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BASEMENT IMPACT ASSESSMENT

100 CHALK FARM ROAD
LONDON
NW1 8EH

Ref:	MES/2411/REG049
Rev:	01
Date:	Nov 2024
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1.0 Non-Technical Summary

At the request of Regal London, a Basement Impact Assessment (BIA) has been carried out at 100 Chalk Farm Road, London, NW1 8EH (the site) in support of an amendment to a planning application for a proposed multistorey development including a basement. A previous BIA (Basement Impact Assessment, March 2024, Pell Frischmann) has been submitted and accepted by the London Borough of Camden (LBC) and their BIA Auditor Campbell Reith (ref RAkb14006-46-250424-100 Chalk Road F1, April 2024).

This updated BIA relies upon previously agreed assessments where relevant, with updated assessments presented where required to reflect the revised development proposals. The relevant amendments to the proposed construction from that assessed in the previous BIA relates to the now confirmed construction methodology (contiguous piled retaining walls), updated structural drawings and drainage assessment. There are no significant changes in depth or scale of the basement from that previously assessed.

The assessments have been undertaken by appropriately qualified professionals, including a Chartered Hydrogeologist (CGeol FGS) and Chartered Civil Engineer (CEng MICE).

The site is underlain by the London Clay Formation, suitable bearing strata for the proposed development's foundations, confirmed by the site investigation. The London Clay has potential to shrink and swell with moisture variation, which may cause movement and damage to structures bearing upon it. The risk of movement and damage to this development due to moisture variation is negligible, considering the proposed depth of the basement and piled foundations.

The London Clay is designated Unproductive Strata. There is a very low risk of groundwater flooding and there will be no impact to the wider hydrogeological environment.

The site and the adjacent properties have not been impacted by flooding. There is no change to the impermeable site area as a result of the development. The SuDS proposals are to attenuate surface water discharge flow off-site, in accordance with best practice. There is a very low risk of flooding to the proposed development and the development will not impact on the wider hydrological environment.

There will be no impact to slopes due to the proposed development. Impacts to the elevated Network Rail lines adjacent have been assessed.

Ground movements caused by the excavation and construction of the proposed development will be minimal. Damage impact to adjacent structures are assessed to be Negligible (Category 0 in accordance with the Burland Scale) with impact to the highway and underlying utilities assessed to be negligible. Asset protection criteria will be agreed with LB Camden (Highways). Additionally, relevant third party asset protection agreements (Party Wall, Network Rail, London Underground and Thames Water) are now in place or in negotiation, along with Category III checks. Structural movement monitoring is proposed and mitigation actions will be implemented if movement trends indicate structural tolerances could be exceeded.

The BIA demonstrates that the proposed development will not cause adverse impacts relating to land stability, groundwater and surface water flow, and is at very low risk of flooding. A Basement Construction Plan (BCP) will be submitted to demonstrate that the strategies and assessment conclusions presented in the BIA will be implemented.

2.0 Introduction

At the request of Regal London, a Basement Impact Assessment (BIA) has been carried out at 100 Chalk Farm Road, London, NW1 8EH (the site) in support of an amendment to a planning application for a proposed multistorey development including a basement.

A previous BIA (Basement Impact Assessment, March 2024, Pell Frischmann) has been submitted and accepted by the London Borough of Camden (LBC) and their BIA Auditor Campbell Reith (ref RAkb14006-46- 250424-100 Chalk Road F1, April 2024). This updated BIA relies upon previously agreed assessments where relevant, with updated assessments presented where required to reflect the revised development proposals.

The updated BIA relies upon the Desk Study, Flood Risk Assessment and Site Investigation as previously submitted. The updated BIA includes:

- Screening and Scoping – reviewed and updated as required;
- a Ground Movement Assessment (GMA);
- a Drainage Strategy;
- and a Basement Impact Assessment (BIA).

2.1 Purpose and Methodology of Assessment

The purpose of this assessment is to consider the impacts of the proposed basement on the local hydrological, geological and hydrogeological environments, including potential impacts on neighbouring properties and the wider area.

The information contained within this BIA has been produced specifically to meet the requirements set out by Camden Planning Guidance - Basements (CPG, January 2021) and the Local Plan 2017: Policy A5 Basements. The development has been granted Planning Permission and this document is provided for reference in relation to the amendments from the original scheme, which (in regards to the proposed basement) are minimal.

The BIA approach follows current planning procedure for basements and lightwells adopted by LB Camden and comprises the following elements:

- Desk Study;
- Screening;
- Scoping;
- Site Investigation and additional assessments identified during Scoping;
- Impact Assessment.

2.2 Authors

The assessment has been reviewed and approved by Chartered Civil Engineer Corrado Candian, MEng CEng MICE and Chartered Hydrogeologist Philip Lewis, BSc CGeol FGS, who both have more than 20 years' relevant experience of design and assessment of residential and commercial developments including basements.

The Supervising Engineer for the scheme is HDR Consulting Ltd, specifically Peter Watkins CEng MIStructE, who has reviewed the relevant geo-structural information and provided confirmation of the suitability and buildability of the scheme, within the guidelines provided by LB Camden, and in conjunction with the Basement Construction Plan (BCP), which will be

submitted to demonstrate that the strategies and assessment conclusions presented in the BIA will be implemented.

2.3 Sources of Information

The following baseline data have been referenced to complete the BIA in relation to the proposed development:

- Geotechnical Design Report (ref GE22556/GDR/JUL24 V1.0) dated 17 July 2024 by Geo-Environmental Services Limited (GESL);
- Structural Engineering Drawings (Rev P2) dated 16 August by HDR Consulting Ltd;
- Basement Impact Assessment (ref 10685-PF-ZZ-XX-RP-C-005, Rev 02, Suit S1) dated March 2024 by Pell Frischmann;
- Basement Impact Assessment (ref RAkb14006-46- 250424-100 Chalk Road F1), March 2024, Campbell Reith;
- Structural Engineering Report (SER) (ref 106885-PF-ZZXX-RP-S-0005, rev. 02) January 2024, Pell Frischmann Consultant Ltd;
- Land Contamination Desk Study Report (ref 106885-PEF-XX-XX-RP-GG-600001_P02 LCDS Chalk Farm Road), February 2024, Pell Frischmann Consultant Ltd;
- Ground Movement Assessment: Impacts relating to Northern Line Underground Railway Tunnels, 100 Chalk Farm Road (ref MES/2409/REG045), September 2024, Milvum Engineering Services;
- Ground Movement Assessment: Impacts relating to Network Rail North London Line, 100 Chalk Farm Road (ref MES/2409/REG046), September 2024, Milvum Engineering Services;
- Ground Movement Assessment: Impacts relating to the Roundhouse, 100 Chalk Farm Road (ref MES/2411/REG048), November 2024, Milvum Engineering Services;
- Assessment of Impact of Enabling and main Works on TWUL Assets (Rev 03), 9 October 2024, Geotechnical Consulting Group;
- Flood Risk Assessment (Ref: 106885-PEF-ZZ-XX-RP-YE-000010, P03), January 2024, Pell Frischmann Consultant Ltd;
- Sustainable Drainage Report (Ref: 106885-PEF-ZZ-XX-RP-CD-000001, P03), January 2024, Pell Frischmann Consultant Ltd;
- Drainage Strategy Report (Ref: CHALF-HDR-RP-C-YY-XX-016), 20 November 2024, HDR Consulting Ltd;
- Construction Management Plan (CMP) (Ref. 1130, rev. 2), February 2024, Regal London.
- Ordnance Survey Mapping;
- British Geological Survey, Geo-Index Onshore (online);
- LB Camden, Planning Guidance: Basements, January 2021;
- LB Camden, The Local Plan 2017: Policy A5 Basements;
- LB Camden, Strategic Flood Risk Assessment (produced by URS), 2014;
- Barton, The Lost Rivers of London, 1992;
- LB Camden, Camden Geological, Hydrogeological and Hydrological Study - Guidance for Subterranean Development (produced by Arup), 2010;
- CIRIA, C760 Embedded retaining walls - Guidance for Economic Design, 2017;
- Predictions of Party Wall Movements Using CIRIA Report C580, Ball, Langdon and Crieghton, 2014;
- Tomlinson, M.J. (2001) Foundation Design and Construction.

2.4 Existing and Proposed Development

The site location and recent aerial photograph are presented in Figures 1 and 2. The proposed development will see the demolition of existing buildings and redevelopment of the site to provide two buildings ranging in height from 6 to 12 storeys containing purpose-built student accommodation with 265 rooms, associated amenity and ancillary space (Sui Generis), 24 affordable residential homes (Class C3), ground floor commercial space (Class E) together with public realm, access, servicing, and other associated works.

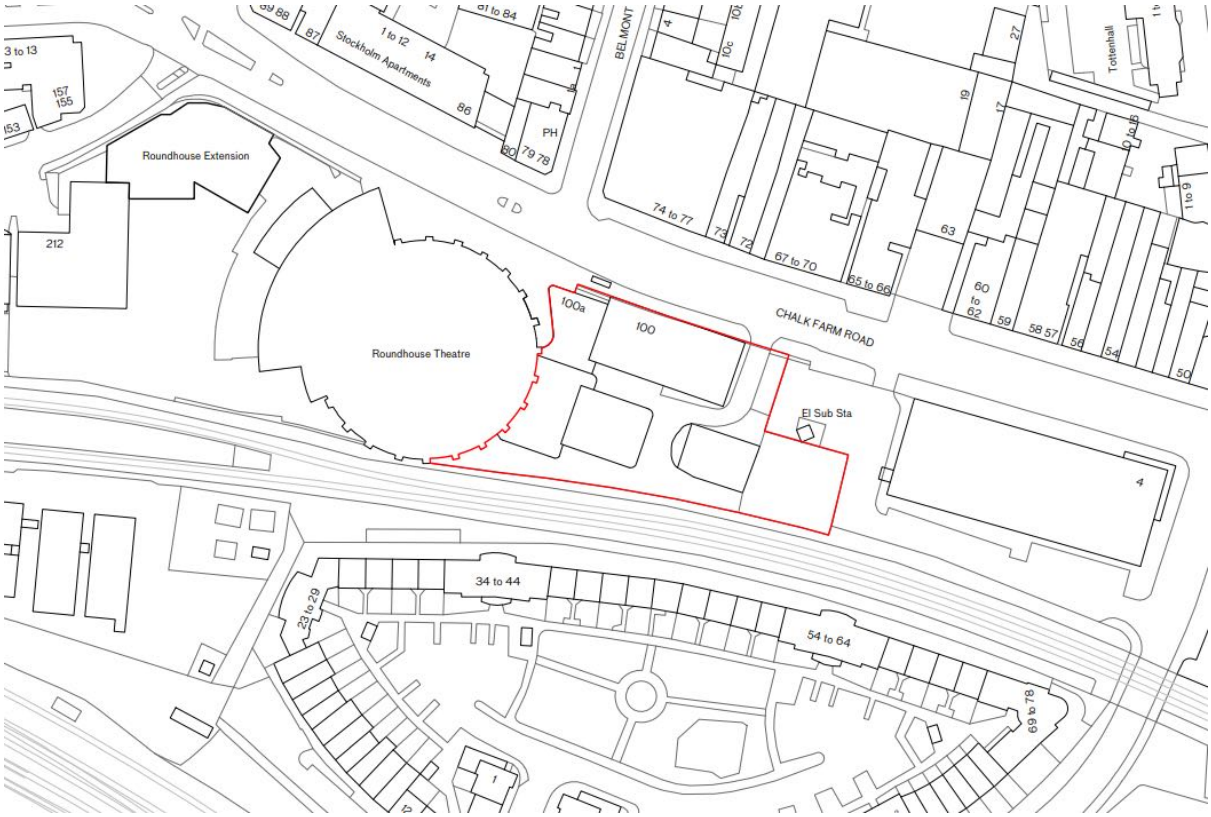

Figure 1: Site Location Plan

The site is located at approximate National Grid reference TQ 28300 84300. It is bounded by Chalk Farm Road (A502) to the north, the car park and supermarket to the east, the North London Line (Network Rail) to the south, and the Roundhouse to the west, plus associated utility and transport assets and commercial and residential properties along Chalk Farm Road and Juniper Crescent:

- Network Rail's North London Line is elevated on arches / embankments parallel to Chalk Farm Road and immediately adjacent to the southern boundary of the site, comprising two operational rail lines.
- London Underground Limited (LUL)'s Northern Line tunnels run below Chalk Farm Road.
- A number of Thames Water Utilities Limited (TWUL)'s assets run below or in the vicinity of the site, including the Lee Tunnel, at between 1m to 36m below the existing ground level (bgl).
- The Roundhouse is a Grade II Listed theatre and performance arts space of 3 to 4 storeys on Chalk Farm Road immediately adjacent to the western boundary of the site.

Figure 2: Aerial Photograph of the Application Site and Surrounding Area

The site ground level is sloping downwards from south to north, with the elevation dropping from about 33.0mOD adjacent to the railway lines to 28.5mOD along Chalk Farm Road. The vegetated area over the easternmost part of the site is relatively flat with an average elevation of about 29.5mOD. The site is currently occupied by the following:

- 1-storey office building adjacent to the Roundhouse.
- 5-storey office building on piles fronting onto Chalk Farm Road.
- 3-storey office building (including 1-level basement) adjacent to the North London Line.
- 2-storey car parking area (including 1-level basement) adjacent to the North London Line.

It is proposed that the basement will occupy the majority of the site demise. The development will be supported by a piled foundation. Retaining walls will be formed by contiguous piling.

The proposed basement slab level level is at approximately 24.5mOD with formation level at 23.8mOD; along the boundary with the Roundhouse and Chalk Farm Road, with ground level at approximately 28.5mOD, approximately 4.7m of soils will require retaining (including excavation to formation levels). The retaining wall at this level will remain stiffly propped at all stages of the work, both in the temporary and permanent cases.

Along the southern boundary with the North London Line, with ground level at approximately 33.0mOD, approximately 10.0m of soils will require retaining (including excavation to formation levels). Along this boundary, in the temporary case, the upper 5.0m will be designed as an unpropped cantilever; a temporary prop will be placed at 28.5mOD and the wall from 23.8mOD to 28.5mOD will remain stiffly propped at all stages of the work, both in the temporary and permanent cases. In the permanent case, the upper section of the wall above 28.50mOD will be propped by the floor slabs at 28.0mOD and 32.0mOD.

Structural drawings of the proposed development are presented in Appendix 1, with extracts within Figures 3, 4 and 5. The proposed construction sequence is:

- Demolish existing structures.
- Install piled retaining walls from current ground levels.
- Cast capping beams to piled retaining walls.
- Install bearing piles.
- Install temporary propping at approximately 28.5mOD.
- Complete excavation to formation level (23.8mOD), adding additional props on a contingency basis if required to maintain ground / structural movements within required tolerances.
- Cast raft slabs and liner walls.
- Sequentially install ground floor slab and remove temporary props.
- Construct cores and superstructure.

Contiguous piling of 12m pile lengths, 600mm diameter at 750mm centre to centre is proposed along the western, southern and eastern boundaries. Contiguous piling of 15m to 17m pile lengths, 750mm diameter at 900mm centre to centre is proposed along the southern (NR) boundary Bearing piles are proposed at 600mm and 750mm diameter.

For the purposes of assessment, the total retained height of soils along the southern (NR) boundary is taken as 10.0m, with the unpropped cantilever being applied over the upper 5.0m. The total retained height of soils along the other boundaries is taken as 5.0m.

Figure 3: Site Plan – North London Line on Southern Boundary (bottom of plan), TWUL's Lee Tunnel (Blue, right of plan), Roundhouse on Western Boundary (left), LUL Tunnels to North

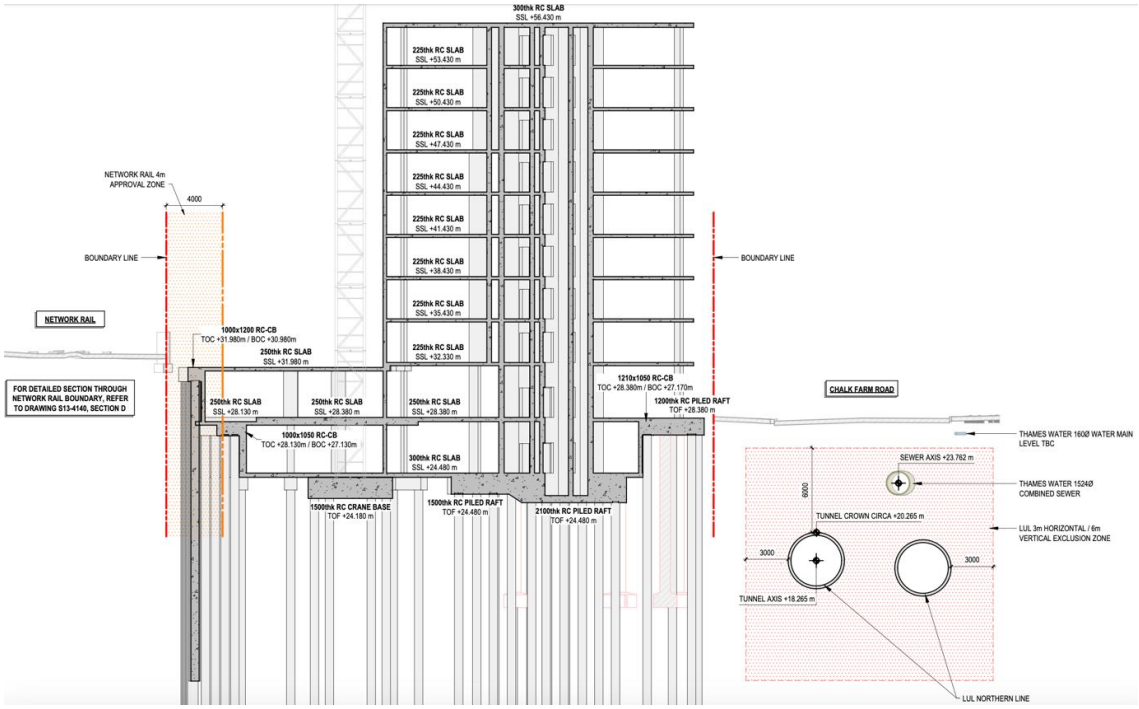

Figure 4: Cross-Section of the Proposed Development (View West)

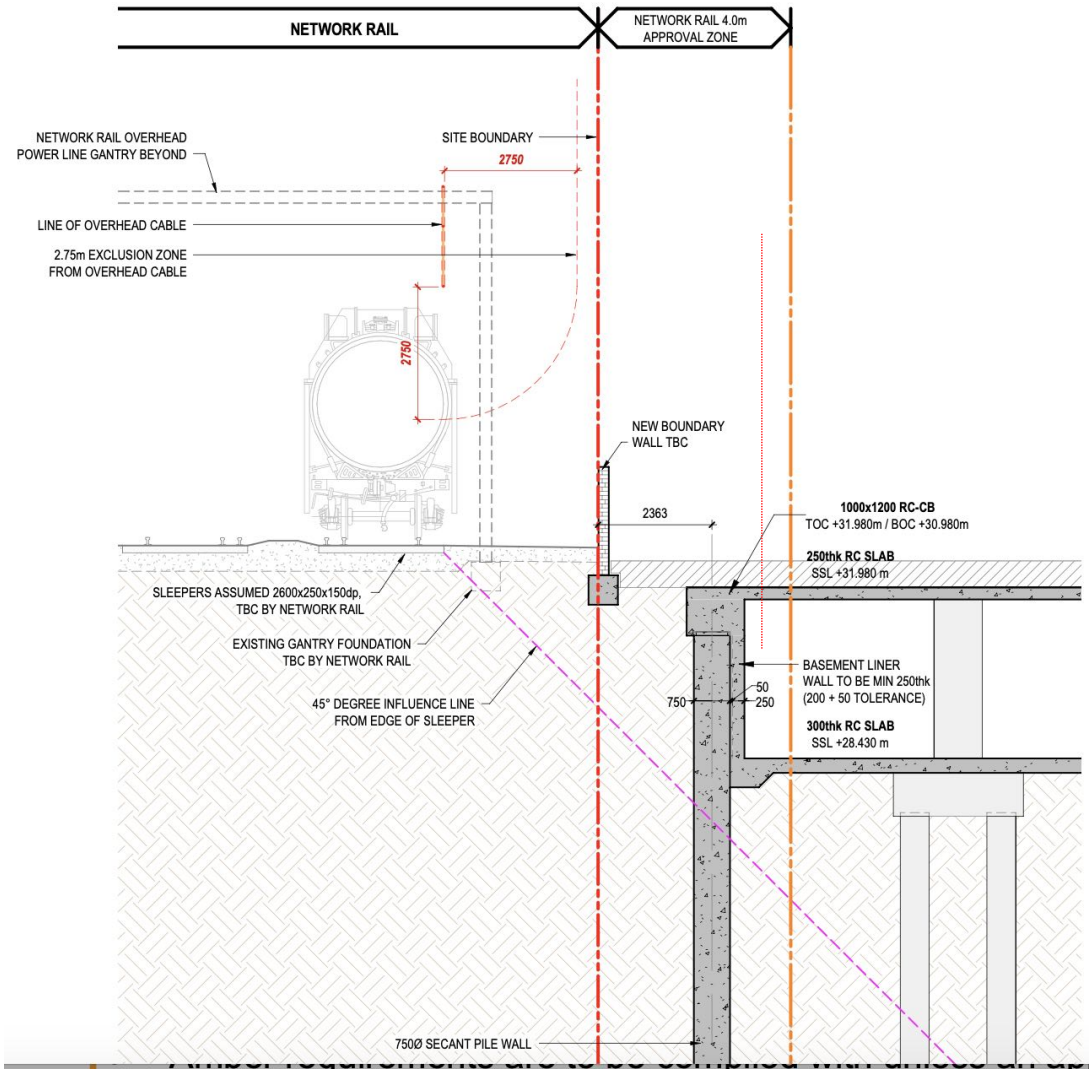

Figure 5: Network Rail Assets Relative to the Proposed Development

3.0 Desk Study

The following sections summarise the findings of the BIA desk study undertaken by Pell Frischmann, with updated assessments presented where required to reflect the revised development proposals.

3.1 Site History

The historical mapping from the 1870s indicates the site is likely to comprise railway land (including railway sidings, turntables, auxiliary tracks and possible stores) and the northern most part of a large Goods Depot (Camden Goods Yard). A large circular Goods Shed (now the location of the Roundhouse Theatre) is shown to adjoin the western boundary. The 'Great Wall of Camden' runs from east to west across the northern boundary of the site. Historical information describes the Goods Depot as having been constructed on a raised platform (approximately 15ft tall) formed of railway tunnel spoil, with the 'Great Wall of Camden' acting as a retaining wall for this material.

By the 1890s, a new railway siding extends into the site from the southwest. Insurance plans indicated that the former off site 'Goods Shed' has extended onto the western part of the site and is labelled as a warehouse used for the storage of bonded wine & spirits owned by W & A Gilbey Ltd (gin distillers).

By the mid-1940s an L-shaped rail platform was constructed across the centre of the site. By the mid-1960s the wine & spirits warehouse was converted to a Theatre, insurance plans show that the extension over the west of the site was used as offices and dressing rooms. By 1973 all railway infrastructure was fully removed from site.

By 1987, the site is shown in its current configuration. The pre-existing structures have been cleared and replaced by two new multi-story office blocks and carparking. Aerial imagery indicate that two potential periods of groundworks and material stockpiling may have occurred over the eastern (soft standing area) part of the site, in 2013 and again in 2021 which appear to be associated with demolition and construction activities occurring off-site to the east.

3.2 Geology

The British Geological Survey (BGS) map indicates that the site is underlain by the London Clay Formation (see Figure 3). A general stratigraphy of the London Basin is presented in Table 1.

Made Ground would normally be expected above the naturally occurring strata related to the historic development on site. Where present, Made Ground is expected to exhibit a certain degree of heterogeneity and the nature of the material can be expected to vary substantially in both composition and thickness over short distances.

The London Clay Formation is typically a firm to stiff, high plasticity silty clay, becoming very stiff with depth. Where encountered near surface and in proximity to vegetation, consideration of desiccation and potential for shrink swell movements to impact shallow foundations is required.

Period	Series		Deposits	
Quaternary	Holocene		Made Ground	
			Alluvium	
	Pleistocene		Langley Silt (Brickearth)	
			River Terrace Deposits	
Palaeogene	Eocene	Thames Group	London Clay Formation	Sub-Divisions A - D
			Harwich Formation	Swanscombe Member
				Oldhaven Member
		Lambeth Group	Woolwich Formation	Upper Shelley Beds
			Reading Formation	Upper Mottled Beds
			Woolwich Formation	Laminated Beds
				Lower Shelley Beds
	Palaeocene		Reading Formation	Lower Mottled Beds
			Upnor Formation	
		Thanet Sand Formation	Thanet Sand	
			Bullhead Beds	
Cretaceous	White Chalk Sub-Group	Seaford Chalk Formation	Haven Brow Beds	
			Cuckmere Beds	
			Bell Tout Beds	

Table 1: General Stratigraphy of the London Basin

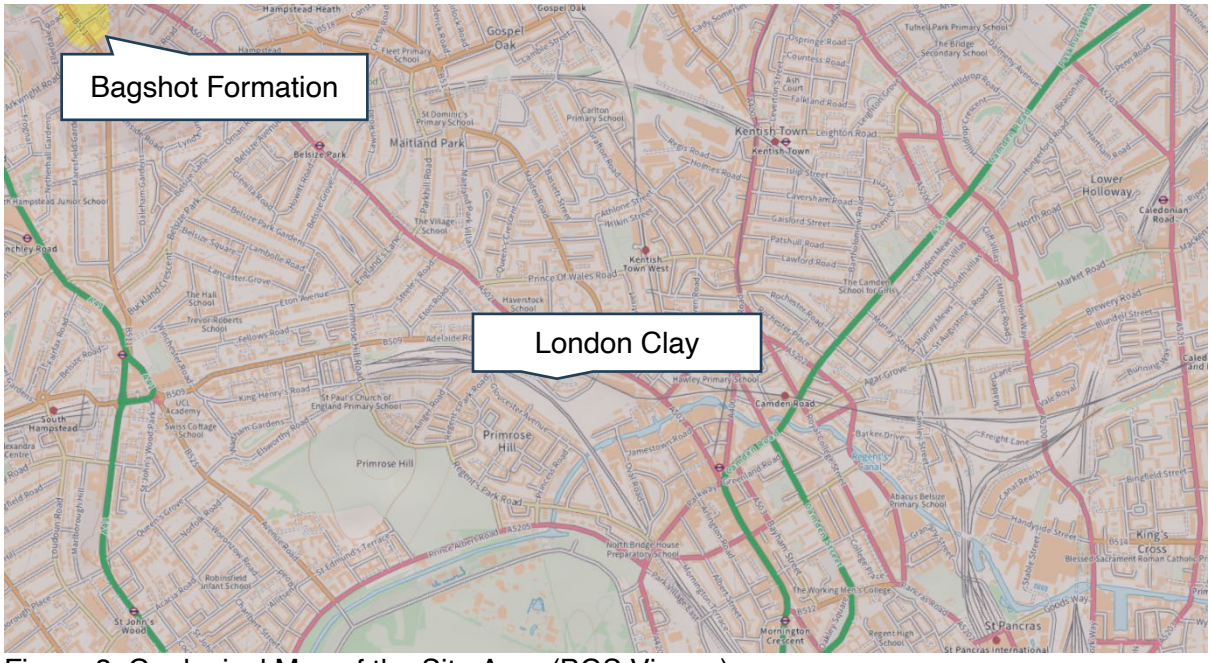

Figure 3: Geological Map of the Site Area (BGS Viewer)

3.3 Hydrogeology

The Environment Agency (EA) Groundwater Protection Policy uses aquifer designations that are consistent with the Water Framework Directive. These designations reflect the importance of aquifers in terms of groundwater as a resource (drinking water supply) and also their role in supporting surface water flows and wetland ecosystems:

- Principal Aquifers – layers that have a high permeability and are likely to support water supply and / or river base flow on a strategic scale.

- Secondary Aquifer (A) - permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.

- Unproductive Strata – predominantly impermeable or low permeability layers that have negligible significance for water supply or river base flow.

The aquifer designation beneath the site for the London Clay is Unproductive Strata. The London Clay is not considered likely to be vulnerable to pollutants or capable of supporting the migration of pollutants on or off site, due to its very low permeability.

The presence of a significant thickness of London Clay beneath the Site means that groundwater resources present in the deeper Principal Aquifer are perceived to be at no risk from activities carried out on the Site.

LB Camden data indicates the site is not within a groundwater source protection zone.

3.4 Hydrology

Barton's map of the 'lost' rivers of London indicates that there are no below ground waterways beneath the site or within 200m of the site.

The Regents Canal is approximately 290m southeast of the site.

The site is not within the catchment of the Hampstead Heath Pond Chain. The nearest part of the catchment is approximately 1.8km northwest of the site.

The site is located in a heavily urbanised area and is currently occupied predominantly by vacant buildings. Piles of construction rubble were observed in the overgrown area of soft standing over the eastern part of the site (observed in September 2022).

The site is located within not within a Critical Drainage Area (Group 3_003) as noted within the Camden SRA but not within a Local Flood Risk Zone.

The site was not subject to surface water flooding in both the 1975 and 2002 flood events.

As stated in the Flood Risk Assessment (January 2024, Pell Frischmann Consultant Ltd) the indicative flood maps for planning and the Envirocheck report flood risk maps show that the Site and the surrounding area are located in Flood Zone 1, indicative of a low probability of flooding.

The site has a low potential for groundwater flooding to occur given the presence of a significant thickness of London Clay.

The mapping indicates the site to be predominantly at negligible risk of flooding from surface water. Areas of high risk are found to the north of the site, primarily confined to the carriageway of Chalk Farm Road. The mapping indicates some slight ingress into the site in the northwest corner where levels are lowest around the existing access. Surface water flood depth mapping, produced by the EA, suggests that under the high-risk event, flooding is generally isolated to the road channel of Chalk Farm Road with depths not generally exceeding 150mm. Due to the elevation rise between the road and the site, the site remains at low risk of flooding.

There is no change in impermeable site area as a result of the proposed development. The site is considered to nearly 100% impermeable area (rooftops and hardstanding). Limited landscaped areas will be replaced on a like-for-like basis.

The Thames Region Catchment Flood Management Plan covers fluvial and non-tidal sections of the River Thames, i.e. the River Thames upstream of Teddington weir and tributaries of the River Thames (e.g. River Mole). The Proposed Development is within Sub-area 9, 'London catchments', here the preferred policy option is 'Policy option 4: Areas of low, moderate or high flood risk where we are already managing the flood risk effectively but where we may need to take further actions to keep pace with climate change'. Climate change has been considered and accounted for within the FRA and Drainage Strategy.

3.5 Utilities and Underground Infrastructure

Based on TFL indicative property asset mapping (Figure 4 below) of the London Underground Network, the site is shown to be located within 10m of a London Underground line (Northern line). The northern half of the site is located within the London Underground Limited (LUL) zone of influence for the underground. There are two London Overground rail lines (North London line) located directly adjacent to the site's southern boundary.

Figure 4: Transport for London Asset Register Map

3.6 Geotechnical Risk / Unexploded Ordnance Risk

As reported in the previous BIA, the potential risk from Unexploded Ordnance (UXO) should be considered as the piled foundations and basements are designed to be deeper than previous construction on the Site.

Unexploded bomb (UXB) risk map (Zetica) classifies the site and the surrounding area with a potential high bomb risk. London County Council WW2 Bomb Damage Map does not show damage to the site, but non-structural blast damage to the Warehouse to the west of the site and to properties to the north is noted (see Figure 5). WW2 bomb census mapping (London Blitz between 07/10/1940 and 06/06/1941, collated by the Bomb Sight project) indicates that bomb strikes were not recorded on-site, records indicate four strikes within 60m of the site. The nearest recorded strikes are located 20m north and relate to two Hight Explosive Bombs on the corner of Chalk Farm Rd and Belmont Street.

Figure 5: London County Council WW2 Bomb Damage Map

A site specific pre-desk study assessment ordered from Zetica states “Site was located in the Metropolitan Borough (MB) of St Pancras, which officially recorded 663No. High Explosive (HE) bombs with a bombing density of 246.1 bombs per 405 hectares (ha). Readily available records have been found to indicate that several HE bombs fell in close proximity to the Site.” The assessment recommends that a detailed desk study is commissioned to assess and potentially zone the UXO hazard level for the site.

4.0 Screening

A screening process has been undertaken in accordance with the most recent guidance (CPG Basements, 2021) and the findings are described below.

4.1 Subterranean (Groundwater) Flow

Question	Response	Details
1a. Is the site located directly above an aquifer?	No	The site is located over the London Clay Formation, designated as Unproductive Strata.
1b. Will the proposed basement extend beneath the water table surface?	Yes	Ground investigation indicates perched water in Made Ground above the proposed basement level. Carry forward to scoping.
2. Is the site within 100m of a watercourse, well (used / disused) or potential spring line?	No	Regents Canal is approximately 290m southeast of the site.
3. Is the site within the catchment of the pond chains on Hampstead Heath?	No	The site is not within the catchment of the Hampstead Heath Pond Chain. The nearest part of the catchment is approximately 1.8km northwest of the site.
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	No	Proportion of hardstanding not changing as part of the development.
5. As part of site drainage, will more surface water (e.g. rainfall and run-off) than a present be discharged to the ground (e.g. via soakaways and/or SUDS)?	No	Sustainable Drainage Report proposes a use of attenuation tank. This tank is to be designed to accommodate the water inflow from the SUDs. The unproductive strata will not be able to absorb the surface water
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 or spring line?	No	There are no local ponds present in the near vicinity of the site.

4.2 Slope Stability

Question	Response	Details
1. Does the existing site include slopes, natural or man-made greater than 7° (approximately 1 in 8)?	No	Topographic shows the site to be sloping less than 7 degrees.
2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7° (approximately 1 in 8)?	No	No slopes greater than 7 degrees.
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7° (approximately 1 in 8)?	Yes	A retaining wall exist southeast of the site. Carry forward to scoping.
4. Is the site within a wider hillside setting in which the general slope is greater than 7° (approximately1 in 8)?	No	Figure 16 from GHHS shows that the site is not within a wider hillside with a general slope greater than 7 degrees.
5. Is the London Clay the shallowest strata at the site?	Yes	The London Clay Formation is the shallowest natural strata. Made Ground is anticipated above the London Clay.
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?	No	
7. Is there a history of seasonal shrink-swell subsidence in the local area and/or evidence of such effects at the site?	Unknown	Carry forward to scoping.
8. Is the site within 100m of a watercourse or a potential spring line?	No	Regents Canal is approximately 290m southeast of the site.
9. Is the site within an area of previously worked ground?	Yes	Carry forward to scoping
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 London Clay Formation is classified as an Unproductive Strata.
11. Is the site within 5m of a highway or pedestrian right of way?	Yes	Carry forward to scoping
12. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Yes	Carry forward to scoping
13. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	Yes	Carry forward to scoping

4.3 Surface Water and Flooding

Question	Response	Details
1. Is the site within the catchment of the pond chains on Hampstead Heath?	No	The catchment area of the ponds chains is approximately 1.8km from the site.
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	SuDS Strategy will provide betterment over existing.
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?	No	The impermeable area remains 0.28 hectares for the proposed development, same as existing site.
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	SuDS Strategy will provide betterment over existing.
5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	No	SuDS Strategy will provide betterment over existing.
6. Is the site in an area identified to have surface water flood risk according to either the Local Flood Risk Management Strategy or the Strategic Flood Risk Assessment or is it at risk from flooding, for example because the proposed basement is below the static water level of nearby surface water feature.	No	Figure 15 from the GHHS shows that the site is not in an area at risk of surface water flooding. This is seconded by the FRA which identifies the site to be at a Low Risk from surface water flooding.

4.4 Non-Technical Summary of Screening Process

The screening process identifies the following issues to be carried forward to scoping for further assessment:

- The proposed basement level is below the recorded groundwater strikes.
- The proposed development has retaining walls with a retained height of 5m to 10m.
- The proposed development will increase the differential foundation depth with neighbouring buildings.
- The shrink-swell ability of the London Clay Formation.
- The site is within 5m of Chalk Farm Road and its pedestrian walkway.
- The site is within the exclusion zone of Thames Water's Lee Tunnel, Network Rail lines and London Underground lines.

The other potential concerns considered within the screening process have all been demonstrated to be not applicable or not significant when applied to the proposed development.

5.0 Scoping

The following issues have been brought forward from the screening process for further assessment:

5.1 Geology / Land Stability

Shrink Swell

The London Clay is typically firm to stiff and should provide sufficient bearing capacity for the proposed development. The volume change potential of the London Clay could result in shrink / swell movements impacting foundations. The risk of movement and damage to this development due to moisture variation is negligible, considering the proposed depth of the basement and piled foundations.

A site investigation is required with appropriate geotechnical assessment to ensure a suitable foundation design.

Differential Depth of Foundations

Excavation for a basement may result in structural damage to neighbouring properties if there is a significant differential depth between adjacent foundations. A ground movement assessment (GMA) is required to assess potential impacts.

Adjacent Highways / Exclusion Zones

The site is within 5m of the highway (Chalk Farm Road) and pedestrian rights of way and adjacent to / over asset exclusion zones; therefore a GMA is required to assess potential impacts.

5.2 Hydrogeology / Groundwater Flow

Considering the hydrogeological properties of the London Clay (i.e. a very low permeability formation, designated as Unproductive Strata) the presence of a continuous groundwater body is discounted. There will be no impacts to groundwater flow or the wider hydrogeological environment as a result of the proposed basement. However, there is potential for perched water to be present within the Made Ground or local seepage within the London Clay which may require groundwater control to be employed during construction to ensure stability is maintained.

A site investigation is required to determine the presence of perched water or groundwater.

6.0 Ground Conditions

The ground conditions and geotechnical parameters have been assessed by GESL and the piling contractor, Central Piling. In summary, the ground conditions comprise Made Ground overlying London Clay.

Based on experience of similar projects in London, the soil parameters derived by Central Piling are considered suitable for the retaining wall calculations and use in the GMA. For the purposes of this assessment, the following simplified stratigraphy was adopted:

- Made Ground 33.0mOD to 29.5mOD
- London Clay Formation 29.5mOD to -15.0mOD
- Rigid Boundary -15.0mOD

Characteristic soil parameters and groundwater conditions adopted for retaining wall calculations are as follows:

SOIL PROFILE

Stratum no.	Elevation of top of stratum	Soil types Left side	Soil types Right side
1	33.00	1 Made Ground	1 Made Ground
2	29.50	2 London Clay undr.	2 London Clay undr.

SOIL PROPERTIES

No.	Soil type -- Description (Datum elev.)	Bulk density kN/m3	Young's Modulus Eh,kN/m2 (dEh/dy)	At rest coeff. Ko (dKo/dy)	Consol state. NC/OC (Nu)	Active limit Ka (Kac)	Passive limit Kp (Kpc)	Cohesion kN/m2 (dc/dy)
1	Made Ground	18.00	10000	0.640	NC (0.250)	0.416 (1.522)	2.738 (4.527)	3.000d
2	London Cl.. (29.50)	19.00	39000 (3510)	1.000	OC (0.490)	1.000 (2.389)	1.000 (2.390)	65.00u (5.850)
3	London Cl.. (29.50)	19.00	31200 (2808)	1.000	OC (0.250)	0.416 (1.522)	2.738 (4.528)	5.000d

Additional soil parameters associated with Ka and Kp

No.	Soil type	--- parameters for Ka --- Soil friction angle	Wall adhesion coeff.	Back-fill angle	--- parameters for Kp --- Soil friction angle	Wall adhesion coeff.	Back-fill angle
1	Made Ground	21.00	0.670	0.00	21.00	0.670	0.00
2	London Clay undr.	0.00	0.500	0.00	0.00	0.500	0.00
3	London Clay drained	21.00	0.670	0.00	21.00	0.670	0.00

GROUND WATER CONDITIONS

Density of water = 10.00 kN/m3

	Left side	Right side
Initial water table elevation	23.80	23.80

Automatic water pressure balancing at toe of wall : No

Water press. profile no.	Left side Point no.	Elev. m	Piezo elev. m	Water press. kN/m2	Right side Point no.	Elev. m	Piezo elev. m	Water press. kN/m2
1	1	32.00	32.00	0.0	1	23.50	23.50	0.0

For the ground movement calculations in PDisp and finite element modelling the characteristic parameters and insitu shear strength profile (and corresponding stiffness) presented in Table 2 have been adopted. The Made Ground is assumed to have a drained response to load changes, whereas the London Clay Formation is assumed to be undrained in the short-term and drained in the long-term.

Stratum	γ	C_u	c'	E'	E_u	Poisson Ratio
	(kN/m³)	(kPa)	(kPa)	(MPa)	(MPa)	v
Made Ground	18	-	-	10	-	0.2
London Clay	19	60+10.5z*	0	0.8Eu	450Cu	0.5

*z=0 at top of London Clay, then z=incremental increase in kPa/m

Table 2: Soil Parameters (PDisp / MIDAS)

It should be noted that with reference to published papers from Crossrail, Eu >750Cu have been adopted for assessment purposes. By comparison, the range presented in this assessment is therefore considered conservative.

6.1 Groundwater

Variable shallow levels of perched groundwater within the Made Ground have been monitored, overlying the London Clay. Whilst groundwater control methods may be employed during the construction process the perched groundwater does not represent a continuous aquifer.

7.0 Flood Risk Assessment and Drainage Strategy

A Flood Risk Assessment (FRA) and a Drainage Strategy Report have been submitted as part of the planning application. It should be noted that there will be no change in impermeable site area due to the proposed development.

7.1 Flood Risk Assessment

The conclusions of the FRA can be summarised as follows:

- The site is wholly within Flood Zone 1 (Low Probability) and so considered to be at low risk of flooding from rivers and the sea.
- Local documentation and geology indicate the site is at low risk of groundwater flooding.
- The site is considered to be at low risk of surface water flooding, with areas of high risk found along the northern boundary, but generally contained within the road channel and with topography encouraging flows away from the site.
- There are a limited number of public sewers found within the vicinity of the site and are mostly found along Chalk Farm Road. However, topography is likely to encourage surcharged flows away from the site.
- There are no canals nearby to the site that would pose a risk of flooding, therefore the risk of flooding from this source is low.
- Mapping provided by the EA suggests the site falls outside of any modelled flood extents from reservoir flooding and as such is at low risk of flooding from this source.

7.2 Drainage Strategy

The drainage strategy (Appendix 2) has been drafted by HDR Consulting Ltd and consented by Thames Water. The strategy states:

> *The aim of this strategy is to manage and treat where feasible, surface water run off as close to source as possible. This will be provided through a combination of cellular storage tanks below ground and both green and blue roof space.*
>
> *The green roofs are located at high level, providing water quality improvement. The blue roof will provide both a treatment stage at source together with a storage medium at podium level. The remainder of the surface water run off generated through this development will be attenuated in below ground storage tanks. All storage has been designed to cater for all storms up to and including the 1:100 year plus climate change event. One of the tanks has been designed integral to the basement structure considering the feasibility and sequencing of works on this site.*
>
> *Surface water discharge from the development to the existing surrounding sewer network will be limited to a total of 4 litres per second (2l/sec from each of the two outfalls) which is in accordance with the approved strategy.*

7.3 FRA and Drainage Strategy, Non-Technical Summary

From a review of the sources of flooding that could influence the proposed works on site, it has been determined that there is a low risk of flooding to the development.

It is not considered that the proposals would result in an increased risk of flooding at the property location or surrounding area or that the effects of climate change will significantly change the current day regime. The surface water management measures to be adopted will provide betterment compared to the existing run-off drained from site.

8.0 Ground Movement Assessment

8.1 Ground Movement Assessments

Ground Movement Assessments (GMAs) have been undertaken separately in regard to the following structures and assets:

- Network Rail (North London Line). The GMA has been accepted by Network Rail (Appendix 3).
- London Underground (Northern Line Tunnels) (Appendix 4).
- Thames Water (Lee Tunnel and other assets). The GMA has been accepted by Thames Water (Appendix 5).
- Roundhouse (Appendix 6). Category 0 (Negligible) impacts in accordance with the Burland Scale were predicted.

Category III checks have also been commissioned for the GMAs and they have been submitted as part of asset protection agreements / Party Wall Agreements.

A GMA for the remaining properties within the zone of influence of the site, along Chalk Farm Road and Juniper Crescent, has been completed and follows in Sections 8.2 and 8.3, with calculation outputs presented in Appendix 7. The assessed properties are:

- Juniper Crescent, Numbers 1 to 22;
- Chalk Farm Road, Numbers 63 to 86.

8.2 Ground Movements generated by the Proposed Development

Typically, the following construction processes are likely to give rise to ground movements:

1. Installation of basement retaining walls.
2. Excavation of the basement.

The GMA primarily adopts an assessment based on CIRIA C760 (and its predecessor C580) which considers movements due to installation of the basement retaining walls and excavation of the basement. This is considered pertinent since the proposed embedded piled retaining walls have not been designed for axial loading along their full lengths (only at isolated locations), and therefore are not subject to long term settlement of any significance and will contain any heave / settlements generated during the excavation and construction process. Its further noted that, due to piling being undertaken at ground level in advance of basement construction, the bearing piles will further mitigate against significant heave being generated during excavation.

The C760 assessed movements have been plotted in Oasys XDisp against the geometry of the site and neighbouring Roundhouse to assess the impacts (movements / strains).

C760 GMA

Based on the guidance provided in CIRIA C760, ground movements resulting from installation of a contiguous piled retaining wall and excavation in front of the wall have been estimated. The C760 guidance is considered relevant to the site, given that it is based on numerous case

studies on the behaviour of embedded retaining walls in London (ie with piles embedded in the stiff, over consolidated London Clay).

For movement due to retaining wall installation, the magnitudes of the movements are dependent on the total wall depth. Maximum vertical movements occur at the pile wall itself. C760 indicates movements will be 0.04% of the pile length, with negligible vertical movement at twice the pile length from the wall. On this basis, maximum vertical movements due to pile installation of <5mm are predicted with vertical movements extending to a maximum of 24m from the wall.

Anticipated maximum horizontal movements due to wall installation are 0.04% of the pile length, with negligible horizontal movement one and a half times the pile length from the wall. Maximum horizontal movements are therefore predicted to be <5mm with horizontal movements extending to a maximum of 18m from the wall.

For movements due to excavation in front of the retaining walls, the magnitudes of the movements are dependent on the excavation depth. Based on the Contractor adopting a stiffly propped method of excavation, C760 indicates maximum vertical movements of 0.10% of excavation depth (lower 5.0m of wall). For the cantilever section (upper 5.0m) of wall a low stiffness has been adopted and C760 indicates maximum vertical movements of 0.35% of excavation depth. Negligible movement is experienced three and a half times excavation depth from the wall. Maximum vertical movements due to excavation of 23mm are predicted, extending 35m from the wall.

Anticipated maximum horizontal movement due to excavation are 0.15% of the excavation depth where stiffly propped and 0.4% of excavation depth where unpropped, with negligible horizontal movements four times the excavation depth from the wall. Maximum horizontal movements are predicted to be <28mm, extending 40m from the wall.

The geometries of the site and surrounding properties (Chalk Farm Road and Juniper Crescent) have been imported into XDisp and ground movements modelled based on C580 (equivalent to C760). The displacement profiles assume greenfield movements and predict movements at ground level (28.5mOD).

8.3 Estimates of Ground Movement and Impact

Whilst the CIRIA C760 approach is considered conservative, it has been adopted as the underlying method of analysis precisely for this reason: the actual ground movements generated during the works should be less onerous than those predicted.

The displacement profiles and damage assessment derived using XDisp predict movements at ground level. In relation to the surrounding properties, the movements derived will be an overestimate, as foundations are located at a depth greater than street level.

The ground movements have been used to assess the resultant potential damage that may be experienced by the surrounding properties. The methodology proposed by Burland and Wroth, and later supplemented by the work of Boscardin and Cording, has been used, as described in CIRIA C760 (and preceding CIRIA publications). The ‘Burland Scale’ damage categories are presented in Table 3.

Based on the ground movements calculated, a maximum of Burland Category 0 (Negligible) impact is predicted to occur to neighbouring sites.

Category of damage	Description of typical damage (ease of repair is underlined)	Approximate crack width (mm)	Limiting tensile strain, ε_{lim} (%)
0 Negligible	Hairline cracks of less than about 0.1 mm are classed as negligible	<0.1	0.0 to 0.05
1 Very slight	**Fine cracks that can easily be treated during normal decoration.** Perhaps isolated slight fracture in building. Cracks in external brickwork visible on inspection	<1	0.05 to 0.075
2 Slight	**Cracks easily filled. Redecoration probably required.** Several slight fractures showing inside of building. Cracks are visible externally and **some repointing may be required externally** to ensure weathertightness. Doors and windows may stick slightly.	<5	0.075 to 0.15
3 Moderate	**The cracks require some opening up and can be patched by a mason. Recurrent cracks can be masked by suitable lining. Repointing of external brickwork and possibly a small amount of brickwork to be replaced.** Doors and windows sticking. Service pipes may fracture. Weathertightness often impaired.	5 to 15 or a number of cracks >3	0.15 to 0.3
4 Severe	**Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows.** Windows and frames distorted, floor sloping noticeably. Walls leaning or bulging noticeably, some loss of bearing in beams. Services pipes disrupted.	15 to 25, but also depends on number of cracks	>0.3
5 Very severe	**This requires a major repair, involving partial or complete rebuilding.** Beams lose bearings, walls lean badly and require shoring. Windows broken with distortion. Danger of instability.	Usually >25, but depends on numbers of cracks	

Table 3: Damage Categories on the Burland Scale

Movements to the highway / utilities are considered to be very small, such that they would cause negligible impact. Approval in Principle (AIP) will be agreed with LB Camden (Highways) in advance of construction.

Consultation with relevant asset owners is ongoing to ensure that appropriate design and mitigation measures can be provided for the development such that impacts to utilities / assets are maintained within the agreed limits.

9.0 Basement Impact Assessment

The purpose of this assessment is to consider the potential impacts from basement development on the local hydrology, geology and hydrogeology and any resulting impacts to stability of adjacent structures. The assessments have been undertaken by appropriately qualified professionals in accordance with the guidance.

This updated BIA relies upon previously agreed assessments where relevant, updated where required to reflect the revised development proposals. A Basement Construction Plan (BCP) will be submitted to demonstrate that the strategies and assessment conclusions presented in this BIA will be implemented.

9.1 Geology and Land Stability

The site is underlain by the London Clay Formation, suitable bearing strata for the proposed development's foundations, confirmed by the site investigation.

The risk of movement and damage to this development due to moisture variation is negligible, considering the proposed depth of the basement, the suspended slabs and piled foundations.

Ground movements caused by the excavation and construction of the proposed development have been demonstrated by assessment to be minimal, assuming the adoption of best practice construction methodologies. Damage Impact to adjacent structures is predicted to be Negligible (Category 0 in accordance with the Burland Scale).

Structural movement monitoring is proposed and mitigation actions will be implemented if movement trends indicate structural tolerances could be exceeded.

Movements to the highway / utilities are considered to be very small, such that they would cause negligible impact. Asset protection criteria will be agreed with relevant parties.

9.2 Hydrogeology and Groundwater Flow

The London Clay is designated as Unproductive Strata. There is a very low risk of groundwater flooding and there will be no impact to the wider hydrogeological environment.

9.3 Hydrology and Surface Water Flow

The site and the adjacent properties have not been impacted by flooding. There is a very low risk of flooding to the proposed development and the proposed development will not impact the wider hydrological environment. The proposed drainage strategy should provide betterment and reduce the risk of surface water flooding or sewer surcharging on site and in the immediate vicinity.

The SuDS proposals allow for a suitable attenuated drainage scheme with off-site discharge flow rates limited to the minimum practicable in accordance with best practice.

9.4 Residual Risks and Mitigation

Structural movement monitoring, include precise levelling, reflective survey targets or other appropriate instrumentation as determined by the Engineer (as Monitoring Plan to be provided in the BCP), will be installed on adjacent structures and the highway. This will be agreed under the Party Wall Act and as part of any asset protection agreements required.

Appendix 1 Site Plans and Development Proposals

Appendix 2 Drainage Strategy

Appendix 3 Network Rail Assets - GMA

Appendix 4 LUL Assets – GMA

Appendix 5 Thames Water Assets – GMA

Appendix 6 Roundhouse – GMA

Appendix 7 Chalk Farm Road / Juniper Crescent – GMA Outputs

Appendix 8 Disclaimer

This report has been prepared by Milvum Engineer Services in its professional capacity as soil and groundwater specialists, with reasonable skill, care and diligence within the agreed scope and terms of contract and taking account of the manpower and resources devoted to it by agreement with its client, and is provided by Milvum Engineering Services solely for the use of its client (HDR Consulting / Regal London) and for reference by the London Borough of Camden.

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