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Your ref:
Our ref J14245/HD/02

Aidan Rivett-Carnac
Michael Alexander Consulting Engineers
Foundation House
4 Percy Road
London
N12 8BU

Dear Aidan

Re: 19 PARLIAMENT HILL, LONDON, NW3 2TA

Further to your instruction dated 11th November 2014, on behalf of Gideon and Tammy Wood, we have now completed the ground movement analysis for the proposed development at the above site, and this letter comprises our report on our findings.

A desk study and ground investigation has previously been carried out by GEA (report ref J14245 Issue 1, dated 9 October 2014) and the findings of this investigation and previous investigations in the vicinity of the site have been used in the derivation of parameters for use in this assessment. A Structural Basement Impact Assessment has also been prepared by Michael Alexander Consulting (Ref; P2957, Report Issue 1) dated November 2014). This letter report supplements and should be read in conjunction with the previous reports.

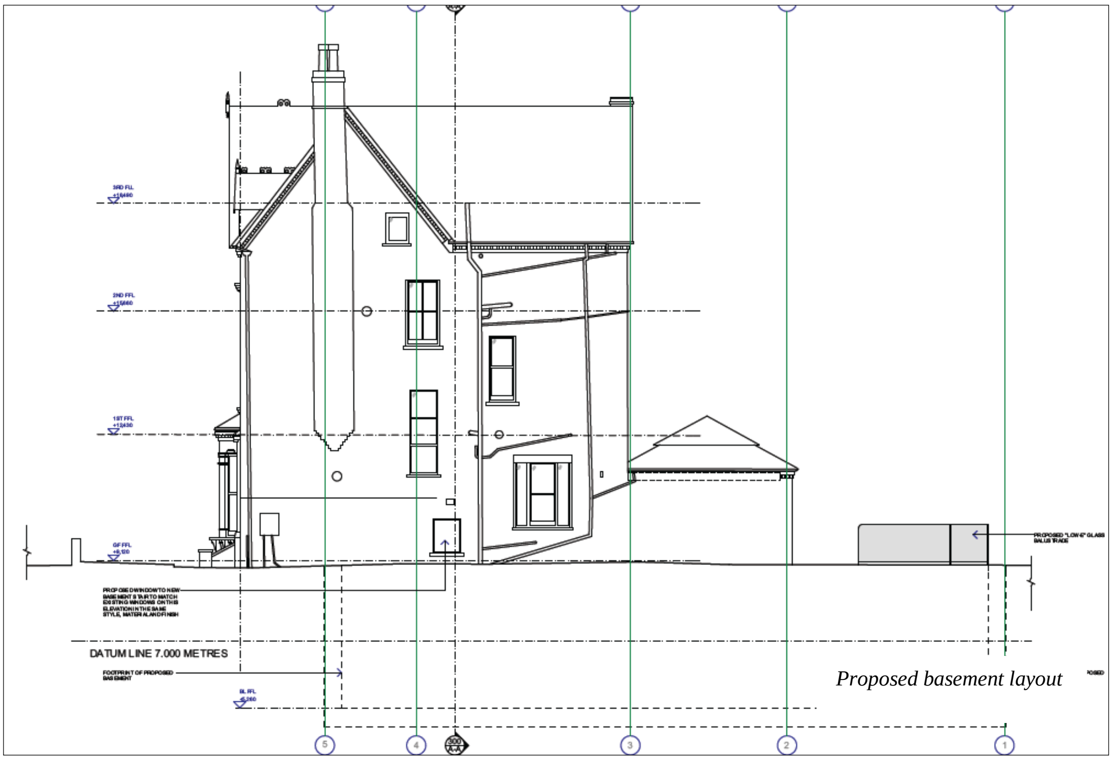
The conclusions and recommendations made in this document are limited to those that can be made on the basis of the investigation. The results of the work should be viewed in the context of the range of data sources consulted and the number of locations where the ground was sampled. No liability can be accepted for information in other data sources or conditions not revealed by the sampling or testing. Any comments made on the basis of information obtained from the client or other third parties are given in good faith on the assumption that the information is accurate; no independent validation of such information has been made by GEA.

1.0 INTRODUCTION

1.1 Proposed Development

Consideration is being given to the construction of a single level approximately 4.00 m deep basement beneath the existing house and patio in the rear garden. It is understood the basement will be formed using reinforced concrete underpinning methods by means of a "hit and miss" approach. The basement will extend below most of the footprint of the existing building with the exception of the front section and below part of the rear garden. Sections and plans of the proposed basement work are enclosed and an extract is included below.

This report is specific to the proposed development and the advice herein should be reviewed if the proposals are amended.



Proposed basement layout

2.0 THE SITE

2.1 Site Description

The site is located in the London Borough of Camden, roughly 200 m to the northeast of Hampstead Heath London Overground Station. It is roughly rectangular in shape, measuring approximately 50 m east to west by 10 m north to south and fronts onto Parliament Hill to the southeast. It is adjoined to No 17 to the northeast and is bordered to the southwest by No 15, both of which comprise semi-detached three-storey houses with roof accommodation, and to the northwest by the rear gardens of properties fronting onto South Hill Park. The site may be additionally located by National Grid Reference 527400, 185790.

The local topography slopes down generally towards the south. The site is essentially on a level plot although ground slopes up along the northwestern boundary of the site.

The site is currently occupied by a three-storey semi-detached house with roof accommodation and a single storey rear extension along with a front and rear garden. A paved area with flowerbed and shrub borders and a single tree is present at the front of the house. A narrow passageway with a drain running through the middle leads along the northern elevation of the house to the rear garden. The rear garden comprises a patio with steps leading up to a central lawn with shrub and flowerbed boarders and a number of trees.

3.0 SUMMARY OF GROUND CONDITIONS

The recent investigation confirmed the expected ground conditions in that, below a nominal thickness of made ground, London Clay was encountered and proved to the maximum depth investigated of 8.45 m.

The made ground extended to depths of between 0.37 m and 0.72 m and generally comprised brown silty sandy clay with occasional flint gravel and fragments of brick and ash. The London Clay initially comprised an upper weathered horizon of firm becoming very stiff brown mottled grey becoming greyish brown silty fissured clay with occasional to abundant partings of fine sand and silt, selenite crystals and mica, which extended to depths of 7.50 m in Borehole No 1, but was not proved at other locations. Below this depth stiff grey fissured silty clay with abundant orange-brown partings of fine sand and silt was encountered. A claystone was encountered in Borehole No 1 at a depth of 0.66 m.

Groundwater inflows were not encountered during drilling although the drilling tools were noted to be wet at a depth of 8.00 m in Borehole No 1. Perched water was noted at the base of a footing exposed in Trial Pit No 2 at a depth of 0.55 m. Subsequent groundwater monitoring has measured groundwater at depths of between 0.75 m and 3.70 m within the standpipes, roughly two weeks after installation.

4.0 CONSTRUCTION SEQUENCE

On the basis of the results of the ground investigation, the basement will have a formation level within the London Clay. Significant groundwater inflows are not expected within the 4.00 m deep basement and it should be possible to adopt traditional reinforced concrete underpins beneath the existing house. Sump pumping should be sufficient to deal with any groundwater inflows.

The existing house and extension is founded on London Clay at depths of between 0.55 m and 0.72 m.

The construction method statement indicates the basement under the building will be generally constructed by underpinning the existing external and internal loadbearing structural walls. Where existing load bearing lines are not being carried through to the proposed basement level then new beams will support the structure over.

Where the basement extends beyond the line of the building the ground at the boundaries will be stabilised by underpinning under garden walls and with reinforced ‘L’ shaped reinforced concrete sections adjacent to fence lines. This will enable the basement within the rear garden to be constructed using retaining walls cast in sections, propped at the corners and back to the ground floor of the house.

5.0 GROUND MOVEMENTS

The proposed construction of the new 4.00 m deep basement will result in a net unloading of about 80 kN/m^2.

The foundation loads of the existing and new structure are not known at present and this analysis assumes a worst case situation. It has been assumed that the foundations of Nos 17 and 19 Parliament Hill are at a similar depth to No 19 Parliament Hill at a depth of about 0.80 m below ground level, based on the findings from Trial Pit Nos 1 and 2.

5.1 Basis of analysis

Our analysis of potential ground movements has been carried out based on the assumption that the soils behave elastically, which provides a reasonable approximation to soil behaviour at small strains.

The table below summarises the assumed soil profile used in the analysis. The soil profile is based on SPTs from Borehole Nos 1 and 3, along with a 20 m deep cable percussion borehole carried out at No 61 Parliament Hill.

Soil Profile	Depth of base of Stratum (m)	Young's Modulus (E' - kN/m2)	Young's Modulus (E_u - kN/m2)	Unit Weight (γ- kN/m3)
London Clay	50	21,000 to 132,000	35,000 to 220,000	19.5
* Strengths interpolated based upon an assumed linear strength profile.				

The elastic analysis requires values of soil stiffness at various levels to calculate displacements. Values of stiffness for the soils at this site are readily available from published data and we have used a well-established method to provide our estimates. This relates values of E_u and E', the drained and undrained stiffness respectively, to values of undrained cohesion, as described by Padfield and Sharrock[1], Butler[2] and more recently O'Brien and Sharp[3]. For the purpose of this analysis, the following relationship has been adopted:

$Eu = 500\ c_u \qquad E' = 300\ c_u$

On the basis of the above we have determined values of stiffness from the undrained cohesion profiles described above. Drained and undrained parameters have been used throughout, to provide an estimate of the total 'long term' and 'short term' movement. More recent published data[4] suggests higher values, but it is considered that the use of the lower values is a reasonable approach for a first analysis. .

A rigid lower boundary for the analysis has been set within the London Clay at a depth of about 50 m below the proposed formation level of the basement, thus at a depth of 54 m below ground level.

5.2 Ground Movements Arising from Basement Excavation

The results of the heave analysis are included in the table presented below and contour plots are enclosed. Full tabular results can be provided upon request.

Location	Movement (mm)		
	Short-term heave (excavation phase)	Long-term heave (post construction)	Total heave
4.00 m deep basement			
Centre of excavation	10	9	19
Edge of excavation	4	5	9

5.2.1 Short Term heave due to excavation (undrained condition)

At the centre of the excavation below the existing house, up to 10 mm of heave has been estimated at the centre of the excavation in the short term, reducing to about 5 mm at the edges of the excavation.

1 Padfield CJ and Sharrock MJ (1983) *Settlement of structures on clay soils.* CIRIA Special Publication 27
2 Butler FG (1974) *Heavily overconsolidated clays: a state of the art review.* Proc Conf Settlement of Structures, Cambridge, 531-578, Pentech Press, Lond
3 O'Brien AS and Sharp P (2001) *Settlement and heave of overconsolidated clays - a simplified non-linear method.* Part Two, Ground Engineering, Nov 2001, 48-53
4 Burland JB, Standing, JR, and Jardine, FM (2001) Building response to tunnelling, case studies from construction of the Jubilee Line Extension. CIRIA Special Publication 200

5.2.2 Long term heave due to excavation (drained condition)

Following completion of the basement construction, a further 10 mm of heave may take place in the centre of the excavation with a further 5 mm of heave predicted at the edges in the long.

The predicted heave movements discussed above are likely to be restrained by the new structure and therefore the movements are likely to be less than the predicted values.

A void should be incorporated into the design of the basement floor slab to accommodate these potential long term movements. If a compressible material is used beneath the slab, it will need to be designed to be able to resist the potential uplift forces generated by the ground movements. In this respect potential heave pressures are typically taken to equate to around 50 % to 60 % of the total unloading pressure.

5.3 Ground Movements Induced by Underpinning

It is expected that settlement will occur at the proposed basement level as a result of the new underpins transferring the existing load from the building above to the London Clay at a greater depth than has hitherto been the case.

The lateral movement of material behind the new underpinned basement walls is unlikely to exceed 2 mm to 5 mm due to the construction process and anticipated stiffness of the walls, although this will depend on the workmanship and quality of the wall during construction.

The settlement will comprise an “immediate” component that may be expected to occur following loading of the soils, together with long term settlement due to consolidation of the clay that would theoretically occur over a period of many years. The excavation of the proposed basement will however result in heave of the underlying London Clay which is likely to reduce the estimated settlements.

6.0 DAMAGE TO NEIGHBOURING STRUCUTRES

The combined movements resulting from the basement excavation have been used to carry out an assessment of the likely damage to adjacent properties of Nos 17 and 21 Parliament Hill and the results are summarised in the table below.

Building Damage Assessment					
Sensitive Structure	Horizontal movements (mm)	Maximum deflection (mm)	Horizontal strain (%)	Deflection ratio (%)	Burland Scale
No 17 Parliament Hill	2	9	0.025	0.113	1.5
No 19 Parliament Hill	2	9	0.025	0.113	1.5

The building damage assessment for the sensitive structures identified in the above table predicts that the effect on the adjacent properties will be ‘slight’ as defined in the Burland damage categories.

7.0 CONCLUSIONS

On the basis of these results for the total movements, the building damage assessments for the adjacent structures of Nos 17 and 21Parliament Hill, based on building a width of 8.00 m for both buildings, fall within Category 2 of the Building Damage Assessment, indicating a slight class of damage which could include, for example, cracks up to 5 mm in width. All estimates of movement may be expected to have a tolerance of + / - 20 %, but this would still fall within Category 2.

Regular monitoring of the underpins should be undertaken during construction and compared with the predicted values. Good quality workmanship and propping in the short term and long term is essential to control ground movements.

I trust we have provided sufficient information but if we can be of any further assistance please do not hesitate to contact me.

Yours sincerely
GEOTECHNICAL & ENVIRONMENTAL ASSOCIATES

Hannah Dashfield
Encs