Ground and Project
CONSULTANTS LTD

14F AVENUE ROAD, PRIMROSE HILL, LONDON NW8 6BP

Basement Impact Assessment: Land Stability

July 2015

Client:

Croft Structural Engineers,
Clock Shop Mews,
Rear of 60 Saxon Rd,
SE25 5EH

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1. Introduction

Ground and Project Consultants Ltd have been instructed by Croft Structural Engineers to undertake the land stability element of a Basement Impact Assessment compliant with CPG4, for 14F Avenue Road, Primrose Hill, London NW8 6BP. The property is located in the London Borough of Camden in the Swiss Cottage ward, its location is indicated on Figure 1.

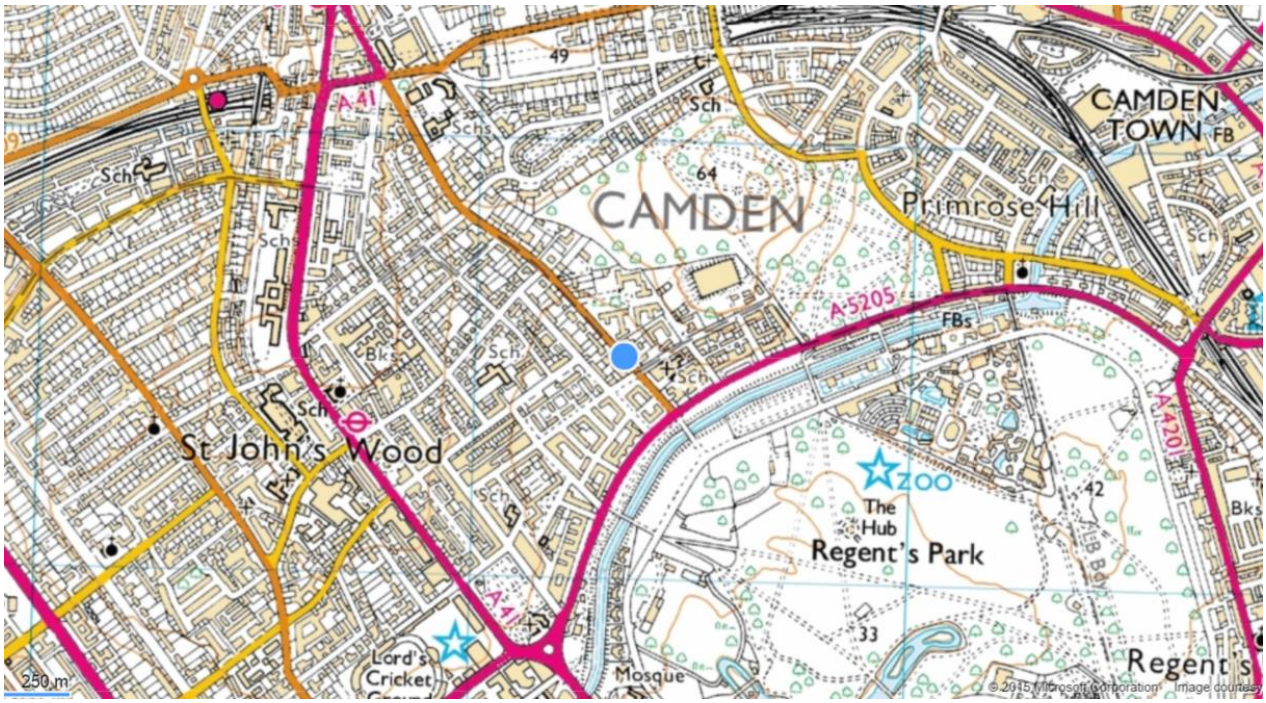

Figure 1: Site Location

2. Scope and Objective

The scope of this report and approach is as follows:

- A review the existing data supplied by Croft has been carried out, including the proposal drawings produced to date, Ground Investigation data, photos of the building and the background data available through LB Camden's website and other freely available data such as BGS geological information.
- In line with the CPG4 guidance:
    - A detailed assessment of the published and encountered geology
    - Development of a ground model including an assessment of geotechnical properties
    - An engineering interpretation including an assessment of slope stability and potential for ground movements.
- Recommendations for additional work/ monitoring and observation have been provided.

This report and the work to support it has been carried out by Jon Smithson who is a Director of Ground and Project Consultants Ltd and is a Chartered Geologist with 30 years' experience.

3. BIA Screening for Slope/Land Stability

A screening exercise has been carried out as per the guidance in CPG4 as follows:

Question	Answer	Action/ Comment
Question 1: Does the existing site include slopes, natural or manmade, greater than 7 degrees? (approximately 1 in 8)	No. The property is located at around 39-40mAOD and there is no significant change in level across the site.	None
Question 2: Will the proposed re-profiling of landscaping at site change slopes at the property boundary to more than 7deg? (approximately 1 in 8)	No. There are no significant planned changes in surface profile.	None
Question 3: Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7deg? (approximately 1 in 8)	No. The nearest railway lines (underground) are approximately 800m away to the west and north. There is a covered reservoir, Barrow Hill Reservoir, approx. 250m to the NW.	None
Question 4: Is the site within a wider hillside setting in which the general slope is greater than 7degrees? (approximately 1 in 8)	No, the site is to the south west of Primrose Hill. This reaches an elevation of around 64m AOD around 500m from the property. The land rises gently up to this point and is steepest near the top of the hill with estimated gradients from OS maps of around 1 in 20.	None
Question 5: Is the London Clay the shallowest strata at the site?	Yes, the geological map (sheet 256) indicates that the site is underlain London Clay with a potential for Head Deposits at site.	The presence of London Clay close to surface is further discussed in the Impact Assessment.
Question 6: Will any tree/s be felled as part of the proposed development and/or are any works proposed within any tree protection zones where trees are to be retained? (Note that consent is required from LB Camden to undertake work to any tree/s protected by a Tree Protection Order or to tree/s in a Conservation Area if the tree is over certain dimensions).	No but there are large mature trees at or close to the property.	Further discussed in the Impact Assessment.
Question 7: Is there a history of seasonal shrink-swell subsidence in the local area, and/or evidence of such effects at the site?	None known. However London Clay is indicated as being present at the property. Head deposits can also have high plasticity.	Further discussed in the Impact Assessment.

Question 8: Is the site within 100m of a watercourse or a potential spring line?	Possibly: Figure 11 of the Arup report indicates a 'Lost River' to the West of the property.	This is further discussed in the Impact Assessment.
Question 9: Is the site within an area of previously worked ground?	None known or suspected.	None
Question 10: Is the site within an aquifer? If so, will the proposed basement extend beneath the water table such that dewatering may be required during construction?	No. The London Clay is classified by the Environment Agency as unproductive strata (rock layers with low permeability and negligible significance for water supply or river base flow). However the site is within a source protection zone of a public water supply likely sourced deep into the underlying chalk.. The basement may extend into the water table.	This is further discussed in the Impact Assessment.
Question 11: Is the site within 50m of the Hampstead Heath ponds?	No. The ponds are around 2.5km to the north.	None
Question 12: Is the site within 5m of a highway or pedestrian right of way?	Yes. The basement will be within 5m from the highway and pavement.	Health Safety and environmental measures will be required to be integrated into the building contractors methods of working. This is further discussed in the Impact Assessment.
Question 13: Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	The base of the basement slab will be around 3.5m below the existing ground floor.	This is further discussed in the Impact Assessment.
Question 14: Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	No. Closest tunnels are approximately 500m away	None

4. Site Information

4.1 Existing Property and Basement Proposals

The property at 14F Avenue Road (B525) is located east side of the road just north of its junction with St Edmunds Terrace. Regent's Park lies around 250m to the South East. The property is located on the South West flank of Primrose Hill. The elevation of the site is around 40m AOD and the land rises t around 64m AOD on Primrose Hill some 500m to the North East. The main west coast and east coast train lines into Euston and King's Cross run around 700m to the north in tunnel and the underground lines (Bakerloo and Jubilee) run around 600m to the East. The Grand Union Canal runs along the northern perimeter of Regent's Park some 250m from the property.

The property is a 1960's (approximately) three storey town house with footprint of approximately 75m^2. The plot is approximately 150m^2 with most of the land at the rear. The property is in a row of 4 (No's 14E, F, G and H) and is set back behind a similar row (No's 14A-D). The front of the property is approximately 30m from Avenue Road itself.

The National Grid reference for the property is TQ 274 835. The location of the property is provided in Figure 1.

It is understood that there is a below ground garage structure at site and a single storey extension to the rear of the property. It is also understood that there are mature and semi-mature trees along the south-eastern boundary of the site in the rear garden.

The basement proposals comprise a single storey construction and will include a cinema/games room, gym and access with a skylight in the garden. The original planning application was for a basement to be constructed beneath the back garden and underneath the rear of the property. A new application is to be submitted for a kitchen beneath the main part of the property. The maximum depth of construction is beneath the rear garden and is approximately 3.5m bgl.

4.2 Topography

The OS map indicates the property is at around 40m AOD and towards the base of Primrose Hill on its South Western flank. The ground surface rises gently to up to Primrose Hill at a gradient local to the property of around 1 in 20 (i.e. less than 3^o). This gradient increases slightly towards the top of Primrose Hill and is at a maximum local to the covered reservoir (due the surrounding engineered fill) of around 1 in 10. The topography in other directions is subdued.

4.3 Geology

The available geological mapping (Ref 1.) indicates that the site lies on London Clay which typically comprises a stiff grey fissured clay, weathering to brown near surface. Concretions of argillaceous limestone in nodular form (Claystones) occur throughout the formation. The geological map (North London 256) indicates that the property is at the edge of an area of 'propensity' for Head Deposits. It appears in this case that the Head Deposits are strongly associated with Primrose Hill. Typically these deposits are thin (<2m) and consist of soft, ocherous brown silty clay with blue-grey mottling in places and angular, frost-shattered fragments of flint occur sporadically throughout. The base of the London Clay is likely to occur some depth below the property. See figure 2 below.

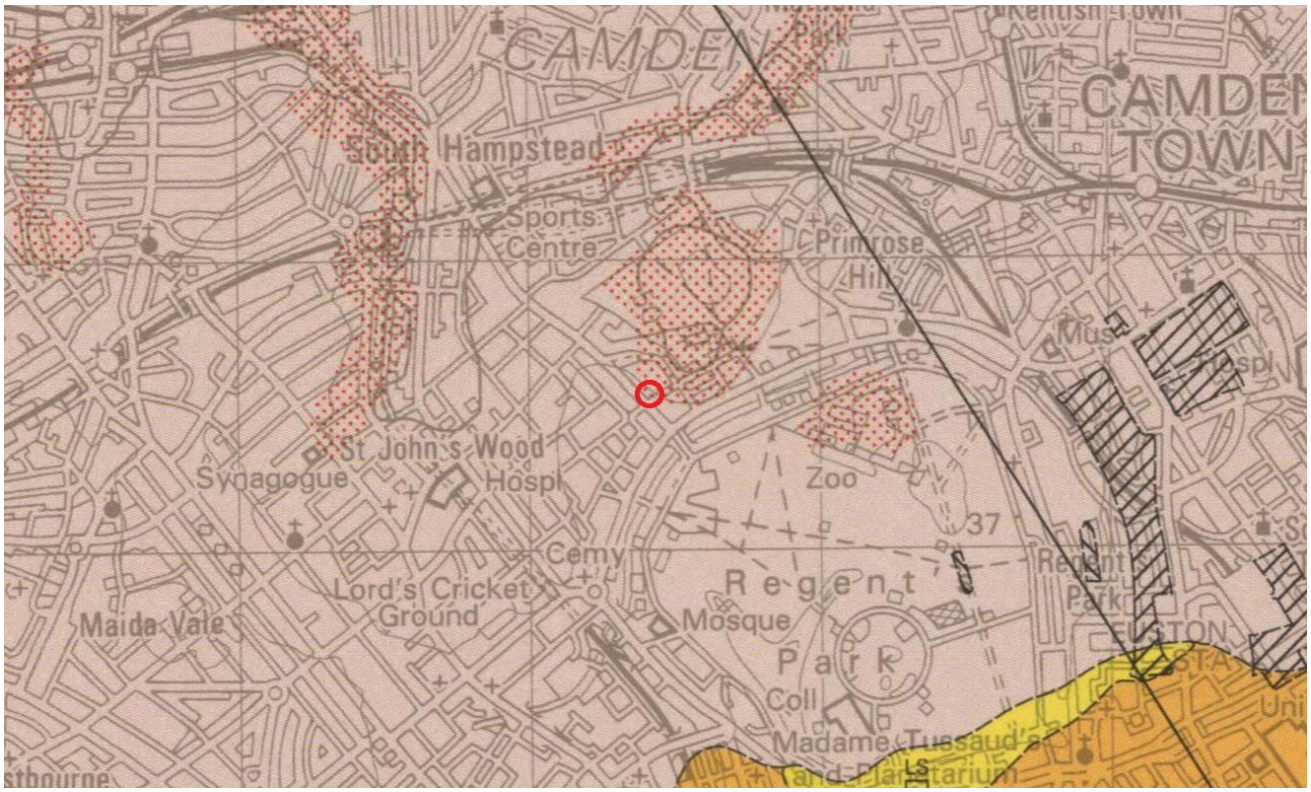

Figure 2: Geology

4.4 Hydrology and Hydrogeology

The OS Map indicates that the Grand Union Canal is around 250m to the South East of the site and Regent's Park Boating Lake is around 800m to the SSE. The Hampstead Ponds are approximately 2.5km to the NNE. There are no springs shown on OS mapping. There is a hidden river indicated on Arup Figure 11, approximately 100m to the West of the site. This appears to be a tributary of the River Tyburn. The London Clay is classified by the Environment Agency as unproductive strata (rock layers with low permeability and negligible significance for water supply or river base flow). The site is located within the Inner zone (zone 1) of a groundwater source protection zone of a public water supply. This is associated with Barrow Hill Reservoir to the North East. See the extract from the EA SPZ Map below.

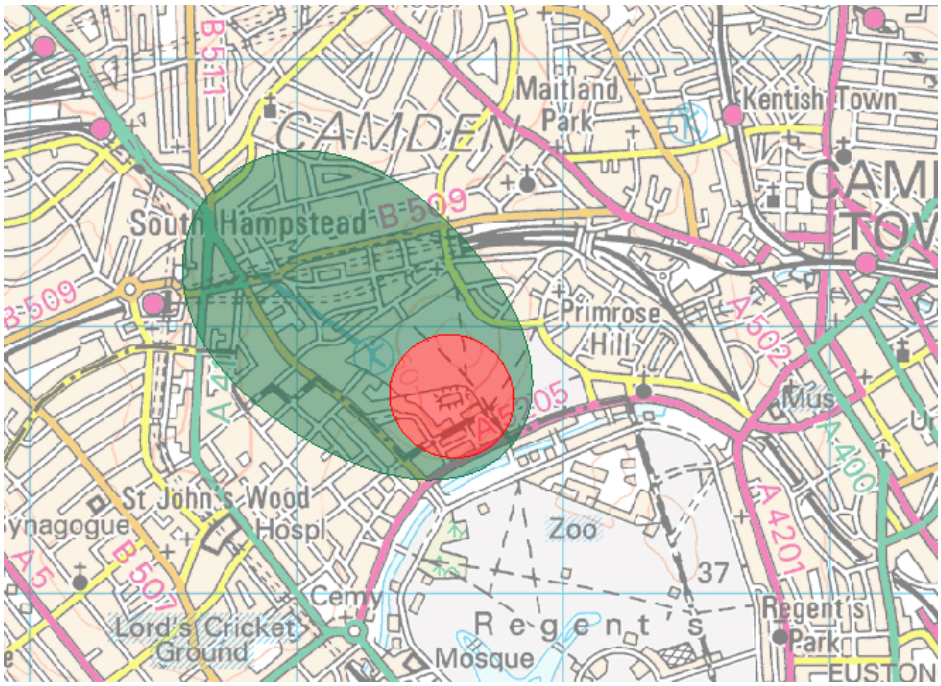

Figure 3: Source Protection Zone

4.5 **Other Environmental Data**

The Groundsure report gives a wealth of background data on local environmental issues and hazards. (See Appendix A). The key issues are summarised in the table below:

Drift Deposits	None are indicated on BGS mapping
Made Ground	None are indicated on BGS mapping
Groundwater Abstraction	SPZ Zone 2. Abstraction point indicated at Barrow Hill (Note that the EA website (above refers) indicates Zone 1). There are a number of groundwater abstraction points within 2km of the site.
Shrink/ Swell	There is a moderate Hazard of shrink and swell from the London Clay soils
Landslide	Very Low Risk:.
Soluble Rocks	Negligible Risk
Compressible Ground	Negligible Risk
Collapsible Ground	Very Low Risk
Running Sand	Negligible Risk
Mining	None recorded

5. Ground Investigation

A ground investigation (GI) has been carried out at the site by Ground & Water Ltd (G&W) and results of these have been made available by Croft. The GI was carried out in October and December 2014.

The work comprised one window sample borehole (WS1) to 6.00m at the rear of the property along with a dynamic probe to 10m bgl. Three trial pits were excavated by hand to inspect the existing foundations at the front and rear of the property.

The borehole encountered a thin cover of Made Ground 0.60m thick, described as dark brown slightly sandy gravelly clay. Gravel is occasional to abundant, fine to coarse, rounded to angular flint, brick and concrete. brown sandy silty clay with gravel of flint, brick clinker. It likely represents reworked natural ground with some man made material associated with the property construction. Below this was a thin layer of what G&W describe as London Clay, although this may represent Head Deposits. It was described as orange brown silty clay and was just 0.7m thick. Below this at 1.40m bgl was a Brown, with occasional blue grey mottling, silty CLAY with silt partings. Some selenite crystals were noted.

The dynamic probe indicated relatively low shear strengths to 6m bgl, correlating to soft to firm and firm through to stiff from 6m. These represent relatively low results for London Clay and may indicate disturbance.

The Trial Pits TP/FE1to 3 were excavated to expose and examine the existing foundations of the property. TPFE1 and 3 were excavated at the rear of the property at the SE and NE corners respectively and TP/FE2 was excavated to the front on the NW corner. The pits indicted brick wall over either concrete or brick foundations. None of the pits proved the base of the footings with the depths of holes varying from 1.14m to 2.5m. Made Ground was recorded in TP/FE3 as gravel overlying clay.

A standpipe piezometer was installed in WS1 to 5.00m depth. Groundwater was not encountered during drilling and a return visit in October 2014 by Ground&Water to site found the standpipe to be dry. However a return visit in December 2014 dipped the water level at 0.67m bgl.

Laboratory tests were carried out on the samples collected from the borehole. Testing consisted of the following:

4 No. Atterberg Limit test
9 No. moisture content determination
1 No. Consolidation test on a disturbed sample of London Clay
1 No. Sulphate/pH
2 No. Soluble Sulphate, pH and related tests for Concrete Classification on soil samples

Two of the moisture content tests were conducted in Made Ground and the remainder in London Clay. These show little variation and no discernible pattern with depth, ranging from 29 to 33% in the London Clay. Atterberg tests in the London Clay also showed consistent values as follows:

- Plastic Limit : 27 to 30%
- Liquid Limit: 73 to 80%
- Plasticity Index: 46 to 50%

The low moisture content relative to liquid and plastic limit (just above plastic limit) suggests a relatively high shear strength and stiff consistency.

The consolidation test was performed on a presumably remoulded sample so will be of little value but indicates a soil of low compressibility.

6. Conceptual Ground Model

From the above a conceptual Ground model has been developed and is presented in tabular form below:

Strata	Typical Description	Depth at Property encountered in GI	Geotechnical Properties – Tentative Characteristic Values*	Other
Made Ground	Brown silty clayey sandy gravel/ gravelly clay, gravel is clinker, brick, concrete, flint	Ground level to 0.60 – 1.50+m	N/A	Made Ground is unlikely to be encountered to a significant depth. It should not be relied upon as a bearing strata.
Weathered London Clay/Head Deposit	Soft to firm orange brown silty clay	0.60 – 1.30m	N/A	Weathered London Clay is unlikely to be encountered to a significant depth. It should not be relied upon as a bearing strata.
London Clay	Firm becoming stiff silty CLAY with fine sand and silt lenses and cementstone nodules.	From 1.30m (deeper in areas close to existing foundations)to depth unproven	C' =0 $\phi' = 20^o$ Cu = 40 increasing to 100kN/m^2 at depth. Use 50kN/m^2 at formation**	Clay is of high plasticity.
Groundwater		0.67m bgl		May significantly vary seasonally or after prolonged wet or dry periods.

Table 3: Summary of Strata Characteristics

*The determination of parameters is tentative due to the lack of test data.

**The undrained shear strength may have been considerably underestimated by the dynamic probing exercise. Strength should be verified by hand held shear vane/ inspection during ground excavation.

7. Impact Assessment

There are no major issues which should seriously affect the viability of the construction of the new basement. However the assessment of the geological environment of 14F Avenue Road and the screening exercise indicate some areas for further discussion in this report with suggested mitigation where appropriate.

7.1 **London Clay:** The basement will be founded in the London Clay. The soils are of high plasticity and high volume change potential. The basement will be founded at around 3.5m bgl, therefore below any seasonal shrink and swell. The London Clay soils are known for their high levels of soluble sulphate. The concrete mix design should take appropriate account of sulphate levels in accordance with BRE Special Digest 1.

7.2 **Trees:** Large mature trees are located in the rear garden and in the vicinity of the property. Roots have been noted in the ground investigation at 1.70 bgl in the borehole. Care should be taken to minimise root damage during construction works. Should trees be removed there is potential for the soils to swell as a result and this should be accounted for in design.

7.3 **Watercourses**: There is evidence that a 'lost river', a tributary to the River Tyburn is possibly located to the east of the property. It is highly unlikely that any culvert or trace of this will be encountered at the site.

7.4 **Groundwater**: Groundwater was encountered above the proposed basement formation level and close to ground level. It is recommended that a design level of ground surface is used. Groundwater may be encountered during the works, particularly as seepages through sandy silty layers within London Clay or at the base of the Made Ground. These should be and should managed carefully to prevent ground loss particularly through loss of fines and softening of formation. Consideration should be given to limiting the size and time of face exposures during construction should significant flows be encountered during construction. Baseline and ongoing regular monitoring of the building and its immediate neighbours for settlement and movement/distress is highly recommended during building works and for a short period after completion. It is recommended that ongoing monitoring of groundwater levels is carried out during and up to the end of construction of the basement structure.

7.5 **Source Protection Zone**: The site is in a source protection zone (either close to or within Zone 1). Care needs to be taken and best practice outlined in PPG5 followed to avoid pollution or deterioration of the groundwater resource.

7.6 **Basement Depth**: The basement is proposed to be constructed involving an excavation to approximately 3.5m below the existing ground floor. The proposals to construct the basement involves a 'hit and miss' approach in stages so each 'panel' is separated by 3-5 others from the next open one. It will be important that the building contractor is closely supervised and is experienced in this type of construction. It will be critical to prevent exposed faces from collapse or significant ground loss into the new excavation and temporary face support should be maintained where practicable.

8. Conclusions

The methodology and approach of CPG4 has been followed in developing this BIA with respect to Land stability. It is concluded that with the construction of the new basement at 14F Avenue Road should not have significant impacts on land stability provided that:

- Groundwater inflow, if encountered, is reduced to a minimum and properly controlled such that there is no significant wash out of fine material. Groundwater levels should be monitored before and during construction.
- The construction of the basement is carried out by a competent and experienced building contractor and precautions are taken to maintain the stability of the excavations.
- Care should be taken to minimise the disturbance and damage to trees and their roots. Should tress be removed then an assessment of the potential for swelling of the London Clay soils should be carried out.
- Concrete should be designed in accordance with BRE Special Digest 1 accounting for the sulphate conditions anticipated.
- Monitoring of the structures is carried out before and during construction. The exact nature of this monitoring should be determined by the structural engineer.
- The site is in a Source Protection Zone, PPG5 should be followed to avoid any polluting activities during construction which may affect groundwater quality.

9. References

1. BGS Geological Map Sheet 256.
2. Arup: Camden Geological, Hydrogeological and Hydrological Study.
3. Croft Structural Engineers: Design drawings available at the time of reporting.
4. Ground&Water GWPR1072: Ground Investigation Report: 14F Avenue Road, Primrose Hill, London NW8 6BP.
5. Groundsure Enviroinsight report for 14F Avenue Road, GS-1783156

APPENDIX

Groundsure Enviroinsight Report GS-1466122