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**36 HEATH DRIVE,
LONDON, NW3 7SD**

BASEMENT IMPACT ASSESSMENT

Prepared for

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Acting on behalf of

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1.0 INTRODUCTION

1.1 Project Objectives

The purpose of this assessment is to consider the effects of a proposed basement construction on the local groundwater regime at the residential property at 36 Heath Drive, London, NW3 7SD. For this assessment a representative of SAS Limited visited the property on 26th July 2012.

The recommendations and comments given in this report are based on the information contained from the sources cited and may include information provided by the Client and other parties including anecdotal information. It must be noted that there may be special conditions prevailing at the site which have not been disclosed by the investigation and which have not been taken into account in the report. No liability can be accepted for any such conditions.

This report does not constitute a full environmental audit of either the site or its immediate environs.

1.2 Planning Policy Context

Camden Planning Guidance for Basements and Lightwells has been recently revised (CPG4, April 2011) and requires proposed developments to mitigate against the effects of ground and surface water flooding and to include drainage systems that do not impact neighbouring property of the site or the water environment by way of changing the groundwater regime.

Camden Guidance CPG4 sets out 5 Stages:

1. Screening
2. Scoping
3. Site Investigation
4. Impact Assessment
5. Review and decision making

This report is intended to address the scoping process set out in CPG4 and the Camden Geological, Hydrogeological and Hydrological Study (CGHHS). It will review existing site investigation data and provide a preliminary assessment of the issues identified by the Site Analytical Services Limited screening process.

This report also provides an impact assessment (4) of the geo-environmental impacts on adjacent structures and the surrounding area based on available site investigation data.

As part of this guidance a subterranean (groundwater) flow screening chart is provided (CPG 4, Figure 1). The completed chart in relation to this development is provided as Table 1, to this report.



2.0 SITE DETAILS

(National Grid Reference: TQ 255 855)

2.1 Site Location

The site is situated on the east side of Heath Drive in the Frugal area of Hampstead, London, NW3 7SD and is currently occupied by a large detached two to three-storey residential property with a large rear garden and a double driveway at the front leading from a small curved access road on the east side of Heath Drive which gives pedestrian access to Bracknell Gardens to the north-east.

2.2 Geology

The 1:50000 Geological Survey of Great Britain (England and Wales) covering the area (Sheet 256, 'North London', Solid and Drift Edition) indicates the site to be underlain by Superficial Head deposits resting on the London Clay Formation. Deposits of the overlying Claygate Member are recorded as outcropping about 200m to the north on higher ground.

2.3 Previous Reports

The results from a Phase 1 Preliminary Risk Assessment and Phase 2 Intrusive Investigation are presented under separate cover in Site Analytical Services Limited reports (Project No's. 12/19442 and 12/19442-1) dated August and July 2012 respectively. The findings from these reports are described in this basement impact assessment.

2.4 Site Layout and History

The site was attended on 20th July 2012 for the purposes of conducting the site walkover.

The site comprises of a large two to three-storey detached house with two-storeys evident at the front and rear and further accommodation within the roof space. There are some small areas of shrub beds at the front around a double tarmac covered driveway with three mature Conifers within the shrub bed adjacent to the road. The large rear garden comprises of a patio adjacent to the house and a large garden set mainly to lawn with shrub beds along the sides which include various conifers as well as specimens of Holly, Laurel and other similar shrubs.

The garden is bounded by thick hedges and close board fencing and contains a trampoline and a small wooden garden shed close to the rear of the garage on the south side of the house.



The site lies on ground sloping down to the south away from Hampstead Heath towards the Finchley Road, although the site itself is mainly flat and landscaped with the front driveway having a slight slope down from the house to Heath Drive with a drop in elevation of approximately 0.5m.

From a review of historical maps it would appear that the site was agricultural land until about 1934 when a residential property is evident. Two small extensions to the building are evident in circa 1954, but no further change is apparent. The area surrounding the site has been dominantly residential in use over the years.

2.5 Proposed Development

It is proposed to construct a new single storey basement to approximately 3.30m below ground level beneath the existing property at 36 Heath Drive, London, NW3 7SD, together with five light wells, rear and side extensions at ground and first floor, roof re-modelling and internal refurbishments.

2.6 Results of Basement Impact Assessment Screening

A screening process has been undertaken for the site in accordance with CPG4 and the results are summarised in Table 1 below:

Table 1: Summary of screening results

Item	Description	Response	Comment
Sub-terranean (Ground water Flow)	1a. Is the site located directly above an aquifer	No	The Bedrock geology underlying the site (solid permeable formations) associated with the London Clay Formation has been classified as Unproductive Strata; rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.
	1b. Will the proposed basement extend beneath the water table surface	Yes	The proposed basement floor level of 3.3m will be below the current water level of approximately 2.0m below ground level.
	2. Is the site within 100m of a watercourse, well (used / disused) or potential spring line	Yes	There are no surface water features within 1km of the site. However, according to the Lost Rivers of London the site is within 100m of a former tributary of the River Westbourne.
	3. Is the site within the catchment of the pond chains on Hampstead Heath	No	The site is away from this area. The nearest surface water feature is recorded to be at least 1km away from the site
	4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas	No	The amount of hardstanding on-site is not expected to change.
	5. As part of site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or SUDS)	No	Existing drainage paths are to be utilised where possible. Whether soakaways/SUDS are used on the proposed is to be confirmed (beyond the scope of this report). An appropriately qualified engineer should be engaged to ensure mandatory requirements are met.
	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	The nearest surface water feature is recorded to be 1km away from the site



Slope Stability	1. Does the existing site include slopes, natural or man-made greater than 1 in 8	No	The site is essentially flat with only minor undulations present, sloping mainly towards Heath Drive, at angles of about 6°.
	2. Will the proposed re-profiling of landscaping at site change slopes at the property boundary to more than 1 in 8	No	Remodelling of the site elevations are not proposed.
	3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 1 in 8	No	The neighbouring land is essentially flat with only minor undulations present, sloping mainly towards the south-west, at angles of between 2° and 4°.
	4. Is the site within a wider hillside setting in which the general slope is greater than 1 in 8	Yes	There is a general slight slope across the site from east to west away from Hampstead Heath down towards the Finchley Road of up to approximately 9 degrees.
	5. Is the London Clay the shallowest strata at the site	No	The site is underlain by Made Ground overlying Superficial Head with the London Clay Formation present at depth
	6. Will any trees be felled as part of the development and/or are any works proposed within any tree protection zones where trees are to be retained	Yes	It is understood that a single tree is to be felled as part of the development.
	7. Is there a history of seasonal shrink-swell subsidence in the local area and/or evidence of such effects at the site	Yes	The site lies above the London Clay Formation, well known to have a high tendency to shrink and swell.
	8. Is the site within 100m of a watercourse or a potential spring line	Yes	The nearest surface water feature is recorded to be 1km away from the site. However, according to the Lost Rivers of London the site is within 100m of an ancient river.
	9. Is the site within an area of previously worked ground	Yes	Made ground has been encountered at the site.
	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 Bedrock geology underlying the site (solid permeable formations) associated with the London Clay Formation has been classified as Unproductive Strata.
	11. Is the site within 50m of the Hampstead Heath ponds	No	The site is not located near Hampstead Heath ponds
	12. Is the site within 5m of a highway or pedestrian right of way	Yes	The site lies adjacent to Heath Drive.



	13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties	No	The majority of surrounding properties already have subterranean basements.
	14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines	No	The nearest tube line is located over 100m from the site.
Surface Water and Flooding	1. Is the site within the catchment of the pond chains on Hampstead Heath	No	The site is not located near Hampstead Heath.
	2. As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route	No	The amount of hardstanding on-site is not changing therefore surface water will not be impacted by the development.
	3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas	No	The amount of hardstanding on-site is not expected to increase.
	4. Will the proposed basement result in changes to the profile of the inflows (instantaneous and long-term) of surface water being received by adjacent properties or downstream watercourses	No	As no changes are occurring above the ground, surface water will not be impacted by the development.
	5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses	No	As no changes are occurring above the ground surface water will not be impacted by the development
	6. Is the site in an area known to be at risk from surface water flooding	No	There are no fluvial or tidal floodplains located within 1km of the site.

3.0 EXISTING SITE INVESTIGATION DATA

3.1 Records of site investigations

Ground conditions at the site were investigated by Site Analytical Services Limited in June and July 2012 (Report Reference 12/19442). The ground conditions revealed by the investigation are summarised in the following table.

Strata	Depth to top of strata, mbgl	Description
Made Ground	0.00	Surface layer of topsoil underlain by a mixture of brick and concrete rubble and stiff to very stiff sandy silty clay with fine gravel, ashes and brick fragments
Superficial Head	0.25 (proven in Borehole 2 only)	Stiff mottled sandy clay with occasional fine to medium flint gravel
London Clay Formation	1.40 to 1.60	Stiff becoming very stiff silty clay with occasional partings of silty fine sand and scattered gypsum crystals

Groundwater was not encountered during boring operations in Borehole 1 and the material remained essentially dry throughout. Groundwater was encountered as a seepage at a depth of 11.00m below ground level in Borehole 2 and is likely to be associated with a claystone nodule which are often found to be water bearing.

Groundwater was subsequently recorded at respective depths a depth of 2.44m and 2.01m below ground level in the monitoring standpipes installed in Boreholes 1 and 2 after a period of approximately four to five weeks.

3.2 Hydrological Context

During the monitoring visit on the 10th July 2012 the groundwater in Borehole 1 was measured at 2.11m below ground level. Subsequently the well was purged and the water level reduced to 4.04m. During the subsequent 60 minute period the following recharge levels were recorded:

Time after purging well (minutes)	Water Level (mbgl)
0	4.04
5	3.80
10	3.65
15	3.51
30	3.21
60	2.99

4.0 SUBTERRANEAN (GROUNDWATER FLOW)

4.1 Introduction

This section addresses outstanding issues raised by the screening process of Subterranean (Groundwater Flows) (see Table 1).

4.2 Groundwater Flow and Depth to Groundwater

The ground floor level of the proposed development is at a maximum depth of approximately 3.3m below ground level. In Borehole 1, located towards the north western section of the site, the encountered groundwater is approximately 0.86m above proposed floor level and in Borehole 2 located towards the south eastern section of the site groundwater is at least 1.29m below ground level. It is considered that this water level represents the accumulation of surface run-off emanating from the base of the Claygate Member recorded about 200m north of the site on the higher ground around Hampstead Heath accumulating within the relatively permeable made ground and superficial deposits perched on top of the virtually impermeable deposits of the London Clay present below.

Water levels in the immediate vicinity of the property have been recorded above floor level of the proposed basement and as a result, the construction of the proposed basements may result in some changes to the groundwater regime around the property. However, given the low permeability of the near-surface cohesive soils, it is considered that any changes will be very limited in extent and confined to the immediate vicinity of the property. This can be illustrated by considering the theoretical steady-state radius of influence of any groundwater level changes (whether drawdown or raised). The radius of Influence (R_0) can be estimated using an empirical relationship derived by Sichardt (CIRIA, 2000). For linear features, R_0 is given by;

$$R_0 = C (H - h_w) \sqrt{(2.4 \times 10^{-7} \text{ m/s})}$$

$$R_0 = 2.2\text{m}$$

Where C is an empirical correlation factor taken as 3000

$H - h_w$ is the drawdown or rise in groundwater level (say 1.5m in an extreme case for the site)

K is the permeability (estimated as 2.4×10^{-7} from field data)

This gives a radius of influence (R_0) of 2.2m, which indicates that, even in extreme conditions, any changes to the groundwater table caused by the new structure will be very localised indeed.

Despite the localised effect of the basement on the groundwater regime, it will be necessary to control water during the construction period originating from the made ground and upper superficial head deposits. Consideration could be given to sheet piling in the temporary case to exclude water and to facilitate basement construction. Given that the property is detached from neighbouring houses it is suggested that the use of a sheet piled wall will not provide a significant barrier to groundwater flow as water will be able to pass around it through the upper permeable soils. Conventional internal pumping methods from open sumps could also be employed.



4.3 Springs, Wells and Watercourses

The nearest surface water feature is recorded to be in excess of 1km from the site. There are no fluvial or tidal floodplains located within 1km of the site.

With reference to 'The Lost Rivers of London' (Barton, 1992) and 'London's Lost River's' (Talling, 2011), the site lies within 100m of a tributary of the River Westbourne, which ran in a south westerly direction from Hampstead Heath through Hampstead, Kilburn, Paddington, Hyde Park, onto Knightsbridge and out into the Thames at Chelsea. The river is now completely enclosed and used as a sewer.

Given the predominantly clayey and low permeability nature of the near-surface soils, it is expected that there is very limited surface water infiltration potential and groundwater flow rates in the vicinity of the property will be very low. The historic development of the area for housing will have further limited surface water infiltration.

As a result it is considered that the proposed development will have minimal impact on any nearby watercourses

5.0 SLOPE AND GROUND STABILITY

5.1 Introduction

This section addresses outstanding issues raised by the screening process land stability (see Table 1).

5.2 Slope Stability

The 1:50,000 scale geological map for the area indicates that the site does not lie within an 'Area of Significant Landslide Potential'. No mapped areas of landslips are present in the site's vicinity and the natural ground stability hazards dataset supplied by the BGS (present in the desk study report for the site reference 12/19442-1) gives the hazard rating for landslides in the site area as 'very low'.

Information obtained for the site walkover, site plans and ordnance survey maps indicates that the site itself is essentially flat. There is however, a general slight slope across the site from east to west away from Hampstead Heath down towards the Finchley Road, up to approximately 9 degrees, although it should be noted that the immediate site area is heavily urbanised and slopes at the site / in the site's vicinity may have been altered historically or as part of developments and landscaping.

The slope angle map produced as Figure 16 of the ARUP report indicates that slope angles in the site are less than 7° and that the site does not neighbour any land that contains cuttings/embankments or any other feature with slope angles in excess of 7°.

The proposed development does not include any remodeling of slopes to angles greater than 7° that could potentially result in slope stability issues. It is therefore considered that slope stability can be maintained through the proper design of any necessary mitigation measures described in Section 4.2.

5.3 Shrinking/Swelling Clays

Atterberg Limit tests were conducted on six selected samples taken from the essentially cohesive natural soils encountered in the boreholes and showed the samples tested to have a high susceptibility to shrinkage and swelling movements with changes in moisture content, as defined by the NHBC Standards, Chapter 4.2.

It is understood that a single tree is to be removed from the site as part of the development. The depth of foundation required to avoid the zone likely to be affected by the root systems of trees is shown in the recommendations given in NHBC Standards, Chapter 4.2, April 2003, "Building near Trees" and it is considered that this document is relevant in this situation.

5.4 Heave of underlying soils

The main phase of uplift or heave from the cohesive soils will come immediately following the excavation of the basement when the greatest elastic rebound of the soil (caused by the loss of the overburden pressure) will occur. Heave can be reduced by proceeding with the excavation in stages and observing and recording any movement that occurs over a set period of time. It may therefore be advantageous to delay the construction until an adequate proportion of the uplift has occurred. Once this monitoring period has elapsed and a suitably qualified engineer is confident that the majority of uplift has occurred, basement construction can commence.

These processes and other ways of dealing with ground movements are described at length in BS8004 (British Standard Code of Practice for Foundations).

5.5 Compressible/Collapsible Ground

The natural ground stability hazards dataset supplied by the BGS gives the hazard rating for collapsible ground as 'very low' and compressible ground at the site is listed as 'no hazard'.

5.6 Springs, Wells and Watercourses

As discussed in Section 4.3 it is considered that the proposed development will have minimal impact on any nearby watercourses.

5.7 Made Ground

In the boreholes drilled at the site, made ground was found to extend down to depths of between 0.25m and 1.40m below ground level and comprised a surface layer of topsoil underlain by a mixture of brick and concrete rubble and stiff to very stiff sandy silty clay with fine gravel, ashes and brick fragments

A result of the inherent variability of uncontrolled fill, (Made Ground) is that it is usually unpredictable in terms of bearing capacity and settlement characteristics. Foundations should therefore, be taken through any made ground and either into, or onto suitable underlying natural strata of adequate bearing characteristics.

The bearing capacity of the made ground should therefore be assumed to be less than 50kN/m² because of the likelihood of extreme variability within the material.

Contamination testing of the Made Ground is likely to be required during any second phase of ground investigation.

The proposed basement is not to be extended below Heath Drive and therefore it is suggested that the impact on this local access road is likely to be minimal.

6.0 CONCLUSIONS

1. The proposals for the site include the construction of a new single storey basement to approximately 3.30m below ground level together with five light wells, rear and side extensions at ground and first floor, roof re-modelling and internal refurbishments
2. Ground conditions at the site were investigated by Site Analytical Services Limited in June and July 2012 (Report Reference 12/19442). The exploratory holes revealed ground conditions that were generally consistent with the geological records and known history of the area and comprised between 0.25m and 1.40m thickness of made ground locally overlying materials typical of Superficial Head with the London Clay Formation at depth.
3. Water levels in the immediate vicinity of the property have been recorded above floor level of the proposed basement and as a result, the construction of the proposed basements may result in some changes to the groundwater regime around the property. Despite the localised effect of the basement on the groundwater regime as determined by initial calculations, it will be necessary to control water during the construction period originating from the made ground and upper superficial head deposits. Consideration could be given to sheet piling in the temporary case to exclude water and to facilitate basement construction.
4. The nearest surface water feature is recorded to be in excess of 1km from the site. The site lies within 100m of a tributary of the River Westbourne, although the river is now completely enclosed and used as a sewer. As a result, it is considered that the proposed development will have minimal impact on any nearby watercourses
5. The proposed development does not include any remodeling of slopes to angles greater than 7° that could potentially result in slope stability issues. It is therefore considered that slope stability can be maintained through the proper design of any necessary mitigation measures
6. It is understood that a single tree is to be removed from the site as part of the development. The depth of foundation required to avoid the zone likely to be affected by the root systems of trees is shown in the recommendations given in NHBC Standards, Chapter 4.2, April 2003, "Building near Trees" and it is considered that this document is relevant in this situation.
7. The natural ground stability hazards dataset supplied by the BGS gives the hazard rating for collapsible ground as 'very low' and compressible ground at the site is listed as 'no hazard'.



8. The main phase of uplift or heave from the cohesive soils will come immediately following the excavation of the basement when the greatest elastic rebound of the soil (caused by the loss of the overburden pressure) will occur.
9. Contamination testing of the Made Ground is likely to be required during any second phase of ground investigation.
10. The proposed basement is not to be extended below Heath Drive and therefore it is suggested that the impact on this local access road is likely to be minimal.
11. The findings of this scoping report are based on a Phase 1 Risk Assessment and Phase 2 intrusive investigation which have already been carried out on the site and are provided under separate cover. On the basis of this information it is considered that the proposed development will not have a detrimental effect on groundwater or surface flooding in the vicinity of the site subject to the control mechanisms described in this report.

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