flooding:

10.8.8 The Camden SFRA noted that Thames Water's DG5 Flood Register had records of eight properties being affected by internal flooding from public sewers in this post code area ('NW3 3'), while none were recorded as having been affected by external sewer flooding (see paragraph 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 the Applicant's control and largely outside of the Council's influence. The probability of future sewer flooding affecting No.58A is considered to be low, provided that the sewer system is well maintained and appropriate flood resistance measures are implemented, as set out below.

10.8.9 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 and lower ground floors. During major rainfall events, it is possible for some sewers to overflow at ground level, although this is rare.

10.8.10 Camden's CPG Basements requires all basements to be "*protected from sewer flooding by the installation of a positive pumped device*" (paragraph 6.16 in CPG, 2018). Non-return valves and pumped loop systems must therefore be fitted on the drains serving the basement, lowered ground floor and the lightwells, in order to ensure that water from the mains sewer system cannot enter these areas 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, roof water, and surface water from the lightwells and rear garden (as relevant). A battery-powered reserve pump should be fitted to ensure that the system remains functional during power cuts.

10.8.11 The pumped loops must rise high enough to create sufficient pressure head to open the non-return valves when the mains 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 then temporary interception storage would be required, to hold temporarily the predicted maximum volume of water from all relevant sources which discharge via the valve-protected outfall(s) (including surface water from the various roofs, rear garden and lightwells, and foul water), for the duration of the predicted surcharged flows in the sewer. If the lightwells are used for interception storage, deepened as necessary to provide adequate capacity, then they must be protected from backup of foul sewage, for which separate storage might be required. This temporary interception storage would require formal design to ensure satisfactory performance.

10.9 Mitigation

10.9.1 The following mitigation measures should be implemented:

- Installation of an engineered groundwater bypass, in the unlikely event that the basement excavations encounter, and would completely obstruct, a local deposit of more permeable soils containing mobile groundwater (10.2.7).
- Cracks and past repairs which have weakened the structural integrity of load-bearing walls in the vicinity of the works should be repaired, in accordance with recommendations from the appointed Structural Engineers, before any underpinning is carried out (10.4.4).
- Subject to Party Wall Agreement negotiations, transitional underpins should be considered beneath the adjoining load-bearing walls to No's 56 & 60, where the differential founding depth exceeds 1.0m (10.4.14).
- Implementation of the recommended flood resistance measures (10.8.6), including:
    - temporary intervention storage of surface water from various locations, possibly combined with watertight doors which would help to reduce the volume of interception storage required;
    - options for either provision of an upstand around the top of the retaining wall around the rear lightwell, or ensuring that the glass balustrades are fully watertight with ramped paving to exclude surface water at the head of the staircase within the lightwell;
    - a nominal upstand along the front side of the front lightwell.
- Implementation of one or more of the options identified for sustainable drainage systems (SuDS) as mitigation for the increased paved surface area and the associated potential increase in surface water discharge to the mains drainage system from the property (10.8.7).
- Non-return valves and pumped above-ground loop systems should be fitted to the drains serving the basement, lightwell and rear garden in order to ensure that water from the sewer system cannot enter the basement when the mains sewer is operating under surcharge (10.8.10 & 10.8.11).

11. NON-TECHNICAL SUMMARY – STAGE 4

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

11.2 A services search should be undertaken (10.1.3).

11.3 The proposed basement is considered acceptable in relation to the likely limited or nil flow of groundwater through the clayey Made Ground, the possible Head deposits and the weathered London Clay, while flow of any perched groundwater in the granular Made Ground is blocked by the existing foundations and the underlying clays. For the same reasons, the combined presence of No.56's basement and the proposed basement is not expected to create any cumulative effect (10.2.1 to 10.2.6). In the unlikely event that the excavations encounter a local deposit of more permeable soils which has remained undetected, then it is possible that an engineered groundwater bypass might be required (10.2.7).

11.4 A design groundwater level equal to ground level is recommended, which means that the basement must be able to resist buoyant uplift pressures (un-factored) which vary across the basement from up to 60kPa to up to 45kPa (10.2.8, 10.2.9). The basement will need to be fully waterproofed (10.2.10, 10.2.11).

11.5 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).

11.6 There are no concerns regarding slope stability subject to allowance for the slope in the rear garden in both design and construction (10.4.1).

11.7 The basement will be constructed using a combination of RC underpinning techniques and bored pile walls. Use of best practice methods and high stiffness temporary support systems, installed in a timely manner, will be crucial to the satisfactory control of ground movements around the basement (10.4.2 to 10.4.8).

11.8 Various other guidance is provided in relation to the geotechnical design of the basement's perimeter walls (10.4.10, 10.4.11).

11.9 A bearing pressure of 125kPa may be used for the underpins, although it would help to minimise differential settlements if the actual bearing pressures are kept below this figure. (10.4.12, 10.4.13).

11.10 Good practice requires stepping up between the footings at different depths beneath a single structure, so consideration should be given, during the Party Wall Act negotiations, to the inclusion of transition underpins beneath all load bearing walls in No.60 that adjoin No.58, where the difference in founding level will exceed 1.0m, and beneath the front wall of No.56. (10.4.14).

11.11 The basement slab must be designed to accommodate swelling displacements/ pressures generated by heave of the underlying clays. A preliminary heave/settlement assessment has been undertaken (using PDISP software) which predicted between 1mm of settlement and 9mm of heave beneath the underpins and RC retaining walls, and up to 10mm of heave below the various areas of 225mm thick basement slab. However, those areas of basement slab will be protected from the anticipated heave movements by the underlying void former (Section 10.5).

11.12 Damage category assessments indicated that, provided best practice construction methods are employed, the worst case predicted deformation affecting No.56 (front wall only) and the two-storey link between No's 58 and 60 is likely to fall within Burland Category 0, termed 'negligible' (Section 10.6).

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

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

11.15 Fellows Road is recorded as having flooded during the 1975 event, but not in 2002; that flooding was almost certainly remote from No.58, which is close to the highest point of the road (10.8.3). The Camden SFRA shows that Fellows Road is within Critical Drainage Area 'Group3_005'; however, it was not in any of the Local Flood Risk Zones and other evidence presented herein indicates that No.58 is **not** in a generally flood-prone area (10.8.4).

11.16 The Environment Agency's recent modelling of risk of flooding from surface water predicts a Very Low flood risk for the majority of No.58's site and the adjoining properties, with the exception of a narrow strip of Low and Medium flood risk alongside the rear walls of these buildings. Modelling by Ambiental Risk Analytics gave a 'negligible' risk of surface water flooding (10.8.5). Recommendations are given for flood resistance measures which will be required to protect the basement and ground floor from surface water flooding, while the proposed re-profiling of the path alongside the property will eliminate the low area at the rear of the property alongside the basement (10.8.6).

11.17 The ground floor extension and most of the basement outside the footprint of the existing building will be in areas which are soft landscaped. In order to mitigate this increased paved surface area and the resultant potential increase in surface water discharge to the sewer system, one or more of the identified SuDS options should be implemented (10.8.7).

11.18 Thames Water had have eight records of internal flooding from public sewers affecting postcode area 'NW3 3' and no records of external flooding, so the probability of future sewer flooding affecting No.58 is considered to be low, provided that the sewer system is well maintained and appropriate flood resistance measures are implemented (10.8.8).

11.19 Non-return valves and pumped above-ground loop systems should be fitted to the drains serving the basement, lowered ground floor and lightwells. Temporary interception storage may also be required, with sufficient capacity for the predicted maximum volume of discharges (from all sources) via the 'protected' outfall pipe(s), for the duration of the predicted surcharged flows in the sewer; formal design would be required (10.8.9 to 10.8.11).

11.20 Mitigation measures which have been recommended in Sections 10.2-10.8, are summarised in Section 10.9.

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