The Heath & Hampstead Society

The Society examines all Planning Applications relating to Hampstead, and assesses them for their impact on conservation and on the local environment.

To London Borough of Camden, Development Control Team

Planning Ref: 2019/1515/P

Address: 26 Netherhall Gardens

Case Officer: David Peres da Costa **Date:** 6th January 2021

Campbell Reith has responded only partially to my objection of 20th July, so I am sending a further response to this as part of our overall objection to this planning application.

A main concern is that the BIA-Audit-3 contains some opinion without always presenting facts to support this. It may be that facts are available, but these should be presented for scrutiny. Equally, it appears that some concerning facts presented by local people, including H&HS, have not been addressed in the audit.

I have included many facts within my original objection which I believe still need addressing with evidence to support their dismissal.

Arup's three 'principle impacts of basements in LB Camden' in their '*Camden geological, hydrogeological and hydrological study: Guidance for subterranean development*' are

- 5.1 Surface flow and flooding
- 5.2 Subterranean (groundwater) flow and
- 5.3 Slope stability.

5.2 and 5.3 of course are very pertinent for this site. In my opinion the facts indicate that both the principle impacts of groundwater flow and slope stability require a request from the BIA Auditor for further critical analysis.

Evaluation of Groundwater Impact

I agree with BIA-Audit-3 that the direction of groundwater is clear, indeed very clear, however this is not the only information required about the ground and the potential groundwater below the proposed building. The BIA-Audit-3 repeats in 4.7 the Byrne Looby statement that the London Clay is designated an unproductive strata. From my knowledge of the local hydrogeology of the Hampstead area and seeing or hearing about some of the effects of basement construction within this locality, I consider that not only are the implications of the superficial Head deposits and Claygate Beds layers not adequately addressed or understood but, strictly speaking and for the purposes of basement construction in Hampstead, the more clayey layers below the Claygate Beds - while less permeable - should not be considered unproductive strata either. The variable, laminated and erodible nature and water carrying capacity of all of the ground are key, both in terms of the investigations that should be done and the construction methods used.

Hampstead is the source of four of London's rivers. Due to its geology and topography

a) It is ringed by an area of high and very high risk of landslide (ARUP (2010) Figure 17), movement frequently aided by groundwater lubrication and changes to pore water pressure.
b) It has been described as the Subsidence Capital of the world.

c) A study of local subsidence cases is finding patterns related to silt erosion and to landslide caused by basement digging out and construction. Peri-excavation landslide is still occurring where it should have been expected.
d) Silt erosion from groundwater action causes Hampstead to suffer from frequent potholes, sinkholes and carriageway collapses of its roads, and foundation erosion beneath its services with the resulting frequent mains water pipe bursts and leaking of underground sewage pipes.
e) Examples exist where
    - Building sites were washed away by groundwater surges when the site was open during storms (e.g. Air Studios, Lyndhurst Road);
    - Lakes formed below buildings on encountering water under pressure in sand partings with serious destabilisation of existing buildings and of neighbours' too (e.g. 22 Christchurch Hill).

It is thus not only knowledge of the direction of groundwater that is required but the flow rate under high rainfall and storm conditions: the effects of groundwater storm surges, and *where it is coming from* i.e. which aquifer, which level of sand parting etc. and the likely volume of the hill's ground above that will be charging this (determined by both quantity and timing of surging once heavy rainfall begins). This is required in such a site since this will

a) Demonstrate the level of risk while the site is open during dig-out and a rainstorm were to occur – both for the personnel undertaking this and for any neighbouring properties and roads, particularly downhill. This risk is of course rapidly increasing with climate change, reflected in the large increase in storms over the last decade and visible in rainfall reports on nw3weather.co.uk which also illustrates that this is magnified in Hampstead which has by far the largest rainfall of London due to its elevation: the highest in London.
b) The effect of constraining this groundwater and diverting most of it now beneath the shallow foundations of 24A Netherhall Gardens and thence below a more specific part of the Netherhall Gardens' roadway.

Proper testing will help discover if this water is likely to be of sufficiently large volume and pressure to potentially cause too great a risk, or not. It is *why* ARUP request the items in the BIA audit check list.

A tributary of the Westbourne used to flow beneath 32 and 31 Netherhall Gardens (NG). This is only three buildings away from 26 NG (see ARUP, 2010: Figure 12). A good deal of this water will now be in a large conduit/drain, but all the sand partings in the ground around this old river bed – as were found in the boreholes at 26 NG - will still carry water as they used to, particularly that fed by the spring line on which 26 NG virtually sits, even if this is intermittent. This water will eventually find its way into the drains lower downstream, but it is still running through the ground here that is a broad and very variable Transition Zone between Claygate Beds and Unit D of the London Clay Formation. Thus, it can be blocked by basement walls causing ponding behind and to the sides, constraint to the existing flow, and an increase in groundwater storm surges following heavy rainfall. This will cause an increase in erosion of the high (but unevaluated in this application) proportion of silt and sand from this ground and thus volume loss and subsidence, just like the frequent huge potholes and carriageway collapses we have under the roads in Hampstead. I consider the fact that this groundwater has not been assessed at all is of critical relevance.

Considering it is likely that groundwater has already been constrained into the gap between the existing basements of 24 and 26 NG, including under the shallow foundations of 24A NG, measures to quantify the changes to this are required, since the proposed basement will close up most of the remaining gap here, sending more constrained groundwater under higher pressure with increased erosive effects beneath 24A NG.

In BIA-Audit-3 para 4.9 it states

> 'given the underlying London Clay, it is evident that perched groundwater flow can only occur within the very shallow soils of the Made Ground and Head and / or Claygate Member, where present.'

This repeats the assumption that the ground below the Claygate Beds is an unproductive layer and the assumption that the method of investigative drilling does not need consideration.

It has been stated that

> London Clay is a very low permeability soil and is designated as Unproductive Strata. Any groundwater flow within the London Clay is isolated to discrete bands where permeability is slightly increased, but would not readily transmit large volumes of water, and flow rates would be expected to be low.

To illustrate the consequences of not knowing the actual hydrogeology of this area, this is the report of an incident at Air Studios Haverstock Hill during its redevelopment from Congregational church to world-renowned recording studios, a building on not dissimilar ground, on a rather less-inclined slope:

> "There was considerable rain during the night of 30 July 1991…. This heavy rain resulted in the instantaneous swelling of the underground watercourse discovered below the centre of the building known as Lyndhurst Hall, Lyndhurst Road, Hampstead.
>
> The resultant underground torrent washed away much of the soil surrounding the foundations of the building known then as "The Cottage" leaving it looking the next morning as though it was standing on brick pillars!".
>
> Up until that time groundwater had not been a problem…
>
> A borehole had been drilled to assess the ground conditions and recorded 1.3m of Made Ground (silty clay with flint gravel) over weathered London Clay. No water was recorded *"during the short time the hole was open"* (quote from BH log).
>
> Formation level for the basement was approximately 4.5m below ground level and thus within the weathered London Clay.
>
> … the void eroded from beneath the Cottage and what is now the Reception… give an approximate volume of 60m^3. The void contained groundwater which could be see flowing from the area of the lift towards the front door, but in the ground. …Samples of water revealed it contained traces of sewage; i.e. it was a mixture of pure ground water and leaking utilities.
>
> The basement was full of water which when pumped out revealed its floor was covered in sediment. ...The dimensions of the basement…9.5m x 9.5m x 4.5m = 406m3…the sediment eroded from beneath the Cottage landed up in the basement covering the reinforcing with silt, sand and clay to a depth of approximately 0.7m.
>
> *The material point* is that failure occurred on the night a pulse of water infiltrated from rainfall, augmented by the sudden discharge from leaky sewers and soakaways, could be expected within the sediment above the London Clay. A change in the level of water came and went within the space of hours, and found any weakness in the engineering that stood in its way. Further, the Made Ground, i.e. the material above the London Clay in this case, eroded readily given the circumstances to do so.

The material point for the 26 NG site is the potential but as yet unexamined effect of the local hydrogeology on 24A NG. While it is indeed the case that the existing foundations of Number 26 are indicated to already penetrate between 0.6m and 1.5m below ground level and that these foundations effectively cut off the most permeable layers of soils (i.e. the shallow ground described as 'Made Ground' though in fact the superficial deposit 'Head' with brick fragments), the shallow flow regime will be affected. It would seem likely to be diverted beneath 24A NG by further closure of the gap by the new basement and thence on and beneath the Netherhall Gardens roadway foundations.

It is known that the Claygate Beds and, to a lesser but still significant extent, the Unit D of the London Clay Formation, particularly in transition zones, can transmit groundwater, and that this ability to transmit increases during storm surges. To state the weathered clay beneath the superficial deposits is unproductive without providing any evidence for this when the site is close to a Spring line and the boreholes clearly demonstrate its potential water transmissibility requires further examination.

Testing for groundwater presence

The superficial transported and stratified deposits of Head are of high relative permeability. The layers below contain a mixture of thin seams and lenses of variable permeability, some more permeable than others. The more permeable seams, rich in silt and sand, act as micro-aquifers and can be visualised as thin bands in which ground water travels at a greater rate than the more clay rich material which bounds them. Such seams act almost as separate micro-aquifers, and measuring the water level within each requires special techniques not usually employed in standard ground investigations. In vulnerable areas this is essential. Vertical bore holes through this sequence invariably miss this data and create an hydraulic connection that joins horizons which nature had separated; such water levels as may be measured in them are usually corrupt. When, in addition, only a few isolated measurements are performed during and preceding periods of dry weather no evaluation can be said to have been performed.

The ground beneath 26 NG and its neighbours would be expected to be stratified and is described as such in the Trial Pit and Borehole logs of the report:

Borehole 1	'very sandy silty clay with laminations of silty fine sand' down to 4.25m; 'silty clay with occasional partings of light brown silty fine sand' down to 6 metres, with 'fissured silty clay and occasional partings of light brown silty fine sand' below that.
Borehole 2	'with laminations of silty fine sand' down to 4.7 metres in and with 'silty clay with occasional partings of light brown silty fine sand' down to 9.2 metres, with 'fissured silty clay and occasional partings of light brown silty fine sand' below that.

This helps to confirm that it is on the 'Transition Zone' between the Claygate Beds and Unit D of the London Clay Formation, and the transition zone *nature* of the erodible ground here.

It is also important to understand the implications of test boring through mixed layers of water-bearing material without taking precautions to shield one layer from another. This is why groundwater - which should frequently be encountered in the Hampstead area - is often not noticed, and certainly when it is, we notice that the operators almost always do not know where it comes from, how to calculate its likely parameters in a severe rainstorm, or its likely behaviour and *the implications of this*.

Testing for ground water behaviour across time

Despite its requirement in the Local Plan (and, although this is not applicable here since it is outside the Plan area but nevertheless has a degree of relevance, in the Hampstead Neighbourhood Plan) testing of groundwater behaviour across storms is not being enforced. Best practice of continuous monitoring across periods including very heavy rainfall is now becoming rare, even for vulnerable sites such as here. This is clear for 23 NG opposite for example, where monitoring was performed *only once in an unusually dry month*, missing surges and their timing in relation to rainstorms. This where the BIA Audit for a basement extension did point out the perched water in the 'Made Ground' (actually an aquifer at the base of 'Head' superficial deposits), but no recommendations were made as a result of this.

At 26 NG 'monitoring' was only performed twice, both in June 2014 and again in an unusually dry month. Thus, data on the origin, timing and force of groundwater that (inevitably with the test methods used) falls to the bottom of the borehole, has been neither gathered nor particularly noticed, and certainly not evaluated for its likely impact. For 26 NG this is what should allow the contractors to:

- Estimate the maximum groundwater flow during storms to assess its ability to washout an open site.
- What are the constraints to drainage - though it depends on the methods used as to whether they are adequate to assess this.
- Assess the potential of what could happen in the future for the neighbours to the side, above and below.
- At the very least the feasibility and the degree of measures necessary to ensure control of the flow of groundwater under the basement and safely away from 24A NG require assessment: in the long term regarding fines erosion beneath neighbours and roads/pavements/services, and in the short term for destabilising storm surges.

Acknowledgement by the BIA-Audit-3 of a lack of groundwater monitoring data over a winter period is insufficient. Why is adequate evaluation not a requirement at such a sensitive site?

While our mains service pipes are slowly being replaced, there are still many that are not. Mains fractures are still occurring, and the fracture of soil service pipes is not being addressed at all despite the presence of sewage within the groundwater in our area when groundwater testing is done, for example at 33 Willoughby Road and Airs Studios. This project as it stands will only add to this problem; ignoring it will not help.

The site investigation report that the existing foundations and retaining walls to 26 Netherhall Gardens already penetrate these [clay] soils forming a barrier to any groundwater flow is merely an opinion, not fact. I dispute in the absence of evidence that it can be considered a complete barrier, but also point out that being a barrier in itself is a problem. The nature of the soils found demonstrate that the existing foundations are on a potentially water-bearing transition zone material (also known to be a spring line), groundwater that has been found has been ignored, and no tests have been performed to *adequately* demonstrate its presence or its absence and its behaviour in terms of volume and timing in relation to severe rainstorms. The presence of confirmed subsidence in more than 20 properties in Netherhall Gardens – as detailed in my previous objection with several discoveries since – should be sufficient evidence in itself that there could be a subsidence problem related to the hydrogeology here.

Landslide and Subsidence Risk

According to the British Geological Survey the slopes here are expected to be of laminated silty clay topped with a thick irregularly laid layer of more permeable and unstable superficial deposits designated as of very high risk of landslide (see my previous objection). Thus, as well as silt erosion, the site is vulnerable to landslide, itself aggravated by the presence of groundwater and altered pore water pressures. BIA-Audit-3 has noted that Made Ground is more erodible and permeable, but it has not noted that *it is the manner in which these layers were originally laid down* that is what is particularly pertinent for landslide. Landslide can be prompted by ground pressure release and vibration, but can also be acutely aggravated by groundwater and groundwater surges. There have been numerous examples of subsidence locally, some presented in my original objection. I know of 20 cases of subsidence in Netherhall Gardens alone now, and many of these will be from silt erosion rather than landslide, however landslide is still being experienced in Netherhall and Maresfield Gardens and Finchley Road below. With a case not far distant it is possible to insert one's fist beneath an internal wall where the floor has subsided and rotation-slid from landslide prompted by neighbouring excavation.

A reduction in the pore water pressure of ground, often accompanying a lowering of water levels associated with either flow to excavations nearby or dewatering activities to deal with encountered groundwater (as planned here), can potentially cause the ground to shrink from consolidation. Since there are signs that subsidence is already occurring to 24A NG (cracking and dropping of the internal ground floor, whether due to fines erosion or ground consolidation, see the photographs in my previous objection), an activity likely to enhance this would seem unwise.

The BIA-Audit-3 states in 4.8 that it is unclear why HHS consider the use of rotary percussive boreholes, a standard site investigation technique, not to be suitable.

Rotary percussive boreholes are a standard site investigation technique for doing the Standard Penetration Test and gathering soil for analysis, bearing in mind that this produces disturbed samples. That's pretty much all it is useful for though. Thus, only undisturbed samples from one borehole were taken on a site of complex material in a transition zone topped by a transported layer of softer weaker clays.

This is inadequate and makes assumptions based on limited sampling at increased risk of incorrect analysis, particularly when such data is also ignored, as in the Oasys-XDisp analyses where *the clay has been entered as equally stiff across the board*.

Regarding the Standard Penetration Tests performed here, this is one of several essential investigations in this particularly sensitive site for calculating slope stability and the potential damage to neighbouring properties. SPT equipment these days should be calibrated so that its energy relationships are known, enabling the values derived from the number of blows and depth of resulting penetration to be better interpreted. Given the importance of avoiding movement on the steep and unstable slope here, it is important to know whether the SPT equipment had been calibrated and that certificates for this have been checked. It is really important that if the testing is below the recommended standards it should not be accepted for this site.

The SPTs can be summarised as follows:

Depth	**1m**	**3m**	**5m**	**8m**	**11m**	**14m**	**17m**	**19.55m**
Borehole 1, N=	4	8	14	15	37	47	53	62
Compressive Strength BH1	203	324	302	371	287	414		

Thus down to 8m in Borehole 1, the ground is the loose end of medium, while at 11metres N is still only 37 and it doesn't reach dense until 13m and very dense until 17m. The compressive strength values with depth demonstrate the stratified nature and variability of the ground.

Of course Hampstead has had its original buildings founded on just such ground. When they were all built together with practical experience of the ground, it can be seen that clear measures were taken to allow for the groundwater, for fines erosion and for a tendency to landslide. This can be seen for example in the way Teulon built St Stephen's church on a steep slope directly over a sub-surface tributary of the river Fleet that was discovered during the excavation for its foundations.

The trial pit very close by to 24a NG stated the ground at 0.3m to 4.7m was "Firm becoming stiff mottled brown, orange and grey very sandy silty CLAY with laminations of silty fine sand." Quite!

This alone does not take into account potential slip surfaces, and that at a depth of 4.25m (nearest to the bottom of the proposed basement) compared to the depth at 2.21m (nearest to that of 24a NG's foundations) there is an increase to 160% in the compression strength and 159% of the cohesion of the ground across just under 2 metres of depth. These data reflect the transported layer of softer weaker clays on which 24a NG sits compared to the basement foundation level that 26 NG will sit on upon the altered surface of the London Clay in-situ.

Despite this, the ground was still described as stiff, and - crucial to their argument that no significant damage would occur – the Oasys X-Disp analysis of predicted movement was performed erroneously based on the supposition that only stiff clays were present throughout the entire set of calculations. Important calculations as well as opinions and decisions have been based on the assumption that the site is on London Clay i.e. uniform, when in fact their own studies demonstrate its known laminated, erodible and fissured nature, weathered down to the respective depths of 6.00m and 9.20m bgl in Boreholes 1 & 2: highly, highly complex on a steep hillside well beyond the sliding/rolling angles of pure London Clay, and even more so on a steep hillside of Claygate/Unit D transition zone overlain by unstable irregularly deposited and thus laminated 'Head' with potential slip surfaces within and below it. Analysis by Oasys X-Disp can actually cater for different layers, but it hasn't been done here and this alone is inadequate.

Both the Oasys and the Finite Element and Finite Difference Analyses ranges of tests were originally based on assessment for tunnels (Oasys XDisp was itself first developed from the data produced and interpreted by Burland during the building of the Jubilee line). Both have been established for retaining walls and for surface excavations. The most appropriate test needs to be chosen for the situation, the project, the site conditions and other parameters. What is important is not to use a test where the local conditions fail to satisfy the conditions of the test.

It is important to know what displacements will occur as a result of the retaining walls and to digging out, including pure vertical and lateral responses. Oasys XDisp however was developed for stable ground, and is considered inappropriate for changing conditions. Since the ground here is laminated and complex, on a slope of more than 7°, is liable to silt erosion from groundwater action, will likely experience alterations to its pore water pressure, has numerous other cases of subsidence nearby and, crucially, is already deemed to be at high to very high risk of landslide according to the British Geological Survey, it cannot be deemed to be stable.

I would like to know what profile of m with depth was used? Considering the same parameters for stiffness appear to have been entered throughout, I suspect the answer is smooth and linear. The input and output data for Oasys X-Disp have not been provided to me on request, but it would not be surprising if the person entering the Oasys X-Disp data put in a value of 0.5 for m as recommended by Harris & Alvaro for 'typical London clay'. If so, particularly if both are true, this is not appropriate in this area.

The Oasys set of tests also cannot cope with dynamic conditions and so represents ideal circumstances; they don't cater for ground movement due to consolidation from the reduction of pore water pressures, for erosion of fines, for landslides that are creeping as a result of excavation, vibration from construction and ground pressure changes, or for sudden landslide due to a combination of these factors lubricated by groundwater flow. It may be assumed that conditions are reasonable BEFORE excavation commences, but these will change with time to conditions that would not produce predictions of displacements that are acceptable. Conditions such as this are far from present here. Most of these analyses also seem to assume the ground level is horizontal. I invite Camden to view the closeness of the contour lines, the build-up of the roadway to take the slope into consideration and the views pictured in my first objection showing the actual slope involved across Netherhall Gardens rather than that obtained merely by standing on Netherhall Gardens looking towards the house front of number 26.

I note here that Campbell Reith have spotted (in my previous objection) my point about ground strength, as they have now mentioned that the ground changes from firm to stiff. I invite them to consider the adequacy of how ground strength is determined, used in calculations, and considered in a basement construction plan designed to protect the neighbours.

The recent response from Byrne Looby includes their opinion that structural inspection of the external walls of 24A NG indicates that the building appears to be in good condition, and therefore that no further mitigation and/or remediation is necessary. External appearances can be deceptive.

The BIA-Audit-3 has not commented on the large stepped crack within 24A NG photographed and shown in my first objection. I consider it concerning that the neighbours who are concerned about the impact on their property have not had a request from the developer's experts to see this and all the other cracks within the house. The direction and size of the crack would seem to indicate that there has been a loss of ground volume below the foundation on which this floor rests, most probably due to silt erosion by groundwater action with some downhill slippage – as it seems is occurring to the garden wall attached to the front corner of 24A NG. This is now repaired, but is a half brick course difference in height.

This indicates the neighbours are potentially vulnerable to basement construction, and further tests and verification are required. I understand the neighbours are now pooling their resources to obtain an opinion on this.

In the BIA Part 1 pages 8-9 it states that:

> "It is noted that since the analysis is conservative, the ground surface movements predicted in Fig 2.8 of CIRIA 580 have been reduced by 50%. This is because the data upon which the graphs are based is extremely limited and in these ground conditions, if care is taken pile during installation and sequencing then a lower value, closer to that of a contiguous wall, is more appropriate."

I ask Camden to consider that even one 'if' amongst many is too many, here.

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