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GEOTECHNICAL DESK STUDY AND GROUND INVESTIGATION REPORT

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NW3 2TJ

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Report Title: **Geotechnical Desk Study and Ground Investigation Report for 62 Parliament Hill, London, NW3 2TJ**

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1 INTRODUCTION

1.1 Terms of Reference

1.1.1 Pavol Popp ("The Client") has commissioned Jomas Associates Ltd ('Jomas'), to obtain ground parameters at a site referred to as 62 Parliament Hill, London, NW3 2TJ, to enable preliminary foundation recommendations to be offered, prior to redevelopment of the site.

1.1.2 This report and intrusive investigation was undertaken in accordance with Jomas' proposal dated 4th March 2021.

1.2 Proposed Development

1.2.1 The proposed development is to comprise the lateral extension and deepening of an existing basement/cellar to provide habitable space, together with internal refurbishment, and demolition of the existing garage and construction of a replacement elsewhere on the property.

1.2.2 Proposed plans are provided as Figures 4-6 in Appendix 1.

1.2.3 For the purpose of geotechnical assessment, it is considered that the project could be classified as a Geotechnical Category (GC) 2 site in accordance with BS EN 1997.

1.3 Objectives

1.3.1 The objectives of Jomas' investigation were as follows:

- To present a description of the present site status, based upon the published geology, hydrogeology and hydrology of the site and surrounding area;
- To review readily available historical information (i.e., Ordnance Survey maps and database search information) for the site and surrounding areas, with respect to historical land uses;
- To assess ground conditions and obtain geotechnical parameters to inform foundation design, which is to be undertaken by the structural engineer;
- To undertake chemical testing of soils to assist with buried concrete design.

1.4 Scope of Works

1.4.1 The following tasks were undertaken to achieve the objectives listed above:

- A walkover survey of the site;
- A review of third party historical Ordnance Survey maps and a database report (attached in Appendix 2 and Appendix 3);
- Basic intrusive ground investigation to determine shallow ground conditions;
- Laboratory geotechnical and chemical testing on soil samples collected from the site;

- The compilation of this report, which provides data above, and indicative recommendations for foundation design.

1.5 Limitations

1.5.1 Jomas Associates Ltd ('Jomas') has prepared this report for the sole use of Pavol Popp, in accordance with the generally accepted consulting practices and for the intended purposes as stated in the agreement under which this work was completed. This report may not be relied upon by any other party without the explicit written agreement of Jomas. No other third party warranty, expressed or implied, is made as to the professional advice included in this report. This report must be used in its entirety.

1.5.2 The records search was limited to information available from public sources; this information is changing continually and frequently incomplete. Unless Jomas has actual knowledge to the contrary, information obtained from public sources or provided to Jomas by site personnel and other information sources, have been assumed to be correct. Jomas does not assume any liability for the misinterpretation of information or for items not visible, accessible or present on the subject property at the time of this study.

1.5.3 Whilst every effort has been made to ensure the accuracy of the data supplied, and any analysis derived from it, there may be conditions at the site that have not been disclosed by the investigation, and could not therefore be taken into account. As with any site, there may be differences in soil conditions between exploratory hole positions. Furthermore, it should be noted that groundwater conditions may vary due to seasonal and other effects and may at times be significantly different from those measured by the investigation. No liability can be accepted for any such variations in these conditions.

1.5.4 **This report is not an engineering design and the figures and calculations contained in the report should be used by the Structural Engineer, taking note that variations may apply, depending on variations in design loading, in techniques used, and in site conditions. Our recommendations should therefore not supersede the Engineer's design.**

2 GEOTECHNICAL DESK STUDY

2.1 Site Information

2.1.1 The site location plan is appended to this report as Figure 1 in Appendix 1.

Table 2.1: Site Information

Name of Site	Parliament Hill
Address of Site	62 Parliament Hill, London, NW3 2TJ
Approx. National Grid Ref.	527542, 185969
Site Area (Approx.)	0.04ha
Site Occupation	Residential
Local Authority	London Borough of Camden

2.2 Walkover Survey

2.2.1 A site walkover survey was undertaken by Jomas Associates on 15th April 2021.

Table 2.2: Site Description

Area	Item	Details
On-site:	**Current Uses:**	The site comprises an end of terrace four-storey property including a lower ground floor. There is a rear garden and parking space with garage.
	Evidence of historic uses:	There was no evidence of historic uses of the site.
	Surfaces:	Much of the site is hard cover either by the buildings or by paving and patio. A very small soft landscaped area is present at the front (west) of the property. The rear garden is predominantly grass-covered with some overgrown areas that were inaccessible.
	Vegetation:	There is a variety of small deciduous trees and flowers. A ~3m tall tree is located at the front of property. Some area of the rear garden are very overgrown.
	Topography/Slope Stability:	Much of the external areas on site are approximately 1.5-3.0m below surrounding street level. The site generally decreases in level from west to east (front to rear of property). Brick retaining walls are present.
	Drainage:	The site appears to be connected to normal drainage facilities. Drain covers are situated around the site. No drainage issues noted at time of walkover.
	Services:	The site is active and connected to all usual services.
	Controlled waters:	No controlled waters were noted on site.
	Tanks:	A water tank was noted in the rear garden.

Area	Item	Details
Neighbouring land:	**North:**	Residential housing and Hampstead Heath.
	East:	Residential housing
	South:	Residential housing
	West:	Residential housing

2.2.2 Key features noted during the walkover are shown on a site walkover plan in Figure 2, together with site photos.

2.3 Historical Mapping Information

2.3.1 The historical development of the site and its surrounding areas was evaluated following the review of a number of Ordnance Survey historic maps, procured from GroundSure, and provided in Appendix 3 of this report.

2.3.2 A summary produced from the review of the historical map is given in Table 2.3 below. Distances are taken from the site boundary.

Table 2.3: Historical Development

Dates and Scale of Map	Relevant Historical Information	
	On Site	**Off Site**
1870/72/74 1:1,056 1:2,500 1:10,560	Site comprises part of a field/agricultural land.	Railway line, cuttings and Hampstead Heath Station approximately 250m south of site. Hampstead Heath Ponds (reservoirs) approximately 200m west of site. Town of Hampstead approximately >400m south-west of site.
1894/96 1:1,056 1:2,500 1:10,560	A residential building is shown in the west of site with an associated garden in the east. The site is situated on the corner of Parliament Hill Road and Tanza Road. The site resembles the present-day configuration.	Residential development of surrounding area. Parliament Hill (wooded and open parkland) ~75m north of site.
1915/20 1:2,500 1:10,560	No significant changes	No significant changes
1936/38 1:2,500 1:10,560	No significant changes	No significant changes
1951/52/53/54/58 1:1,250 1:2,500 1:10,560	Small building (possibly garage) shown in south-east of site. Site identified as number 62 Parliament Hill.	Houses 150m west of site no longer shown - possibly indicative of WWII bomb damage.

Dates and Scale of Map	Relevant Historical Information	
	On Site	Off Site
1965/68 1:2,500 1:10,560	No significant changes	No significant changes
1974/78/79	No significant changes	New houses built 150m west of site
1991	No significant changes	Residential building built 100m south of site. Railway cuttings approximately 250m south of site are now shown as allotment gardens.
2001/03	No significant changes	No significant changes
2010	No significant changes	No significant changes
2021	No significant changes	No significant changes

2.3.3 Aerial photographs supplied as part of the GroundSure Enviro+GeoInsight report range from 1999 to 2019. These generally show no significant changes between these dates, with the site being situated in a residential setting approximately 75m to the south of parkland.

2.4 Tunnels and Railways

2.4.1 The Groundsure Enviro+Geoinsight Report provides information on railway tunnels and railways on and within the vicinity of the site, as summarised in the table below.

Table 2.4: Tunnels and Railways

Feature	On site	Off-site (within 250m of site, unless stated otherwise)
Underground Railways (London)	None reported	None reported
Underground Railways (Non-London)	None reported	None reported
Railway Tunnels	None reported	None reported
Historical Railway and Tunnel Features	None reported	22No. entries, all reported as railway or railway sidings 200-248m south of site.
Royal Mail Tunnels	None reported	None reported
Railways, Crossrail and HS2	None reported	36No. entries for 'Railways'. All reported 242-246m south of site for North London line rail/multi-track.

2.5 Hydrogeology & Hydrology

2.5.1 General information about the hydrogeology of the site was obtained from the GroundSure Enviro+GeoInsight report and / or the DEFRA "MAGIC" website.

Hydrology

2.5.2 The hydrology of the site and the area covers water abstractions, rivers, streams, other water bodies and flooding.

2.5.3 The Environment Agency defines a floodplain as the area that would naturally be affected by flooding if a river rises above its banks, or high tides and stormy seas cause flooding in coastal areas.

2.5.4 There are two different kinds of area shown on the Flood Map for Planning. They can be described as follows:

Areas that could be affected by flooding, either from rivers or the sea, if there were no flood defences. This area could be flooded:

- from the sea by a flood that has a 0.5 per cent (1 in 200) or greater chance of happening each year;
- or from a river by a flood that has a 1 per cent (1 in 100) or greater chance of happening each year.

(For planning and development purposes, this is the same as Flood Zone 3, in England only.)

- The additional extent of an extreme flood from rivers or the sea. These outlying areas are likely to be affected by a major flood, with up to a 0.1 per cent (1 in 1000) chance of occurring each year.

(For planning and development purposes, this is the same as Flood Zone 2, in England only.)

2.5.5 These two areas show the extent of the natural floodplain if there were no flood defences or certain other manmade structures and channel improvements.

2.5.6 Outside of these areas flooding from rivers and the sea is very unlikely. There is less than a 0.1 per cent (1 in 1000) chance of flooding occurring each year. The majority of England and Wales falls within this area. (For planning and development purposes, this is the same as Flood Zone 1, in England only.)

2.5.7 Some areas benefit from flood defences and these are detailed on Environment Agency mapping.

2.5.8 Flood defences do not completely remove the chance of flooding, however, and can be overtopped or fail in extreme weather conditions.

Table 2.5: Summary of Hydrogeology & Hydrology

Feature		On Site	Off Site
Aquifer	**Superficial:**	None reported within 500m.	None reported within 500m.
	Solid:	Unproductive	Secondary A aquifer 103m north of site.
Surface Water Features		None	3No. water network features and 2No. surface water features reported within 250m of site. Identified as Hampstead Ponds 234-2239m west of site.
Discharge Consents		None	No records within 500m of site.
Flood Risk	**EA Flood Zone 2**	No	Not reported within 50m of site.
	EA Flood Zone 3	No	Not reported within 50m of site.
	RoFRaS	N/A	Not reported within 50m of site.
	Historical Flood Events	None reported within 250m of site.	
	Flood Defences	The site is not within an area benefiting from Flood Defences.	
	Surface Water Flooding	Highest risk on site and within 50m is 'negligible'.	
	Groundwater Flooding	Highest risk on site and within 50m is 'negligible'.	

2.6 Solid and Drift Geology

2.6.1 The British Geological Survey indicates that the site is directly underlain by solid deposits of London Clay Formation.

2.6.2 The BGS describes the London Clay Formation as:

> *"bioturbated or poorly laminated, blue-grey or grey-brown, slightly calcareous, silty to very silty clay, clayey silt and sometimes silt, with some layers of sandy clay. It commonly contains thin courses of carbonate concretions ('cementstone nodules') and disseminated pyrite. It also includes a few thin beds of shells and fine sand partings or pockets of sand, which commonly increase towards the base and towards the top of the formation. At the base, and at some other levels, thin beds of black rounded flint gravel occurs in places."*

2.6.3 No superficial or artificial deposits are reported within 250m of site. However, given the site has been developed, a thickness of Made Ground should be expected.

2.7 British Geological Survey (BGS) Borehole Data

2.7.1 As part of the assessment, publicly available BGS borehole records were reviewed from the surrounding area. No records from within 250m of the site were available.

2.8 Possible Geological Hazards

2.8.1 The following are brief findings extracted from the GroundSure Enviro+Geoinsight Report, that relate to factors that may have a potential impact upon the engineering of the proposed development.

Table 2.6: Geological Hazards

Potential Hazard	Site check Hazard Rating	Details	Further Action Required?
Shrink swell clays	Moderate	Ground conditions predominantly high plasticity.	Yes - Ground Investigation
Running sands	Very low	Running sand conditions are unlikely. No identified constraints on land use due to running conditions unless water table rises rapidly.	No
Compressible deposits	Negligible	Compressible strata are not thought to occur.	No
Collapsible Deposits	Very low	Deposits with potential to collapse when loaded and saturated are unlikely to be present.	No
Landslides	Very low	Slope instability problems are not likely to occur but consideration to potential problems of adjacent areas impacting on the site should always be considered.	No
Ground dissolution soluble rocks	Negligible	Soluble rocks are either not thought to be present within the ground, or not prone to dissolution. Dissolution features are unlikely to be present.	No
Coal mining	None	The study site is not located within an identified coal mining area.	No
Non-coal mining	None	There are no records of historical non-coal mining reported within 100m of site.	No

2.8.2 In addition, the GeoInsight report notes the following:

- 39No. surface ground working features are reported within 250m of the site. Nearest reported 187m west of the site for ponds.
- No other features relating to mining, ground workings or natural cavities are reported within 250m of the site.

2.8.3 Foundations should not be formed within Made Ground or organic rich material due to the unacceptable risk of total and differential settlement.

2.8.4 Foundations must be designed so as not to load nor undermine adjacent boundary walls and buildings.

2.8.5 The presence of Made Ground derived from demolition material may be a source of elevated sulphate, associated with plaster from the previous structures. In addition, the BGS notes disseminated pyrite within the London Clay Formation and as such may be a source of elevated sulphate results. If such levels are noted then sulphate resistant concrete may be required.

2.8.6 The potential for clays beneath the proposed footprint may mean that a suspended floor slab and heave precautions would be required.

2.8.7 A geotechnical investigation is recommended to inform foundation design.

3 GROUND INVESTIGATION

3.1 Scope of Ground Investigation

3.1.1 The ground investigation was undertaken on 5th May 2021, and comprised;

- 1No. modular (restricted access) windowless sampler borehole to 10m below ground level (mbgl) with in-situ testing and sampling;
- 5No. hand excavated trial pits to depths of up to 0.9m bgl, to allow inspection of existing foundations and shallow soil sampling;

3.1.2 Exploratory hole positions were located approximately with reference to known features on site as shown in the exploratory hole location plan presented in Appendix 1. The exploratory hole records are included in Appendix 4.

3.1.3 The exploratory holes were backfilled with the arisings (in the reverse order in which they were drilled) and the ground surface was reinstated so that no depression was left.

3.2 Sampling Rationale

3.2.1 Soil samples were taken at regular intervals throughout the exploratory holes as shown in the records presented in Appendix 4.

3.3 In-situ Testing

3.3.1 In-situ geotechnical testing included Standard Penetration Tests. The determined 'N' values have been used to determine the relative density of granular materials and have been used with standard correlations to infer various other derived geotechnical parameters including the undrained shear strength of the cohesive strata. The results of the individual tests are on the appropriate exploratory hole logs in Appendix 4.

3.4 Laboratory Analysis

3.4.1 Soil samples were submitted to the UKAS Accredited laboratory of i2 Analytical Ltd. for a series of analysis.

3.4.2 This testing was specifically designed to:

- classify the samples
- obtain parameters (either directly or sufficient to allow relevant correlations to be used) relevant to the technical objectives of the investigation

3.4.3 The following laboratory geotechnical testing (as summarised in Table 3.1) was carried out:

Table 3.1 Laboratory Geotechnical Analysis

BS 1377 (1990) Test Number	Test Description	Number of tests
Part 2		
3.2	Moisture Content Determination	6
4.3 and 5.3	Liquid and Plastic Limit Determination (Atterberg Limits)	6

3.4.4 In addition, 4No. samples were tested for water soluble sulphate and pH and the results used in combination with BRE Special Digest 1 to allow buried concrete to be classified. The results of this chemical testing are provided in Appendix 6.

4 GROUND CONDITIONS

4.1 Soil

4.1.1 Ground conditions were logged in accordance with the requirements of BS5930:2015, incorporating Amendment 2. The detailed borehole log is provided in Appendix 4. The ground conditions encountered are summarised in Table 4.1 below, based on the strata observed during the investigation.

Table 4.1 : Ground Conditions Encountered

Stratum and Description	Encountered from (m bgl)	Base of strata (m bgl)	Thickness range (m)
Paving slabs over dark brown mottled yellowish brown sandy gravelly clay with rootlets. Sand is fine to coarse. Gravel consists of fine to coarse angular to rounded brick, shell and charcoal. Becoming less gravelly with depth. (MADE GROUND)	0.0	1.4	1.4
Soft becoming stiff* grey to orangish brown silty sandy CLAY. Sand is fine to medium. (LONDON CLAY FORMATION)	1.4	>10.0 (Base not proven)	>8.6 (Thickness not proven)

**Consistency estimated using semi-empirical correlations with SPT N-values, Plasticity Indices and published literature*

4.1.2 Given the likely ground strata profile identified in Section 2.6, it is considered that the encountered strata represent Made Ground over London Clay Formation.

4.2 Hydrogeology

4.2.1 Groundwater was not reporting during the intrusive works.

4.2.2 A groundwater monitoring visit undertaken on 13th May 2021. The monitoring well installed in WS1 was reported as 'dry' to its base at 6.23m bgl.

5 GEOTECHNICAL ENGINEERING RECOMMENDATIONS

5.1 Introduction

5.1.1 It is understood that the proposed development is to comprise the lateral extension and deepening of an existing basement/cellar to provide habitable space, together with internal refurbishment, and demolition of the existing garage and construction of a replacement elsewhere on the property.

5.1.2 No detailed structural engineering design information, with respect to the type of construction and associated structural loadings, was provided at the time of preparing this report. Consequently, a detailed discussion of all the problems that may arise during the proposed redevelopment scheme is beyond the scope of this report.

5.1.3 Practical solutions to the difficulties encountered, both prior to, and during construction, are frequently decided by structural constraints or economic factors. For these reasons, this discussion is predominantly confined to remarks of a general nature, which are based on site conditions encountered during the intrusive investigations.

5.2 Geotechnical Classification

5.2.1 Prior to commencing the investigation this development was deemed to be a GC2 development in accordance with BS EN: 1997.

5.2.2 The findings of the investigation undertaken and discussed previously do not change this assessment.

5.3 Data Summary

5.3.1 The results of the ground investigation revealed a ground profile comprising Made Ground (up to 1.4m bgl depth), overlying London Clay Formation to at least the base of the borehole at 10m bgl. The base of this deposit was not proven.

5.3.2 Groundwater was not observed during the investigation, nor during return monitoring.

5.3.3 A summary of ground conditions obtained from the ground investigation and the derived geotechnical parameters, is provided in Table 5.1 below.

Table 5.1: Derived Geotechnical Parameters

Strata	Depth Encountered (from-to) (mbgl)	SPT 'N' Value	Inferred Shear Strength (kPa)	Moisture content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (modified plasticity) (%)	NHBC Volume Change Classification
Paving slabs over dark brown mottled yellowish brown sandy gravelly clay with rootlets. Sand is fine to coarse. Gravel consists of fine to coarse angular to rounded brick, shell and charcoal. Becoming less gravelly with depth. (MADE GROUND)	0.0 to 1.4	8	-	23	47	21	26 (22.36)	Medium
Soft becoming stiff* grey to orangish brown silty sandy CLAY. Sand is fine to medium. (LONDON CLAY FORMATION)	1.4 to >10.0 (Base not proven)	8 - 23	36 - 103	24 - 30	45 - 75	22 - 31	23 – 46 (20.9 – 45.5)	Medium to High

**Consistency estimated using semi-empirical correlations with SPT N-values, Plasticity Indices and published literature*

5.4 Undrained Shear Strength

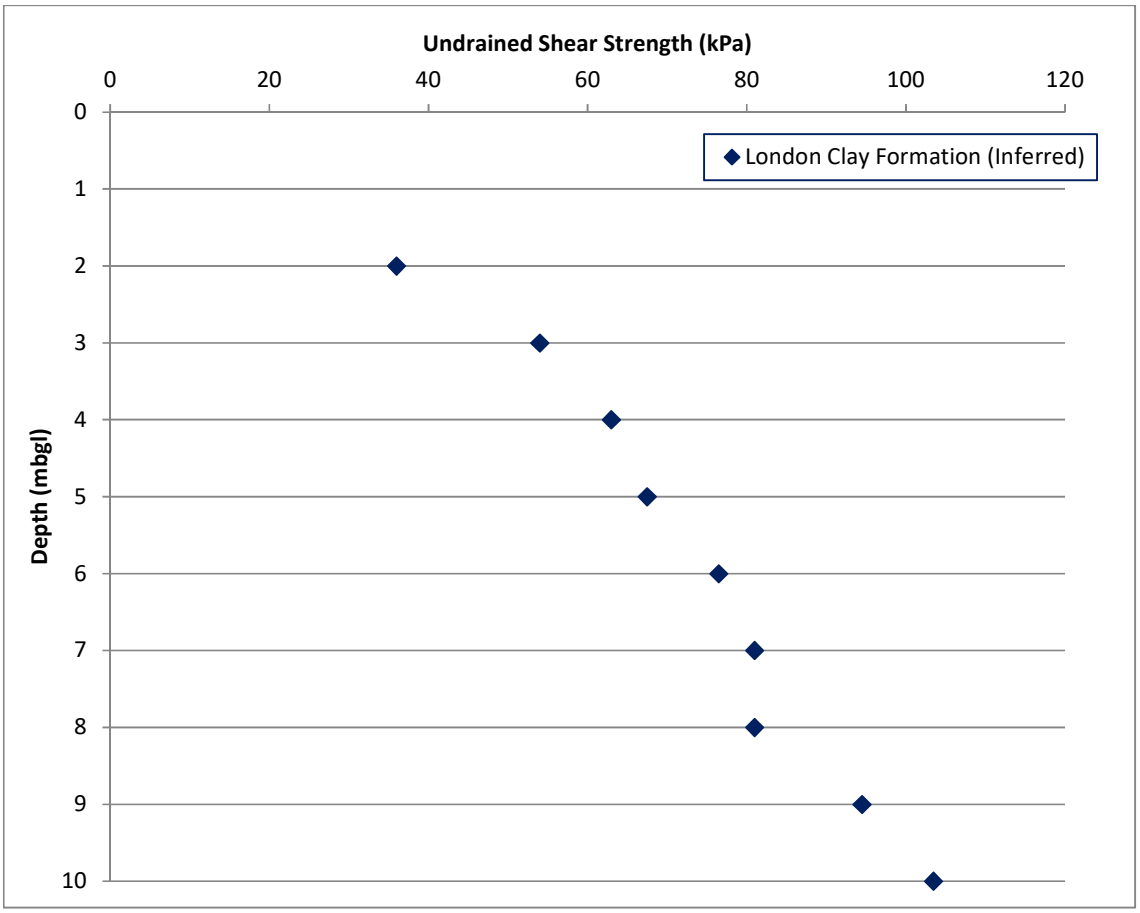
5.4.1 Standard Penetration Tests were undertaken at regular intervals throughout the restricted access windowless sampler borehole. The results of the SPTs have been used to infer the undrained shear strength using the correlation suggested by Stroud (1974).

$c_u = f_1 \times N$ can be applied,

in which
c_u= mass shear strength (kN)
f_1 = constant
N = SPT Value achieved during boring operations

5.4.2 A value for f_1 of 4.5 has been adopted after Tomlinson (2001) to allow for a conservative assessment.

Figure 5.1: Inferred Undrained Shear Strength v Depth



5.4.3 As shown above there is a generally consistent increase in shear strength with depth throughout the London Clay Formation.

5.5 Coefficient of Compressibility

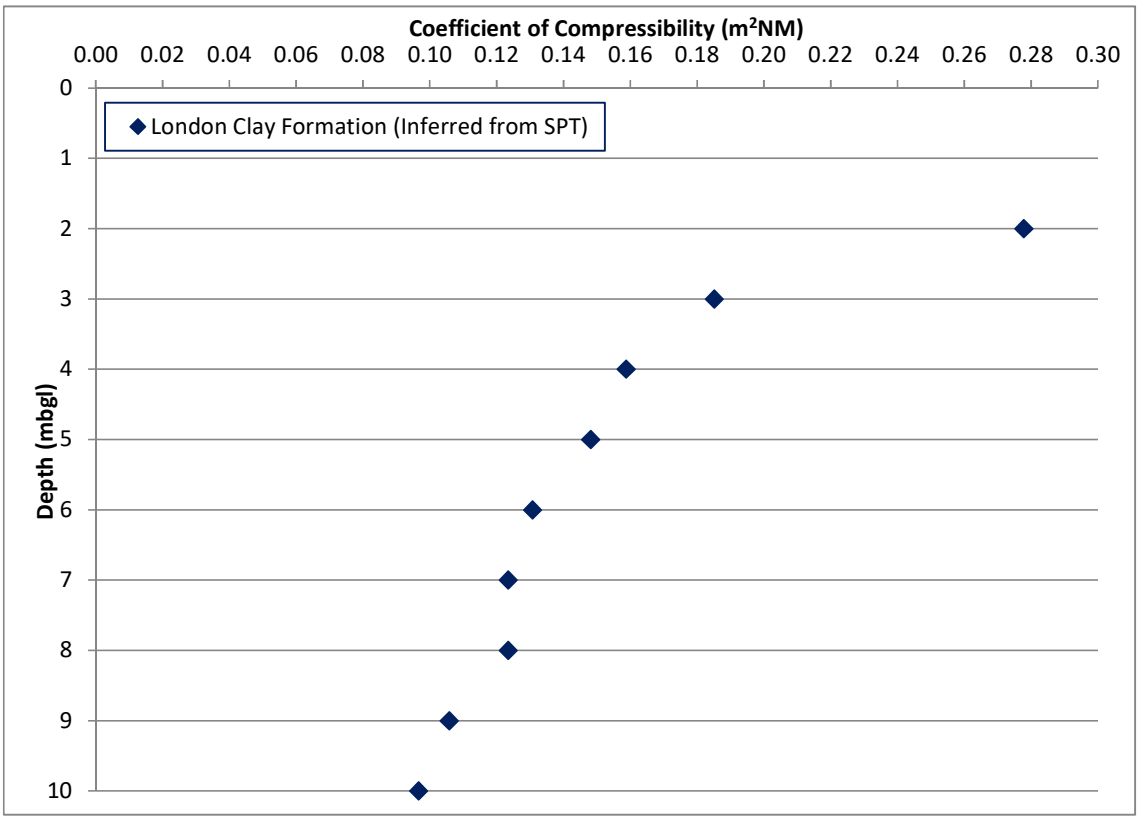
5.5.1 Stroud and Butler (1974) developed a relationship between the coefficient of compressibility (m_v) and SPT 'N' value.

$m_v = 1/ (f_2 \times N)$ can be applied,

in which
m_v = coefficient of compressibility (m^2/MN)
f_2 = constant dependant on the plasticity index
N = SPT Value achieved during boring operations

5.5.2 Using the graphs provided in Tomlinson (2001) a value of f_2 of 0.45 has been taken and used with the SPT 'N' values to infer coefficient of compressibility (m_v). This allows for a conservative assessment.

Figure 5.2: Inferred Coefficient of Volume Compressibility (mv) v Depth



5.5.3 As would be expected the results reduce with depth as the clay increases in strength and the over burden increases, reducing the potential for compressibility.

5.5.4 The results from of the London Clay are generally of "low" to "medium" compressibility".

5.6 Building Near Trees

5.6.1 The underlying soil conditions have been shown to be of high volume change potential.

5.6.2 With reference to NHBC Standards Chapter 4.2 it can be seen that a minimum founding depth of 1.0m will be required.

5.6.3 Presence of existing and proposed trees may increase this minimum depth. It is recommended that a tree survey is carried out that should include: location, species and height of all trees on and near to the proposed development.

5.6.4 Guidance is also given in relation to other aspects of construction where the shrink / swell potential of the soils may be needed to take into consideration. This guidance is summarised in the appropriate sections below.

5.7 Foundations (Existing)

5.7.1 4No. hand excavated trials pit were undertaken at locations specified by the client's representative (Michael Alexander Consulting Engineers).

5.7.2 The locations are shown in Figure 3, Appendix 1.

5.7.3 When assessing the foundations, the following is assumed:

- Walls were constructed symmetrically and centrally on the strip footing to prevent overturning and eccentric loading.
- Where the width of the wall is not known, it is assumed to be 0.30m wide to take into account the walls and any cavity.

5.7.4 The findings and assessment of the foundation as exposed by the inspection pit are summarised in Table 5.2.

Table 5.2: Foundation Inspection Pit Summary

Hole	Total Step Out (m)	Assumed Width (m)	Proven Depth (m bgl)	Apparent Founding Strata
TP-A	0.23	0.76	0.31	Made Ground
TP-B	0.15	0.60	0.52	Made Ground
TP-C	0.00	0.30	0.40	Made Ground
TP-D	0.13	0.56	0.70	London Clay Formation

5.7.5 Whilst some of the foundations appear to have been formed in Made Ground it is considered that this is unlikely due to the risk of total and differential settlement. It is possible that these foundations were formed in the underlying London Clay Formation.

5.8 Foundations

General

5.8.1 A topographic survey of site provided by the client shows the ground level at which WS1 was drilled is 50.15m OD.

5.8.2 Plans show joists within the lower ground floor at an elevation of 48.13m OD. Assuming the basement is extended to form a full ceiling height for habitable space, it is assumed the new basement floor would be formed at 45.13m OD. This equates to approximately 5m bgl from where WS1 was completed.

5.8.3 The Made Ground is not considered to provide a suitable bearing stratum due to its variability and the unacceptable risk of total and differential settlement. All foundations should be deepened beneath these deposits and founded within underlying competent London Clay Formation.

5.8.4 It should be noted that the demolition and removal of existing structures, foundations and services may increase the depth of Made Ground on the site.

5.8.5 The comments provided herein are indicative only, based on limited ground investigation data. Foundations should be designed by a suitably qualified Engineer. Once structural loads have been fully determined a full design check in accordance with BS EN 1997 should be undertaken to confirm suitability of foundation choice.

Cantilever Retaining Walls / Traditional Spread Foundations

5.8.6 It is considered that a cast in-situ cantilever retaining wall formed within natural soils of the London Clay Formation at approximately 5.0m below ground level (approximately 45.13m OD) could be designed with an allowable bearing capacity of 130kPa.

5.8.7 It is recommended that formations are inspected by a geotechnical engineer prior to the pouring of concrete to confirm the bearing capacity.

5.8.8 Geotechnical laboratory testing has indicated the London Clay Formation to be of high volume change potential. Therefore, heave precautions will be required against the side of foundations and ground beams in accordance with the requirements set out in NHBC Standards Chapter 4.2.

5.9 Retaining Walls

5.9.1 At the current time, it is not known how the retaining walls to the basement will be constructed. It is assumed that the retaining walls will be of the cast in-situ cantilever type.

5.9.2 The walls would need to be designed to both withstand the earth pressures and to be able to transfer the above loading successfully i.e. the retaining wall should be designed to act as a foundation for the structure.

5.9.3 A check against sliding failure would need to be made to the retaining wall design. This may alter the above recommendations regarding allowable bearing capacities.

5.9.4 It is considered that a friction angle of 21° may be adopted for the London Clay Formation after guidance in BS8002:2015.

5.9.5 Geotechnical laboratory testing has indicated the London Clay Formation to be of high volume change potential. Therefore, heave precautions will be required against the side of foundations and ground beams in accordance with the requirements set out in NHBC Standards Chapter 4.2.

5.10 Ground Floor Slabs

5.10.1 Given that there is to be a basement formed on the site, it is expected that the finished floor level would be approximately 5.0m below current ground level.

5.10.2 If a cantilever retaining wall is utilised, then a ground bearing floor slab could be used at this depth. Such a slab would need to be constructed on a suitable thickness of engineered granular material.

5.10.3 In this case, formations of the structures should be inspected by a competent person. Any loose or soft material should be removed and replaced with well-graded, properly compacted granular fill or lean mix concrete. The formation should be blinded if left exposed for more than a few hours or if inclement weather is experienced.

5.10.4 All floor slabs would also need to be suitably reinforced, not only to distribute the structural loading but also to ensure that the floor slab can prop the retaining walls and does not buckle from the lateral pressures imposed by the cantilever retaining walls.

5.10.5 The floor slab (and basement walls) would need to be constructed to conform to BS: 8102 (2009).

5.11 Concrete in the Ground

5.11.1 Sulphate attack on building foundations occurs where sulphate solutions react with the various products of hydration in Ordinary Portland Cement (OPC) or converted High-Alumina Cement (HAC). The reaction is expansive, and therefore disruptive, not only due to the formation of minute cracks, but also due to loss of cohesion in the matrix.

5.11.2 In accordance with BRE Special Digest 1, the characteristic values of sulphate used to determine the concrete classification are determined using the methodology summarised in the table below.

Table 5.3: Concrete in the Ground Characteristic Value Determination

No. Samples in the dataset	Method for determining the sulphate characteristic value
1 - 4	Highest value
5-9	Mean of the top 2No. highest results
10 or greater	Mean of the top 20% highest results

5.11.3 Table 5.4 summarises the analysis of the aggressive nature of the ground for each of the strata encountered within the ground investigation.

Table 5.4: Concrete in the Ground Classes

Stratum	No. Samples	pH range	Characteristic WS Sulphate (mg/l)	Design Sulphate Class	ACEC Class
Made Ground	1	8.0	66.2	DS-1	AC-1
London Clay Formation	3	7.2 – 8.1	347	DS-1	AC-1s

5.11.4 It should be noted that the BGS description of the London Clay Formation notes that it includes "disseminated pyrite". It is therefore common practice to ensure that buried concrete formed in London Clay Formation has a Design Sulphate Class of at least DS-2.

5.11.5 The concrete structures, including foundations, will need to be designed in accordance with BS EN 1992-1-1:2004+A1:2014.

5.12 Excavations

5.12.1 Temporary excavations are anticipated to remain stable for the short term only.

5.12.2 The stability of all excavations should be assessed during construction. The sides of any excavations into which personnel are required to enter, should be assessed and where necessary fully supported or battered back to a safe angle.

5.12.3 Any vertically sided excavations require support to provide safe man access and to support the sides of the excavation. Supports should be installed as excavation proceeds. For service excavations, overlapping trench sheets could be used as close support in the Made Ground deposits to minimise ground loss. Alternatively, consideration could be given to the use of trench boxes provided excavations take place within the boxes.

5.12.4 Cantilever retaining walls should be formed in short sections so to prevent potential stability issues.

5.13 Groundwater Control

5.13.1 Based on the findings to date, significant quantities of groundwater are not expected during site works. However, subject to seasonal variations, an allowance should be made for any encountered groundwater to be readily dealt with by conventional pumping from a sump. This would need to be assessed at the time of construction.

5.13.2 Surface water or rainfall ingress into excavations could be similarly dealt with.

6 REFERENCES

BRE Special Digest 1: Concrete in Aggressive Ground, 2005

British Standards Institution (2015) BS 5930:2015 Code of practice for ground investigations. Milton Keynes: BSI

CIRIA C580, Embedded retaining walls – guidance for economic design

Code of Practice for Ground Investigations BS5930: 2015

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NHBC Standards Chapter 4.2: 2021

APPENDICES

APPENDIX 1 – FIGURES

APPENDIX 2 – GROUNDSURE REPORT

APPENDIX 3 – HISTORICAL OS MAPS

APPENDIX 4 – EXPLORATORY HOLE RECORDS

APPENDIX 5 – GEOTECHNICAL LABORATORY TEST RESULTS

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APPENDIX 7 – GROUNDWATER MONITORING RECORDS

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