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Elizabeth Beaumont
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Regeneration and Planning
Culture and Environment
London Borough of Camden
6th Floor
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London WC1H 8EQ

Dear Ms Beaumont,

Re: 53 Fitzroy Park, Highgate, London, N6 6JA,
Application. No,'s 2011/1682/P and 2011/1686/C

At the request of Postcruise Ltd., the following letter report addresses concerns raised by the London Borough of Camden (LBC) relating to the effects of a proposed basement as part of the above planning application. In particular this letter seeks to offer assurances concerning the stability of slopes on the property and the effects of basement wall construction and their effects on ground movement.

In undertaking this review we take cognisance of LBC's guidance note CPG4[4] and a further report produced for LBC by Ove Arup & Partners[3].

Existing Slope Stability

Two intrusive ground investigations[1,2] have been carried out at the site each reveal the site to be underlain by the London Clay formation described as soft/firm orange/brown and grey green silty clay becoming stiff fissured dark brownish clay. There is some evidence of desiccation probably as a result of localised water demand from surrounding trees. The London Clay is overlain by a thin mantel of Made Ground described as grass over slightly sandy gravelly clay with rootlets and fragments of brick, ash and concrete. There is evidence of a former pond in RSK boreholes 3A and 4A indicated by the presence of wet organic clay below the topsoil.

The undrained shear strength (C_u) of the London Clay has been established by undertaking Standard Penetration Tests (SPT) at regular intervals and also by undertaking Quick Undrained Triaxial tests on a number of samples obtained via undisturbed samples. RSK[2] have adopted a correlation by Stroud[5] ($C_u = f_1N$) to convert "N values" obtained from the SPT to undrained shear strength, typically the correlation is in the range 4 to 6 and RSK[2] appear to have used 5. (f_1=5. C_u =5N). The graph appears at Figure 6[2]) and a best fit straight line can be plotted on this graph to develop a strength envelope for the London Clay formation against elevation as follows:

C_u = 25 kPa at 82.00 m OD + 12.5 kPa/m depth

RSK[2] make an assessment of the weathered and underlying "fresh" London Clay and based on the results of laboratory tests they conclude that there is no material distinction discernible between each of these soil types with all analyses falling within the high to very high plasticity clay classification. No significant sand or silt dominated beds were encountered, and the principal lithologies encountered were clay dominated (i.e. the primary soil type was a clay). On this basis they considered that the encountered stratum is compatible with Unit D of the London Clay Formation. Furthermore the undrained shear strength profile shown in Figure 6[2] falls within what can be considered typical for the London Clay formation throughout the London Basin. We conclude from this that the underlying natural soils that will dominate slope stability at this site <u>are</u> London Clay and the following discussion acknowledges this.

Our clients have requested their architect prepare a document entitled "Spoil Removal Calculation Document[6]", this shows as a three dimensional visual the existing site and gardens followed by sequential 3D visuals during and after construction of the proposed development. Currently the <u>on-site</u> slope falls away from Fitzroy Park to the south west towards the valley occupied by Highgate Ponds at an angle of approximately 1v in 6 to 7h or between 9.5 and 8.1° to the horizontal. GEA[1] note that the <u>general topography</u> *"slopes away at 1 vertical to 9 horizontal..... losing approximately 45 metres in elevation over a distance of 400 metres"* (approximately 1v in 9h or 6.4°). Skempton[7] suggests that the critical angle for natural slopes in London Clay is 10° with slopes less than this stable and greater than 10° potentially susceptible to movement. From the above it is clear that the existing natural slopes on site and within the general surrounding topography <u>are</u> less than 10° which is also confirmed by Figure 16 of Ove Arups' report[3] for the site location.

Ove Arup[3] also note that Hutchinson[8] observes that the critical angle for London Clay has been as low as 8° especially where the groundwater level in the clay is close to the surface because the saturated clay possesses reduced strength compared with dry clay. Figure 16[3] also shows areas within LBC that have slope angles in the range 7 to 10° and clearly the on-site slopes in question fall within this range, it is noted however, that 7° is used in place of 8° noted by Hutchinson[8] as a margin of error rather than any sound engineering principle. It is also further noted that the general slope topography noted as 6.4° by GEA[1] does indeed fall within the LBC 7° limit.

A walkover survey undertaken by an independent Geotechnical Engineer in the Autumn of 2009 concluded that there were *"no signs of slope movement or structural damage to the existing building[1]"*. A further walkover survey undertaken in Autumn 2010 by a second independent Geotechnical Engineer states *"the site reconnaissance survey did not reveal any obvious significant issues associated with the stability of slopes on the site or immediate surrounding area. Under the proposed development plan slope stability issues are unlikely to affect the proposed residential structure, although it may need to be taken into consideration with regard to any landscaping proposals[2]."*

RSK[2] have installed piezometers in 9 boreholes at the site, their conclusions are that groundwater is present at the site in several distinct settings, these are:

- Perched water locally encountered during site works as a minor seepage at the Made Ground/London Clay interface (BH8A only).
- Minor seepages encountered at depth within the London Clay.
- Groundwater/perched water encountered within alluvial-type sediments associated with the former pond (BH3A and 4A only).
- Soakaway tests undertaken to assess the soils beneath the site with respect to soakaway drainage indicated the soils to be unsuitable for this drainage technique.

Given that RSK[2] have shown via rising head tests that the coefficient of permeability of the London Clay is in the range 1.8 to 2.0 x 10^7 m/s where seepages had been recorded and 1.4 x 10^8 m/s where seepages had not been recorded, we concur with RSK's[1] observation that groundwater flow within the London Clay is likely to be fissure dominated. No silt, sand or gravel horizons have been recorded in the London Clay and given the slope angle surface water is likely to run off, therefore it is difficult to see how the London Clay could become saturated to any extent given its low permeability. We would suggest that given the site history and the lack of any evidence at the site of any slope movements as witnessed by both GEA[1] and RSK[2], that the existing site slopes are currently stable as they are less than 10° as suggested by Skempton[7]. The requirement for them to be less than 8° or even 7° as apparently arbitrarily applied by LBC is not supported by the soils encountered which are dry and stable. Nevertheless, by inspection the general topographical slopes in the locality down towards the Highgate Ponds fall within the LBC limit of 7° and would comply with the recommendations following Hutchinson[8]) including for the margin of error imposed by LBC.

Effects of Proposed Development on Existing Slope Stability

As noted above Emrys Architects Ltd., have produced a useful study[6] describing using 3D visuals the demolition, excavation, proposed new construction and reuse of on site spoil within the existing site boundaries. The report shows the placement of some 638 m^3 of spoil won from the proposed basement excavation to the north west and west of the proposed new property, a substantial portion of which will sit behind a new garden retaining wall on an area of ground which is currently shown as a plateau at an elevation of 80.50 m OD approximately. The excavation will take place below a proposed embedded retaining wall forming temporary excavation support for the basement construction to the new dwelling. Some spoil will be placed on the lower slopes closer to the pond and the slope angle will be raised slightly from about 8.6°currently, this fill placement is localised in the context of the natural topographical slope in its entirety, where possible however the remodeled slope here should not exceed 10°. Additional material could be placed here if required to raise the ground further but in so doing it would be prudent subject to detailed design, to construct a further retaining wall close to the pond.

The fill placement to the plateau as noted above will have the effect of stabilising further the upper slopes but may reduce the stability of the lower slopes beyond the pond by acting as a surcharge. The engineering design of the garden retaining wall shown here will need to take this possibility into consideration, for a retaining wall in a slope this is standard practice.

The slopes above the proposed new dwelling and Fitzroy Park will be influenced by the construction of the basement. The proposed construction method is a top down method of construction using contiguous bored piles and this is ideal for minimising ground movements around the proposed excavation. This construction method is commonly used on city centre sites where properties are immediately adjacent, it is a low noise, low vibration technique that will provide a robust stiff box able to resist the earth pressures surrounding it and preventing any instability in the surrounding soils and adjacent properties. Typically bored pile walls are designed to high standards of safety and wall movements and their effects are a critical consideration.

As general guidance CIRIA C580[9] presents an overview of wall movements and their effects taken from various researchers work over the past 50 years based on observed measurements. One researcher normalized observed data against excavation depth and produced a graph[9, Fig 2.11] showing Distance from wall/[1]Maximum excavation depth versus Ground surface settlement/Maximum excavation depth. For this site the nearest property to the proposed basement is 11 metres and the general maximum excavation depth (excluding the localised sump) is around 5 metres. From Figure 2.11 of CIRIA C580 the percentage of Ground surface settlement/ Maximum excavation depth is 0.06% for a bored pile wall with intermediate wall stiffness hence the anticipated vertical ground movement 11 metres distant from the bored pile wall is estimated at around 3 mm. Note this is a first order approximation based on published data, a higher stiffness wall would produce a better result of around 2 mm, more accurate indications can be obtained using finite element analysis techniques for the particular ground conditions, pile types, internal propping and geometrical constraints.

We conclude therefore that a contiguous bored pile wall will provide a suitable means of support for the adjacent ground and Fitzroy Park and minimise the effects of ground movements on nearby properties whilst allowing groundwater to continue to flow below the new dwelling.

I trust this letter has resolved the outstanding issues to your satisfaction.

Yours sincerely

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[1] Read as Distance from wall divided by Maximum excavation depth

References

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2) RSK Group Ltd., 53 Fitzroy Park, Highgate, London, North West London, Geotechnical, Hydrological and Geoenvironmental Site Investigation Report, Project no. 241919-01 (00), December 2010.

3) London Borough of Camden, Camden Geological, Hydrogeological and Hydrology Study, Guidance of subterranean development, Ove Arup & Partners Ltd., November 2010, Issue 01.

4) London Borough of Camden, Camden Planning Guidance, Basements & Lightwells, CPG4.

5) Stroud, M.A., The standard penetration test in insensitive clays and soft rocks, Proc. Euro. Symp. on Penetration Testing, 2, 367-375 (1975).

6) Emrys Architects Ltd., 53 Fitzroy Park, Spoil Removal Calculation Document, Doc. Ref. 0932_2.01.04_Spoil Removal Report_007_P03.

7) Skempton, A.W., and De Lory, F.A., (1957), Stability of natural slopes in London Clay, Proc. Of 4th Int. Conf. on SMFE, Vol. 2, p.378-381.

8) Hutchinson, J.N., The free degradation of London Clay cliffs, Proc. of Geo. Conf., Oslo, (1967), Vol.1, p.113-118.

9) CIRIA Report C580, Embedded retaining walls: guidance for economic design, CIRIA, London, 2002.