Engineering Services

Milvum Engineering Services Ltd
71-75 Shelton Street
London WC2H 9JQ

t: +44 7472 611560
e: contact@milvumgroup.com

www.milvumgroup.com

BASEMENT IMPACT ASSESSMENT

29 INGLEWOOD ROAD
LONDON, NW6 1QT

Ref:	MES/2311/RESI053
Rev:	01
Date:	November 2023
Prepared:	Heather Shaw BSc MSc DIC
	Giulia Forlati MEng PhD
	Chris Emm MEng
Reviewed:	Phillip Lewis BSc MSc CGeol FGS
	Corrado Candian MEng CEng MICE

Table of Contents

1.0 Non-Technical Summary

At the request of RESI, on behalf of Jyothin Sethi, a Basement Impact Assessment (BIA) has been carried out at 29 Inglewood Road, London, NW6 1QT in support of a planning application for a proposed new basement development to an existing three-storey mid-terrace house. Basement retaining walls will be formed using underpinning techniques.

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

The British Geological Survey (BGS) map of the area indicates that the site is underlain by the London Clay Formation. The London Clay formation typically comprises firm to stiff clay of medium to high strength and is a suitable bearing stratum 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.

The London Clay is designated Unproductive Strata. There is a very low risk of groundwater flooding or potential for impacting the wider hydrogeological environment.

The site and the adjacent properties have not been impacted by flooding. 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. The main site is level and is not situated in a wider hillside environment of slopes of 7° or more.

Ground movements caused by the excavation and construction of the proposed development will be minimal. Damage impact to adjacent structures is assessed to be a maximum of Very Slight (Category 1 in accordance with the Burland Scale) with impact to the highway and underlying utilities assessed to be negligible.

It is recommended that structural movement monitoring is undertaken and mitigation actions 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.

2.0 Introduction

At the request of RESI, on behalf of Jyothin Sethi, a Basement Impact Assessment (BIA) has been carried out at 29 Inglewood Road, London, NW6 1QT in support of a planning application for a proposed new basement development to an existing three-storey mid-terrace house. Basement retaining walls will be formed using underpinning techniques. The following assessments have been carried out:

- a Desk Study;
- Screening and Scoping;
- a Site Investigation;
- a Ground Movement Assessment (GMA);
- a Flood Risk Assessment (FRA);
- a Drainage Strategy;
- and a Basement Impact Assessment (BIA).

The proposed basement is to share the Party Wall with the existing basement to 27 Inglewood Road. Basement retaining walls will be formed using underpinning techniques, cast in a traditional hit and miss sequence.

2.1 Purpose and Methodology of Assessment

The purpose of this assessment is to consider the impacts of the proposed basements 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 in order to assist the London Borough (LB) of Camden with their decision-making process.

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 DVP Structures in conjunction with Piledesigns Ltd, specifically Val Pseneac CEng MIStructE and Mike Johnson CEng MIStuctE CSSW, who have reviewed the relevant geo-structural information and provided confirmation of the suitability and buildability of the scheme, within the guidelines provided by LB Camden, as presented in their Construction Method Statement (CMS).

2.3 Sources of Information

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

- Site walkover (April 2023).
- Ordnance Survey Mapping;
- British Geological Survey, Geo-Index (online);
- Groundsure Mapping Report (ref GS-ORK-7ZZ-N5W-VP3), Historical Mapping Data;
- Groundsure Enviro + Geo Insights Report (ref GS-PG3-LKI-I50-5ZL), Geology and Subsurface Structure (Infrastructure and Utilities) Data;
- RESI Drawings of Existing and Proposed Development, May 2023;
- DVP Structures / Piledesigns, Construction Method Statement (ref 23106), October 2023;
- Land Utility Group, Site Survey, September 2023;
- The Drain Guys, Drainage Survey (ref 4745), September 2023;
- 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;
- Tomlinson, M.J. (2001) Foundation Design and Construction;
- ASUC, Guidelines for Safe and Efficient Basement Construction Directly Below or Near to Existing Structures, 2nd Edition, 2016.

2.2 Existing and Proposed Development

The site location and recent aerial photograph are presented in Figures 1 and 2, Appendix 1 and Appendix 3. Existing and proposed development plans are presented in Appendix 2.

The Application site fronts Inglewood Road, which forms the northern site boundary, and comprises a 3-storey mid-terrace residential property with a partial existing basement and associated front yard and rear garden area. The site occupies an area of 0.02 hectares and is roughly rectangular.

Survey data and the site walkover indicates that the site area is relatively level at approximately 57.00mOD. The gradient along Inglewood Road falls from east to west at between approximately 1° and 3.0°. Across the wider area and local streets, the slopes are less than 7°. This is confirmed by LB Camden mapping data (Appendix 3, Figure 7) and OS data.

The front of the site is largely paved over fronting the pavement and road, with a small soft-landscaped border (hedge). The house is typically 4.0m from the footway (6.0m from the highway), with the stairway to the existing basement being 3.0m from the footway, 5.0m from the highway. The rear garden is laid to paving nearest the house and astroturf beyond. The borders are fenced on all sides.

To the east and west the immediate neighbours are residential buildings of three storeys (Nos. 27 and 31 Inglewood Road respectively). No. 27 has a basement. The rear garden of No. 26 Dennington Park Road bounds the site to the south.

The Construction Method Statement (CMS, Appendix 2) provides more detailed description of the existing structure / site and proposed development works.

The proposed development comprises the construction of a single storey basement beneath the main footprint of the existing house, excluding the rear ground floor projection (kitchen).

The basement formation level will be at approximately 3.50m below ground level (bgl), constructed by reinforced concrete retaining walls, underpinning the existing building's foundations. Underpinning of the neighbouring basement wall will be undertaken, if required.

The proposed structural arrangements are described in detail in the CMS. In summary, the basement retaining walls will be cast and stiffly propped by the basement and ground floor slabs.

The temporary works methodology also includes stiff propping of the retaining walls to ensure ground movements are limited to within the minimum practicable.

The development will be founded upon thickened edges to the basement wall underpin stem bases, which will transfer the loads into ground in conjunction with the ground bearing basement slab. Internal slab thickening is to be adopted where steel columns are proposed to be supported by the basement slab. The slab is intended to be sized such that the heave and hydrostatic pressures are resisted without heave protection measures.

Formation level is within the underlying natural London Clay of suitable bearing capacity.

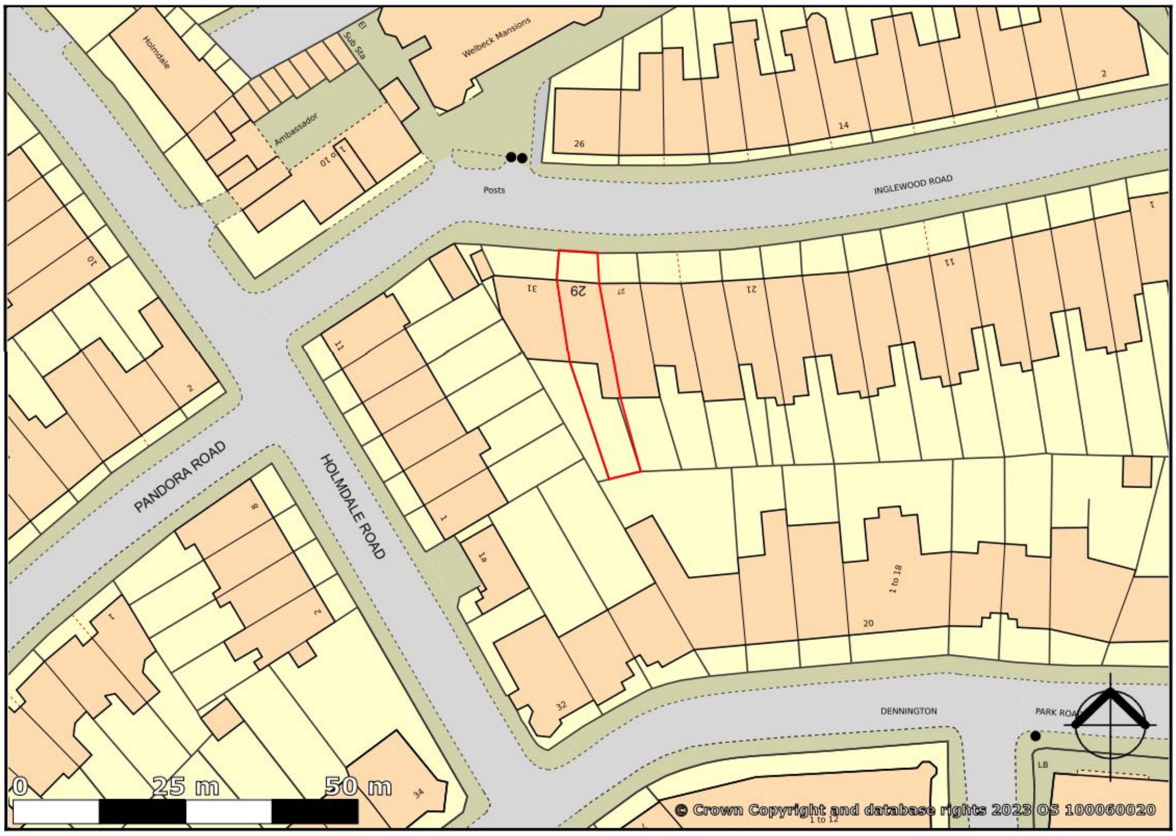


Figure 1: Site Location Plan

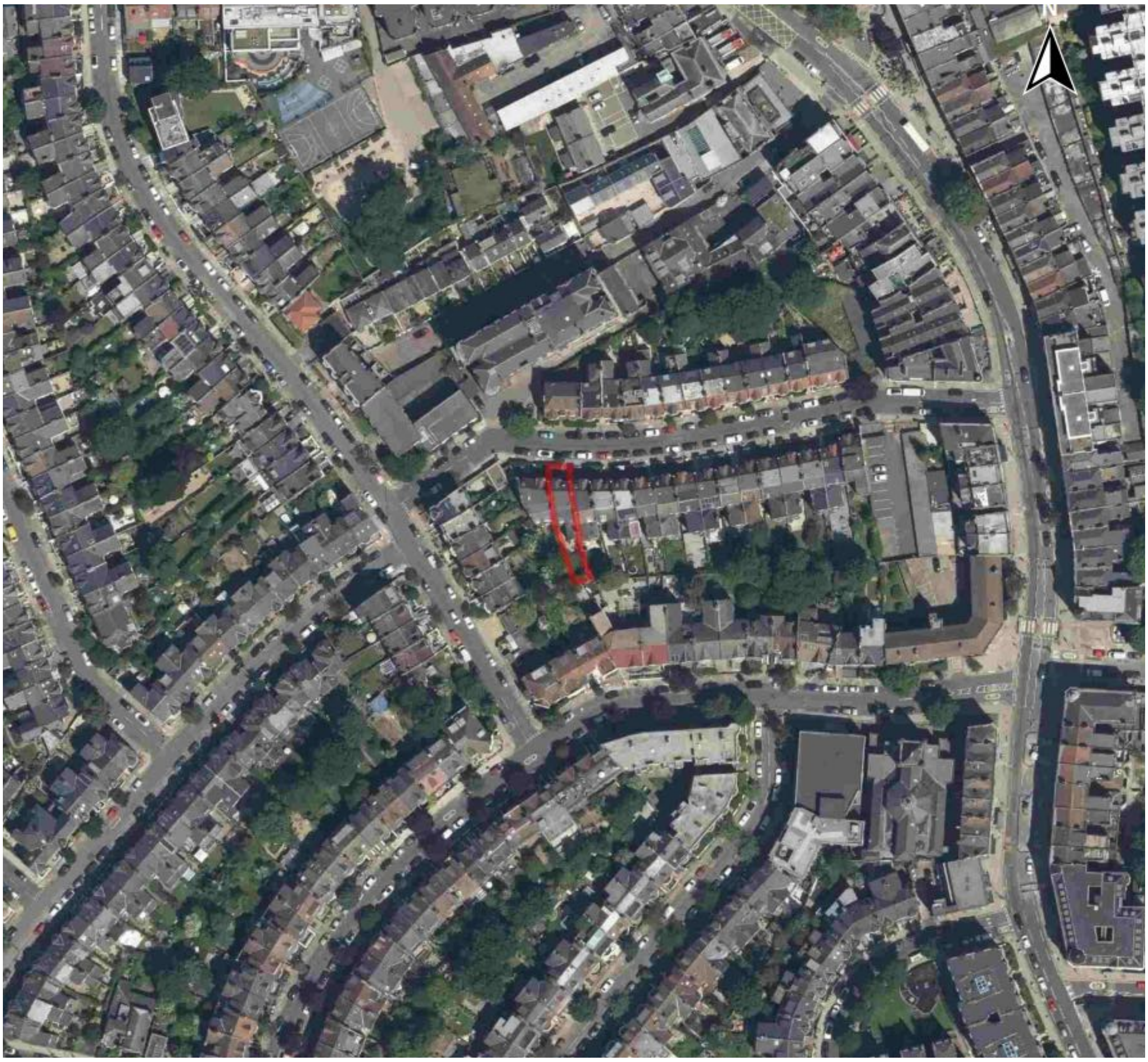


Figure 2: Aerial Photograph of the Application Site and Surrounding Area

3.0 Desk Study

The desk study has been researched with reference to the Groundsure Enviro + Geo Insight Report and historical mapping, presented in Appendix 3, in addition to other data sources as referenced.

3.1 Site History

The historical mapping indicates the site comprised garden and wooded area to a large residential property to the east from at least 1871. The next available OS map, dated 1896, shows that construction of the Inglewood Road carriageway has been completed prior to this date; however, only No.23 Inglewood Road had been built at the western end of Inglewood Road. By the time the 1915 OS map was published, all of the properties on Inglewood Road had been completed (including No.29).

A pond was located 40m east of the site until it was infilled and the aforementioned residential properties were constructed above.

The railway line has been present 200m south of the site since at least 1870.

Hampstead Foundry (Iron) was present 30m north of the site from at least the 1870s until it was redeveloped in 1897 into residential apartments (Welbeck Mansions).

An Omnibus Depot was located 100m northwest of the site from 1915 which was subsequently labelled as the Post Office Garage by the 1950s and remained unchanged until the 1990s when the buildings were cleared and the area marked as a 'Play Area'.

A 'Light Engineering Works' was located 100m north of the site from the 1950s, subsequently labelled as a 'Coach Works' by the 1970s and remains as a 'Works' in 2003 mapping.

A garage was present 75m northeast of the site from the 1950s until the early 2000s when it was redeveloped to form residential properties.

A Fire Station has been present 110m northeast of the site since at least the 1950s. An electrical substation has been located 30m northwest of the site since the early 1970s.

No historical tanks are reported on site. The historical potentially contaminative land uses within the vicinity (250m) relate to the historical infilled pond, Foundry, Omnibus Depot, Garage, Works, railways sidings and electrical substation.

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.

Head Deposits, naturally reworked soils, are common within north London, typically comprising a thin layer of firm sandy gravelly clay.

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

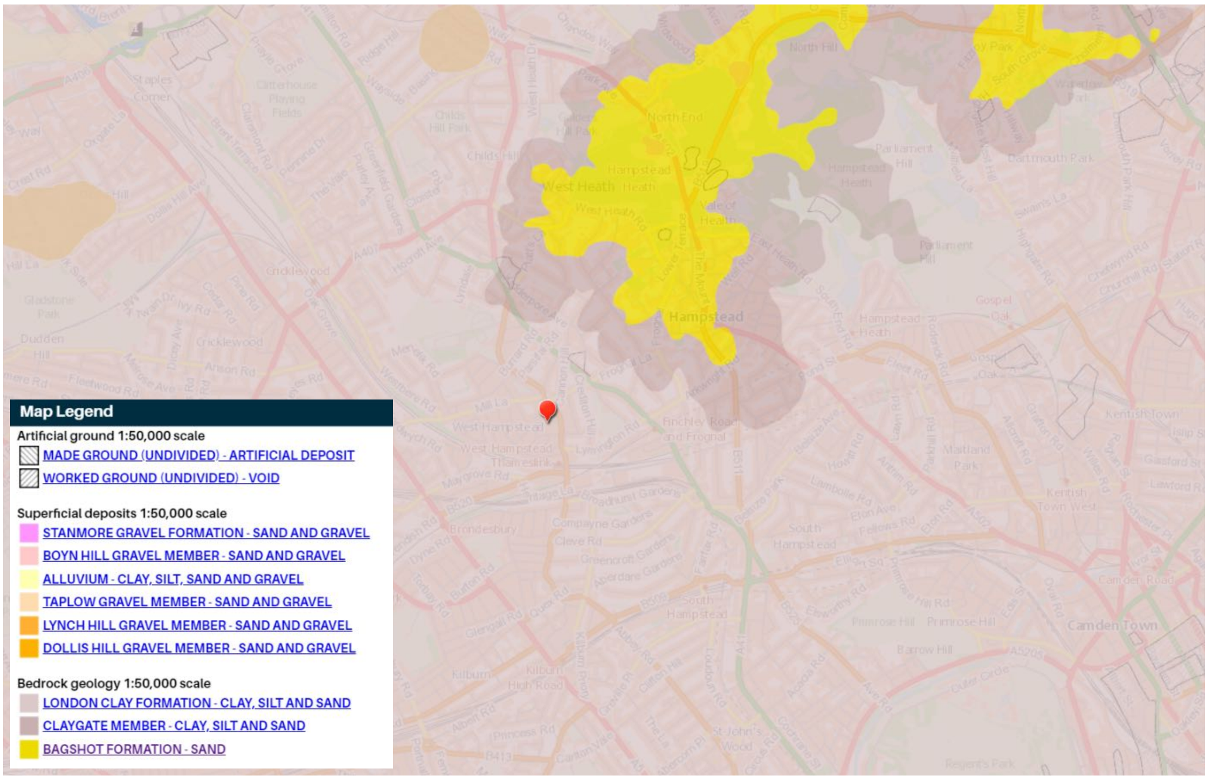


Figure 3: Geological Map of the Site Area (BGS Geo-Index)

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.

Perched groundwater would typically be expected in any Made Ground, and possibly also in any Head Deposits which overlie the London Clay, in at least the winter and early spring seasons. Variations in groundwater levels and pressures will occur in response to seasonal climatic changes and with other man-induced influences.

LB Camden data (Appendix 3, Figure 12) indicates the site is not within a groundwater source protection zone.

3.4 Hydrology

Barton's map of the 'lost' rivers of London (Figure 4) indicates that a former tributary of the Westbourne is located approximately 120m east of the site. It is not considered to have an impact on the site or the adjacent properties as a result of constructing the proposed development.

There are no current surface water features within 250m of the site.

The site is not within the catchment of the Hampstead Heath Pond Chain. The nearest part of the catchment (Golders Hill Chain Catchment) is approximately 1.2km northeast of the site.

The site surface area immediately to the front of the existing house is currently 100% of hardstanding, and therefore infiltration to ground will be limited to cracks / gaps in hard surfacing and leakage from drains, with the remaining rainfall discharged to the local sewer network. In addition, the site surface area immediately to the rear of the house is currently 100% of hardstanding. The proposed basement beneath the house does not change the impermeable site area.

The site is within a Critical Drainage Area (Group 3_010) but not within a Local Flood Risk Zone.

Inglewood Road was subject to surface water flooding in the 2002 flood event.

The following risk of flooding is reported (detailed in Section 11 and Appendix 3) for the proposed development area:

- Very low risk (<1 in 1,000 annual probability) – rivers and seas.

- Low risk (between 0.1% and 1% annual probability) – surface water.

- Very low risk (<1 in 1,000 annual probability) – reservoirs.
- Negligible (no shallow aquifer) – groundwater.
- Negligible (no recorded instances within 100m) – sewer surcharging.

A Flood Risk Assessment (FRA) and Drainage Strategy is provided in Section 8.

The site is within the London Management Catchment draining to the Tidal River Thames, which is protected by The Water Framework Directive, an EU-led framework for the protection of inland surface waters, estuaries, coastal waters and groundwater through river basin-level management planning.

3.5 Utilities and Underground Infrastructure

As indicated in the search results presented in Appendix 3, there are no reported tunnels or utility infrastructure beneath the site. The standard utilities are present within Inglewood Road and the adjacent residential properties (e.g. mains water, foul and surface water sewers, gas, electricity, telecoms etc). Future development should carefully consider the route of existing utility connections across the site.

3.6 Geotechnical Risk / Unexploded Ordnance Risk

Very low or negligible risks relating to ground dissolution of the soluble rocks, landslides, collapsible deposits, compressible deposits and running sands have been identified from the Desk Study references.

Shrink / swell or subsidence movements to buildings placed on shallow foundations within cohesive deposits (ie London Clay) may occur. Shrink / swell risk to the proposed basement development is considered to be very low due to the depth of the proposed foundations. The site walkover did not indicate any signs of distress to the property which could be linked with existing shrink / swell movements.

The London County Council Bomb Damage Map for this area (London Topographical Society, 2005) shows that bombs landed 50m southeast and 75m east of the site, affecting properties at the eastern end of Inglewood Road and on Dennington Park Road. These properties are recorded as having been "Seriously damaged, but repairable at cost" and the properties on the corner of West End Lane and Dennington Park Road were recorded as "Damaged beyond repair".

It is recommended that a detailed risk assessment and / or appropriate UXO risk mitigation is undertaken prior to intrusive works (e.g. site investigation and subsequent basement construction).

3.7 Environmental Database Search

A complete search of environmental registers is presented in Appendix 3. A summary of information is presented in Table 2.

Within 250m from the site, historical potentially contaminative land uses relate to the historical Foundry, Omnibus Depot, Garage, Works, railways sidings and electrical substation.

Environmental Search	On-Site	Within 50m	Within 250m
Potentially Contaminative Land Uses – historical industrial sites including tanks, energy features, fuel sites, garages, infilled land	0	6	43
Environmental Permits, Incidents and Registers – including discharge consents, radioactive substance authorisations, hazardous substance consents and enforcements, site determined as contaminated land	0	0	6
Landfill and Waste Sites	0	0	1
Current Land Uses – including industrial sites, fuel sites, underground electrical cables, gas transmission pipelines	0	0	0
Designated Environmentally Sensitive Sites - the site is located within a SSSI Impact Risk Zone	1	0	0
Mining, Quarrying – Relating to an historical pond 43m northeast and historical gravel pits from 83m north	0	1	2

Table 2: Environmental Database Search Summary

3.8 Environmental Sensitivity

Overall, the site setting is considered to be of **low** environmental sensitivity, for the following reasons:

- The site is located in an urban, predominantly residential area;
- The final end use of the site will be residential;
- The site is underlain by Unproductive Strata;
- There are no known surface water features in proximity to the site boundary.

3.9 Preliminary Conceptual Site Model

The information presented within chapters 2 and 3 of this report has been used to complete a Preliminary Conceptual Site Model (PCSM) that details the potential contaminant sources, pathways and receptors, with regard to:

- Environment Agency/DEFRA; Priority Contaminants for the Assessment of Land (CLR8).

Whilst it is noted that this document has been withdrawn it is still considered pertinent to identifying potential sources of contamination. The PCSM is presented in Table 3.

Potential for off-site sources of contamination (e.g. Made Ground associated with historic development) within soils and groundwater have been identified but with low potential for contaminated groundwater / ground gas / volatile vapours to migrate onto site that could impact future site users, construction and maintenance workers and buildings.

Potential for on-site sources of contamination (e.g. Made Ground associated with historic development) within soils have been identified but with low potential to impact future site users, as the proposed basement will result in the majority of shallow soils being excavated and removed from site, and the permanent concrete basement structure will sever any pathways to receptors. Construction workers should be vigilant for the presence of contamination during development and follow best practice if encountered to mitigate any on-going risks and liabilities, as applicable.

Potential Contaminant Sources	On-site	• Made Ground associated with historic development. • Potential WW2 unexploded ordnance.
	Off-site	• Made Ground associated with historic development. • Potential WW2 unexploded ordnance.
Associated Contaminant	On-site	• Heavy metals and inorganic contaminants including Asbestos Containing Materials (ACM). • Organic contaminants including hydrocarbons (e.g. diesel, petroleum and PAHs). • Possible generation of bulk ground gases & volatile vapours.
	Off-site	• Heavy metals and inorganic contaminants including Asbestos Containing Materials (ACM). • Organic contaminants including hydrocarbons (e.g. diesel, petroleum and PAHs). • Possible generation of bulk ground gases & volatile vapours.
Receptors		• Future site users. • Construction workers. • Buildings.
Pathways to Receptors		• Site underlain by low permeability London Clay. Migration via groundwater or migration of ground gasses is unlikely.

Table 3: Preliminary Conceptual Site Model

3.10 Preliminary Risk Assessment (PRA)

The Preliminary Risk Assessment (PRA) considers the information provided in the previous sections, including the PCSM. The PRA and risk ratings assigned in Table 4 are based on the qualitative risk assessment matrices presented in CIRIA C552 which are reproduced in Appendix 7.

The likelihood of pollutant linkages being present between the potential contaminant sources, pathways and receptors identified in the PCSM are outlined in Table 4.

Based on the results of the PRA:

- The site is considered to be of **low** environmental sensitivity.
- The potential **low** risks identified are associated with bulk ground gases and volatile vapours from historic infill materials on site.
- The potential for the site to be designated as contaminated land (as defined in Part 2A of the Environmental Protection Act) is considered to be **low**. However, this is on the

assumption that any planning conditions related to potential land contamination issues are dealt with to the satisfaction of the Local Authority as part of the development.

Pathway Linkage	Likelihood of Pollutant Linkage	Consequences	Risk Rating	Reasoning
Future Site Users (Direct exposure pathway)				
Ingestion / Dermal Contact / Inhalation (Site Users)	Unlikely	Medium	Low	There will be hardstanding across the proposed development areas; Made Ground will be excavated and removed from site beneath the proposed basement area and as part of site enabling works, as required (e.g. from installation of drainage scheme etc); clean cover may be introduced to landscaped areas, if required. Maintenance and construction workers will adopt appropriate management procedures to mitigate potential risks. Workers will wear proper PPE which will avoid contact and inhalation of any contaminant.
Ingestion / Dermal Contact / Inhalation (Maintenance and Construction Workers)	Low	Medium	Low	
Future Site Users (Indirect exposure pathway)				
Enclosed space accumulation of ground gas.	Unlikely	Severe	Moderate / Low	Migration of any ground gas should be precluded by low permeability London Clay and RC basement floor slab and structure.
Outdoor volatile vapour exposure	N/A	N/A	N/A	N/A
Ingress into potable water supply pipes	Low	Mild	Very Low	It is considered unlikely that upgraded water pipe material will be required. However, confirmation with the statutory undertaker is recommended.
Risks to Buildings via accumulation of ground gas and volatile vapours in enclosed spaces and sub-floor voids.	Unlikely	Severe	Moderate	Migration of any ground gas should be precluded by low permeability London Clay, RC basement floor slab and structure.

Pathway Linkage	Likelihood of Pollutant Linkage	Consequences	Risk Rating	Reasoning
Water Environment				
Contaminant migration on to neighbouring land	Unlikely	Mild	Very Low	It is considered unlikely that sources of contamination are present beneath the site at concentrations that are likely to impact neighbouring land. The site is underlain by London Clay, a very low permeability soil that should prevent migration of contaminants.
Contaminant migration from neighbouring land	Unlikely	Medium	Low	
Contamination of groundwater	Unlikely	Mild	Very Low	It is considered unlikely that sources of contamination are present beneath the site at concentrations that are likely to impact groundwater. The site is underlain by London Clay, a very low permeability soil that should prevent migration of contaminants.
Contamination of surface water	Unlikely	Mild	Very Low	It is possible that during any construction phase there could be some limited run-off from stockpiles / earthworks. However, it is considered unlikely that such run-off would be contaminated, and control measures would be adopted. There are no immediate surface water features in the vicinity of the site.
Overall Risk Rating			**Low**	

Table 4: Potential Pollutant Linkages

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. See 3.3 and Appendix 3.
1b. Will the proposed basement extend beneath the water table surface?	No	A continuous groundwater body is not considered to be present beneath the site. However, perched water is likely to be present within any Made Ground overlying the London Clay. See 3.3, 3.4 and Appendix 3.
2. Is the site within 100m of a watercourse, well (used / disused) or potential spring line?	No	There are no current watercourses, wells or spring lines within 100m. See 3.4 and Appendix 3.
3. Is the site within the catchment of the pond chains on Hampstead Heath?	No	Catchment of the pond chains are >1.2km to the northeast. See 3.4.
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	No	The proposed basement beneath the house will not result in a change to impermeable site area.
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	There is no increase in impermeable site area. However, attenuated drainage will be implemented to offer betterment. See Section 11.
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	No local ponds within the surrounding area to the site. See Appendix 3.

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	The site is level, as indicated by survey. See Appendix 2.
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	See 2.2 and Appendix 2.
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7° (approximately 1 in 8)?	No	Maximum overall slope angle in the vicinity of the property is 1° to 3°.
4. Is the site within a wider hillside setting in which the general slope is greater than 7° (approximately1 in 8)?	No	Maximum overall slope angle in the vicinity of the property is 1° to 3°.
5. Is the London Clay the shallowest strata at the site?	Yes	The London Clay Formation is the shallowest natural strata. Made Ground and Head Deposits are anticipated above the London Clay. See 3.1, 3.2 and Appendix 3.
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	No trees will be impacted by the proposed works.
7. Is there a history of seasonal shrink-swell subsidence in the local area and/or evidence of such effects at the site?	No	Whilst the London Clay has the potential to shrink / swell, site observations do not indicate any evidence of this on site.
8. Is the site within 100m of a watercourse or a potential spring line?	No	There are no current watercourses, wells or spring lines within 100m. See 3.4 and Appendix 3.
9. Is the site within an area of previously worked ground?	No	See 3.1 and Appendix 3.
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 site is located on the London Clay Formation, designated Unproductive Strata. See 3.3, 3.4 and Appendix 3.
11. Is the site within 5m of a highway or pedestrian right of way?	Yes	The proposed basement is <5.0m from the pedestrian right of way.
12. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Yes	Whilst the adjacent No.27 has a basement, the adjacent No.31 does not have a basement.

13. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	No	No tunnels within 250m. No utilities within the site boundary apart from domestic connections to the property. See Appendix 3.

4.3 Surface Water and Flooding

Question	Response	Details
1. Is the site within the catchment of the pond chains on Hampstead Heath?	No	See 3.4 and Appendix 3.
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	Proposed SuDS will provide betterment (attenuated discharge). See Section 11.
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?	No	See 2.2 and Appendix 2.
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	Proposed SuDS will provide betterment (attenuated discharge). See Section 11.
5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	No	There will be no changes to the quality of the surface water discharged.
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.	Yes	Inglewood Road was subject to surface water flooding in the 2002 flood event. The site is not located within a Local Flood Risk Zone.

4.4 Non-Technical Summary of Screening Process

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

- Is the London Clay the shallowest strata at the site?
- Is the site within 5m of a highway or pedestrian right of way?
- Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?

- 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?

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, although this is unlikely considering the depth of the proposed basement.

A site investigation is required with appropriate geotechnical assessment to ensure a suitable foundation design, as presented in Sections 6 and 7.

Differential Depth of Foundations

Party Walls are shared with No. 27 and No. 31 Inglewood Road. No. 27 has an existing basement, understood to be at approximately the same depth as the existing basement area to No.29. No. 31 does not have a basement. It is assumed No. 31 has conventional, shallow foundations and that the basement construction will result in a differential depth of foundations between the properties.

A ground movement assessment is required to assess potential impacts, as presented in Section 12.

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, as presented in Section 6.

5.3 Hydrology / Surface Water Flow

The proposed basement beneath the house will not result in any change in impermeable site area. Whilst mitigation measures are not required, in accordance with best practice, considering the site location within a Critical Drainage Area, an attenuated drainage strategy is presented in Section 11.

As the site is within a road that is recorded as having historically flooded, a Flood Risk Assessment is required, as presented in Section 11.

6.0 Site Investigation

6.1 Introduction

A ground investigation was undertaken in September 2023, comprising 1no borehole (WS1) to 6.45m below ground level (bgl) and 4no hand excavated trial pits (TP1 to 4) to a maximum depth of 1.05m bgl. The trial pits were undertaken to observe the existing structure's foundation arrangements.

Prior to undertaking the works, utility service locations were checked and identified by a specialist engineering surveyor by visual inspection with reference to available service plans, by manual lifting and inspection of utility manhole covers and with appropriate radio detection equipment.

All works were supervised by a Specialist UXO Engineer, and a magnetometer survey was undertaken. The presence of potential UXO was not detected.

The borehole was constructed at 100mm diameter. Insitu testing comprising Standard Penetration Tests (SPTs) were undertaken at 1.00m intervals.

Disturbed samples were generally taken at 0.50m intervals and changes in strata to the base of each exploratory hole. A selection of these were tested in the laboratory for: moisture contents and Atterberg Limits, to assess plasticity; and, pH and sulphate testing to assess a suitable design concrete class for foundations.

Additionally, environmental sampling to determine the presence of contamination of soils and Waste Acceptance Criteria (WAC) testing were undertaken within any Made Ground and at the interface with underlying natural deposits.

A groundwater and ground gas monitoring standpipe was installed within the borehole WS1 to a depth of 6.34m bgl. Details of the installation are provided within the exploratory hole logs. Monitoring was undertaken on 3no occasions in September and October 2023.

The exploratory hole location plan is presented in Appendix 1. Exploratory hole logs, laboratory testing and monitoring data are presented in Appendix 4.

6.2 Ground Conditions

The ground conditions encountered were generally as anticipated from the Desk Study. A summary of the encountered ground conditions is presented in Table 5. Interpreted geotechnical parameters are presented in Section 7.

Exp. Hole No.	Top mbgl	Thickness m	Top mbgl	Thickness m	Final Depth mbgl
	Made Ground		London Clay		
WS1	0.00	1.60	1.60	>4.85	6.45
TP1	0.00	1.05	-	-	1.05
TP2	0.00	0.60	-	-	0.60
TP3	0.00	0.60	-	-	0.60
TP4	0.00	0.90	-	-	0.90

Table 5: Summary of Ground Conditions Encountered

Made Ground

A layer of Made Ground was encountered within all the exploratory holes. In WS1 1.00m of Made Ground was encountered, with London Clay underlying. Within the trial pits, natural soils were not encountered to a maximum depth of 1.05m.

The Made Ground typically comprises sandy gravelly clay with fragments of brick, concrete, clinker and tile. Within WS1, the soft clay immediately underlying the Made Ground could be re-worked / backfilled soils rather than insitu London Clay, to approximately 1.60m bgl.

London Clay Formation

The London Clay was encountered from the base of the Made Ground in WS1, proven to >6.45m bgl which was the maximum depth of the borehole.

The London Clay is characterised as a firm to stiff brown becoming mottled grey clay, locally slightly sandy clay and / or with some sand partings noted.

Laboratory testing indicates the deposits to be of high to very high plasticity.

SPT N values indicate medium to high strength / firm to stiff clays, with values ranging from 12 to 27 between 2.00m and 6.00m bgl, with stiffness increasing with depth. The SPT at 1.00m bgl indicated an N value of 5, possibly indicating re-worked rather than insitu soil.

SPT N values and PI may be used to derive approximate values of mass shear strength (c) using a conversion factor (f_1) as follows:

$$c = f_1 \times N \text{ (kN/m}^2\text{)}$$

The recorded unmodified Plasticity Index values for the natural cohesive soils range between approximately 40 to 49% indicating that an f_1 value of approximately 5 would be appropriate. On this basis the SPT N values may be used to derive indicative shear strength of approximately 60 to 135 kN/m^2 between 2.00m and 6.00m bgl.

6.3 Groundwater

Groundwater was not encountered in WS1, nor during subsequent monitoring events in September and October 2023.

Groundwater was encountered within the trial pit excavations TP2 and TP3, excavated from existing basement level, likely to reflect locally perched groundwater within the Made Ground overlying the London Clay due to surface water infiltration and / or leaking drainage.

The London Clay is of very low permeability and is not capable of supporting significant groundwater flows, although localised seepages may occur through more permeable sand / silt partings or travel along claystone bands. Perched water is also common within Made Ground where it overlies lower permeability strata (e.g. Head Deposits / London Clay).

The natural soils and monitoring data is not compatible with supporting a continuous groundwater body. Notwithstanding this, the proposed basement must make allowance for appropriate structural waterproofing and local, temporary sump pumping during construction.

6.4 Existing Building Foundations

Trial Pits were hand excavated to identify the existing building's foundation details (Table 6).

Exploratory Hole / Date	Foundation Depth / Notes
TP1	Masonry wall, corbelled brick footings over concrete strip at 1.05m bgl
TP2	Masonry wall, corbelled brick footings over concrete strip at approximately 0.60m below basement level (obscured by water seepage)
TP3	Masonry wall, corbelled brick footings over concrete strip at approximately 0.52m below basement level
TP4	Masonry wall over concrete strip at 0.85m bgl
TP5	No access for excavation

Table 6: Existing Foundation Depths

The proposed formation level for the basement is approximately 3.50m bgl, therefore underpinning excavations in the order of <1.00m (e.g. under the Party Wall with No.27, as indicated by TP2 and TP3) to approximately 2.50m will be required.

7.0 Preliminary Geotechnical Assessment

7.1 Geotechnical Parameters

A ground model based on the in-situ and laboratory testing is provided in Table 7. Values indicated are characteristic soil parameters. A reasonably conservative ground profile has been adopted for preliminary assessment purposes.

Stratum	**From**	**To**	**Thick**	**γ**	**C_u**	**c'**	**Ø'**	**E'_v**	**$E_{u,v}$**
	(mbgl)	**(mbgl)**	**(m)**	**(kN/m³)**	**(kPa)**	**(kPa)**	**(°)**	**(MPa)**	**(MPa)**
Made Ground	0.0	1.00	1.00	18	-	-	28	-	-
Possible Made Ground / Reworked	1.00	1.60	0.60	18	-	-	23	-	-
London Clay	1.60	>6.45	>4.85	19	60+15z	0	23	$0.8E_{u,v}$	$400C_u$

z = increase in Cu per m depth from 2.00m bgl

Table 7: Geotechnical Parameters

7.2 Underpinned Retaining Wall, Strip Foundations

A preliminary assessment of bearing capacity has been undertaken by a number of methods to provide a sensitivity check, in accordance with:

- BS 8004-1986. A factor of safety of 2.5 has been considered.
- BS-EN-1997-1 (Eurocode 7) and National Annex to BS-EN-1997-1 for combinations 1 and 2 of Design Approach 1.

The thickened edges of the underpinned retaining walls will act as strip foundations, to be formed at approximately 3.50m bgl for the basement. The allowable bearing capacity of the London Clay at formation (i.e. >3.00m bgl) is assessed to be 150 kPa.

However, in order to control ground movements foundations should be sized appropriately to limit bearing pressure to 100kPa. This will ensure impacts to neighbouring properties are within the predicted limits (as further discussed in Section 12).

7.3 Design Concrete Class

Five soil samples were analysed to determine the design concrete class in accordance with BRE Special Digest 1:2005 (Table C2). Samples were tested from within the Made Ground and London Clay. The laboratory results are presented in Appendix 4. The preliminary Design Sulphate Class is DS-3, the preliminary ACEC class is AC-3 and the DC class is DC-3. The soil results are summarised in Table 8.

Parameter	**Observed Range**	**Number of Tests**	**Characteristic Value**
Water Soluble Sulphate (mg/l)	90 to 3,570	5	3,570
pH	7.6 to 10	5	7.6

Table 8: Laboratory Test Results (Soils)

8.0 Generic Quantitative Risk Assessment

8.1 Assessment of Soil Analytical Results

Introduction

The development proposals comprise construction of a new single storey basement beneath the main footprint of the existing terraced house. On this basis, the most appropriate end use scenario for assessment is considered to be residential (with home grown produce).

This section provides a Generic Quantitative Risk Assessment (GQRA) that considers only the shallow soil horizon. No statistical analysis has been completed and recorded concentrations have been compared directly to 'Suitable 4 Use Levels' (S4ULs) considering a residential (without home grown produce) end use.

The LQM/CIEH 'Suitable 4 Use Levels' (S4ULs) applied have been developed in accordance with developments in UK human health risk assessment since 2009, in particular the additional land uses and exposure assumptions presented in Defra's C4SL guidance. The S4ULs are all based on Health Criteria that represent minimal or tolerable levels of risks to health as described in the Environment Agency's SR2 guidance, ensuring that the resulting assessment criteria are 'suitable for use' under planning.

In addition to the S4ULs the provisional Category 4 Screening Levels (pC4SL) developed by CL:AIRE for DEFRA in response to the new definitions within the Contaminated Land Statutory Guidance (ref. DEFRA, April 2012) have also been considered within the assessment. C4SL are, '*designed to reflect a more pragmatic approach to contaminated land risk assessment (albeit still strongly precautionary)*'.

It should be noted that C4SL have not yet been developed for a comprehensive range of contaminants and as such greater emphasis is placed on the S4ULs in determining potential risks to future site users.

8.2 Risk Assessment

Assessment of Potential Risks to Future Site Users (Soil Contamination)

In total seven samples of the shallow soils (between 0.40m to 2.30m bgl) were collected during the ground investigation. These comprised six samples of Made Ground and one sample of the natural soils (London Clay Formation).

The samples were analysed for a range determinands including, asbestos, heavy metals, petroleum hydrocarbons (including using the criteria working group methodology (TPH CWG) and Polycyclic Aromatic Hydrocarbons (PAH)).

Asbestos Containing Materials (ACM)

All seven samples were screened for the presence of Asbestos Containing Materials (ACM). No ACM were detected.

Discussion of Results (Soil Contamination)

Recorded concentrations of contaminants (e.g. heavy metals, petroleum hydrocarbons etc) were generally found to be below relevant criteria considering a residential end use. However, elevated concentrations of PAH species were recorded in one of the Made Ground soil samples analysed from TP4 (0.40 to 0.50m below existing basement in the fill surrounding existing foundations).

No elevated concentrations were recorded in the samples of natural soils analysed.

Reference to the proposed development plans suggests that over the whole of the development area there will be buildings which would sever any direct contact pathways to potentially contaminated soils. In addition, a large proportion of the soils will be removed during the basement excavation i.e. the proposed development will mitigate potential risks to future site users.

A section of the existing rear garden will be retained but the results of the chemical analysis suggest that shallow soils do not contain elevated concentration of contaminants and as such it is unlikely that the identified contaminants would pose a risk to future site users, considering also that the rear garden is covered by either hard standing (paving) or astroturf.

Maintenance and construction personnel involved in below ground works should be vigilant for potential risks (i.e. latent contamination not encountered during the investigation) and adopt appropriate management procedures.

The results are presented in Appendix 4.

Ground Gas Risk Assessment

A ground gas risk assessment based on three rounds of monitoring (September to October 2023) has been undertaken to assess potential risks associated with bulk ground gases (carbon dioxide and methane) and volatile vapours to future site users and buildings.

The assessment has been undertaken in accordance with the CIRIA Report C665, BS8485:2015, NHBC guidance and The VOCs Handbook, as appropriate.

Monitoring results are summarised in Table 9.

Exploratory Hole	Screened Lithology	Max CH_4 (% v/v)	Max CO_2 (% v/v)	O_2 (% v/v)	Max Flow Rate (l/hr)	Gas Screening Value
WS1	Made Ground & London Clay	0.0	4.6	16.60 – 17.1	-0.20	<0.7l/hr

Table 9: Ground Gas Monitoring Results Summary.

Flow rates of <0.10 l/hr were recorded during all rounds of monitoring but for the purposes of the risk assessment have been adjusted to 0.10 l/hr. Review of the monitoring data indicates that monitoring was completed during periods of moderate high atmospheric pressure (1,012 to 1,023mbar).

Based on the results of the ground gas monitoring the risks posed by bulk ground gases would be considered to be very low (CIRIA CS1). There is no requirement for additional ground gas protection measures.

Volatile Vapours

Recorded concentrations of volatile vapours were <0.10 to 1.5ppm in all rounds completed. On this basis the potential risks associated with volatile vapours in relation to new buildings and future site users are considered to be very low.

8.3 Conclusions

Generic Quantitative Risk Assessment (GQRA)

The results of the GQRA have indicated that soil contaminant concentrations are generally below relevant assessment criteria considering residential end use.

Elevated concentrations of PAH have been recorded in one sample of the Made Ground soils but the basement excavation will remove a large proportion of the Made Ground and the proposed reinforced concrete basement construction within the development will generally mitigate potential risk to future site users.

Based on the monitoring undertaken, a ground gas risk assessment has been completed and the potential risks from bulk ground gases on future site users and buildings is considered to be consistent with CS1 i.e. very low risk. In accordance with current best practice guidance no additional ground gas protection measures would be required.

8.4 Recommendations

Based on the proposed development and conclusions presented above, the following recommendations are provided:

- Should any suspected latent areas of contamination be identified during development then it is recommended that works in this area are postponed enabling consultation with an appropriately qualified environmental consultant.
- It is recommended that maintenance and construction workers involved in below ground works adopt safe management procedures including the use of appropriate PPE.

9.0 Preliminary Waste Characterisation

9.1 Introduction

The Landfill (England and Wales) Regulations (2002, as amended), the Hazardous Waste (England and Wales) Regulations (2005, as amended) and the Waste (England and Wales) Regulations (2011) have changed the way in which waste materials have traditionally been managed (i.e. landfill disposal). If materials are to be discarded from site, appropriate characterisation and classification are required prior to disposal, to determine whether a waste should be described as either non-hazardous or hazardous. The process of classification is based around the List of Wastes (England) Regulations in conjunction with the Environment Agency Guidance Document WM3 (edition 1 v.1.1.GB, 2021). Waste Acceptance Criteria (WAC) are often confused as a means of classification when, in actuality, they represent criteria that wastes must satisfy for disposal in target landfill types (i.e. non-hazardous waste may be described as inert if it satisfies the appropriate WAC; however, hazardous waste can never be classified as inert even if it satisfies the WAC for an inert landfill).

Certain categories of waste material are termed 'absolute entries' within the List of Wastes Regulations (2005) and are automatically classified as inert or hazardous e.g. glass packaging and acid tars respectively.

9.2 Source of Potential Wastes

The waste materials on site are considered to comprise the Made Ground soils that occupy the upper 1.00m to 1.50m bgl approximately and fill surrounding existing foundations. In general, this material could be thought of as 'Construction and Demolition Wastes (including Excavated Soil from Contaminated Sites)' and as such soils could be described as inert, non-hazardous or hazardous, dependant on its source and chemical characteristics.

The source of the Made Ground materials appear to comprise a mixture of reworked material considered to have been derived from historical, local construction and demolition.

9.3 Basic Waste Characterisation

Made Ground

On a purely visual basis, a proportion of the Made Ground would appear to conform with 'soils and stones' excluding topsoil, peat and excluding soil and stones from contaminated sites (European Waste Catalogue Code 17 05 04). However, organic and 'peaty' soils were recorded and where soil and stones are not automatically classified as inert they will always be treated as so called 'mirror entries' of the List of Waste Regulations (European Waste Catalogue Code 17 05 03 mirror hazardous or 17 05 03 mirror non-hazardous). An assessment of the composition of the soil is required to determine the concentrations of potentially dangerous substances that maybe present in the soils to allow the waste to be classified accordingly.

As such, chemical analysis has been completed on samples of Made Ground soils in general accordance with the Environment Agency document Disposal of Waste to Landfill (ref. https://www.gov.uk/guidance/dispose-of-waste-to-landfill, January 2020). The results have been used to aid in basic waste characterisation utilising the information presented within the WM3 document for Hazardous wastes.

In addition, six samples of Made Ground soils were tested for the presence of Asbestos Containing Materials with none detected.

Based on the available laboratory results Made Ground soils could conform with non-hazardous wastes. However, it is recommended that a preliminary waste characterisation is undertaken and confirmed by the receiving facility.

In addition, it is recommended that maintenance and construction workers involved in below ground works are provided with this information so that they can adopt appropriate management procedures to mitigate potential risks.

Natural Ground Deposits

The natural soils (London Clay Formation) are likely to be listed as inert (soils and stones, European Waste Catalogue Code 17 05 04). Again, this will need to be confirmed by the receiving facility.

Given the scarcity of inert landfill cells it may be more appropriate (depending on timescales and feasibility etc) to source an alternative use for the soils (such as fill materials or daily cover) or to dispose to non-hazardous landfill.

9.4 Waste Acceptance Criteria (WAC) Testing

It is recommended that the contractor undertakes WAC testing (and possibly additional chemical analysis) to confirm that Made Ground soils would meet the waste acceptance criteria for stable non-reactive hazardous waste in non-hazardous landfill.

10.0 Updated Conceptual Site Model & Pollutant Linkage Assessment

10.1 Introduction

The desk study (including Preliminary Risk Assessment) information summarised in Section 3.0 of this report has been updated based on the results of the ground investigation, laboratory testing and risk assessment herein and is presented in the following sections.

10.2 Conceptual Site Model (CSM)

Geological & Hydrogeological Model

The ground investigation data indicates that the ground conditions comprise Made Ground overlying the London Clay Formation.

Groundwater was not encountered in the borehole; water was encountered in two of the trial pits. The recorded water is considered to be representative of perched groundwater within Made Ground above the London Clay.

Following development, the site area will comprise no change in hard surfacing, and the rear garden area will be retained and thus there is anticipated to be no change in the proportion of rainfall infiltration and direct recharge of groundwater beneath the site.

Direct recharge of groundwater via rainfall infiltration will also be dependent on the Soil Moisture Deficit (SMD) and rates of Evapotranspiration (EP).

The major variation following development will be removal of the majority of the Made Ground soils beneath the house.

Implication for Migratory Pathways

Conceptually the removal of Made Ground will reduce the potential for leaching of contaminants from the Made Ground and remove any potential sources of ground gas.

10.3 Pollutant Linkage Assessment

Based on the results of the Generic Assessment of the analytical results, ground gas monitoring and the information presented in the Conceptual Site Model above the plausible pollutant linkages have been summarised in Table 10.

Pathway Linkage	**Present** / **Not Present**	**Yes** / **No**
Future Site Users (Direct exposure pathway)		
Ingestion/Dermal Contact/Inhalation (Site Users).		**No**
Ingestion/Dermal Contact/Inhalation (Maintenance and Construction Workers).		**Yes**
Elevated concentrations of PAH were recorded in one location but will be removed during development. As per best practice construction/maintenance workers should use of appropriate personal protective equipment.		
Future Site Users (Indirect exposure pathway)		
Enclosed space accumulation of ground gas.		**No**
Outdoor volatile vapour exposure		**No**
Elevated concentrations of ground gas have not been identified.		
Potable water supply pipes		**No**
The selection of any new potable water supply pipes should be confirmed with the statutory undertaker.		
Risks to Buildings via accumulation of ground gas and volatile vapours in enclosed spaces and sub-floor voids.		**No**
Elevated concentrations of ground gas have not been identified.		
Water Environment		
Contaminant migration on to neighbouring land		**No**
Any contaminant source will be removed to facilitate development during basement excavation.		
Contaminant migration from neighbouring land		**No**
Contamination of groundwater		**No**
Contamination of surface water		**No**
No surface water features have been identified within 250m of the site.		

Table 10: Plausible Pollutant Linkages

10.4 Source-Pathway-Receptor Model

Bulk Ground Gases

The results of the GQRA and the subsequent updated CSM indicate that there would not be a requirement for ground gas protection measures at the site.

11.0 Flood Risk Assessment and Drainage Strategy

11.1 Sources of Flooding

Fluvial (Rivers and Seas)

The Environment Agency's Flood Map for Planning (Figure 4) shows the site to be in flood zone 1. This is defined as '*land having a less than 1 in 1,000 annual probability of river or sea flooding*' and the property can therefore be considered to have a low probability of fluvial flooding.

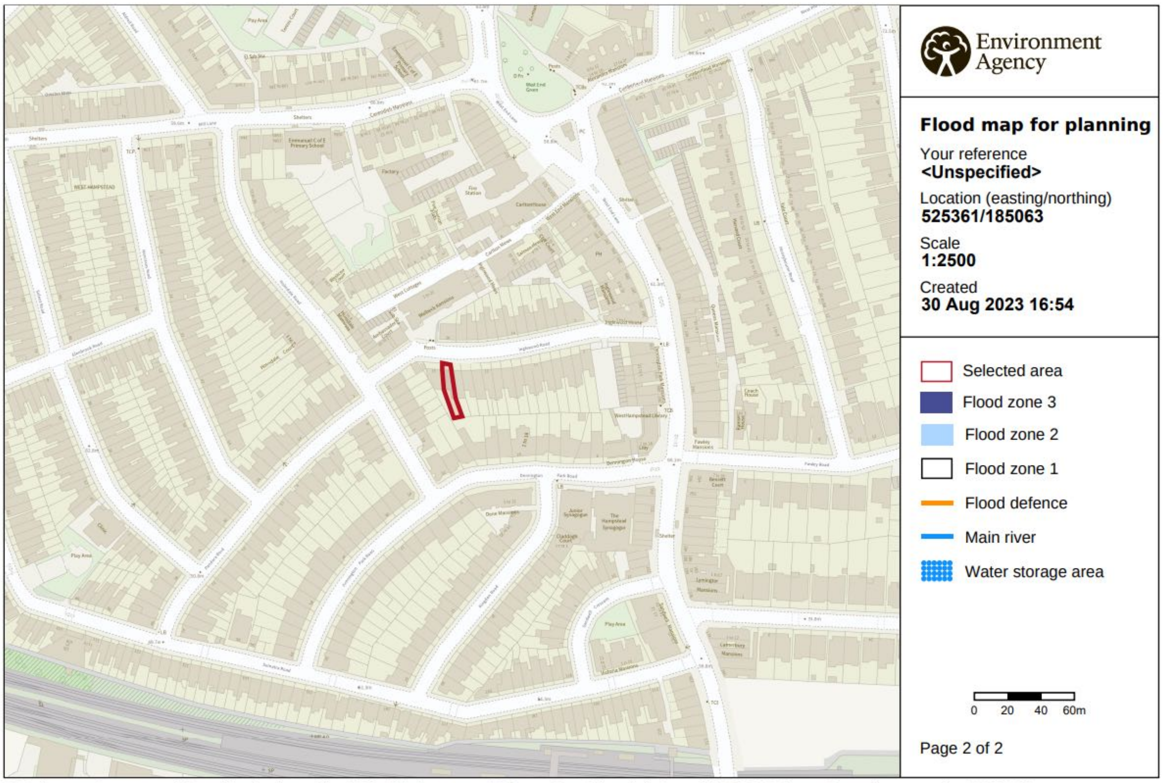
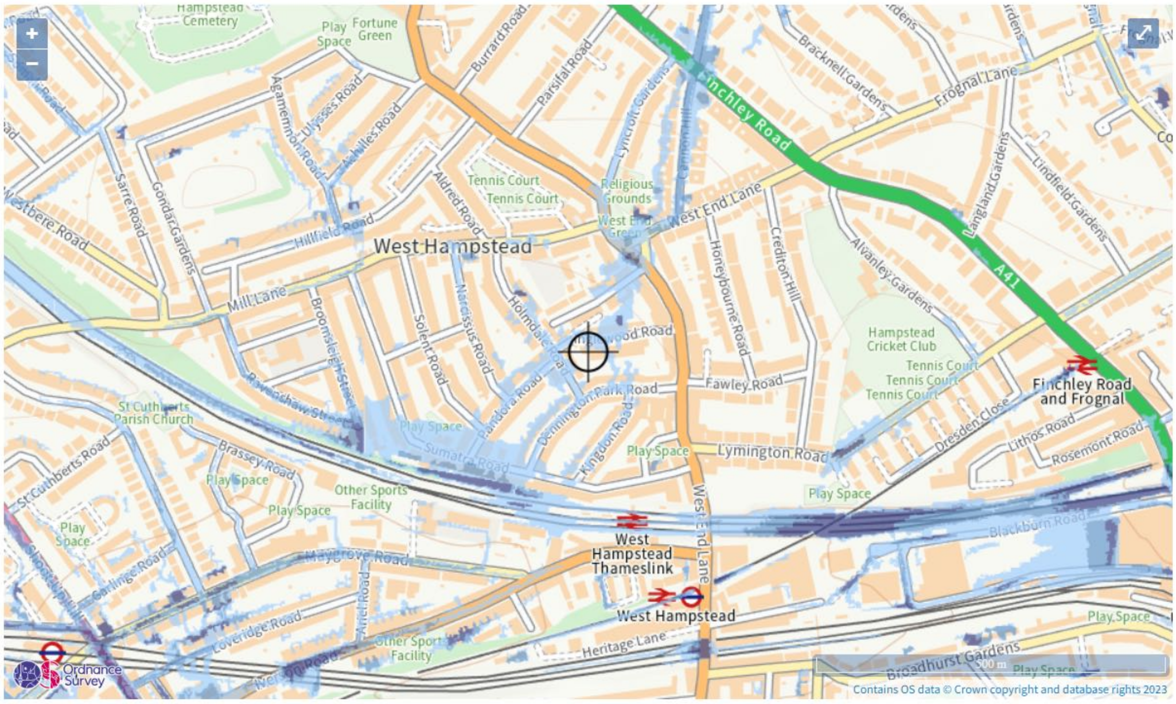


Figure 4: EA Flood Map for Planning[1]

[1] https://flood-map-for-planning.service.gov.uk/confirm-location?easting=525361&northing=185063

Pluvial (Surface Water)

The Long-Term Flood Risk Map for Surface Water (Figure 5) shows the subject property to be at low risk of flooding from surface water meaning that each year the land at the property has a chance of flooding of between 0.1% and 1%.



Extent of flooding from surface water

High Medium Low Very low Location you selected

Figure 5: Long-Term Flood Risk Map - Surface Water[2]

It is noted from Figure 5 that there is a low risk of surface water flooding in the vicinity of the subject property, which is shown as medium risk along Cannon Hill to the north-east. Potentially the areas shown to be susceptible to surface water flooding may reflect the historical route of a tributary to Westbourne River that flows through The Serpentine in Hyde Park, as shown on mapping in Nicholas Barton's 'The Lost Rivers of London'.

The surface water flood extents on Figure 5 are based on current day ground levels generally derived from LiDAR data that has been modified along the route of roads via a nominal 125mm lowering and across the footprint of buildings via 300mm raising of the terrain model. However, it is clear from Figure 5 that the terrace effect of properties along Inglewood Road is not represented in the flood extents.

Whilst the premise for limiting the building upstand to 0.3m is to allow for flood water passing through rather than around buildings, it is also possible that the owners of the properties most at risk (approximately Nos. 10/12 Inglewood Road) could implement measures to protect their building, in which case flood water would deflect around the properties. As shown below on Figure 6, the depth of water to the rear of Nos. 10/12 Inglewood Road is 0.30m to 0.60m and so the 0.3m upstand would be overtopped in the model and would pass southwards onto Inglewood Road.

[2] https://check-long-term-flood-risk.service.gov.uk/map?easting=525361&northing=185063&map=SurfaceWater

To determine the effect of the terrace of buildings presenting a more comprehensive barrier capable of deflecting a greater depth of water, a terrain model using current LiDAR data modified to raise levels within building footprints by 1m has been prepared and a deluge of 50mm depth rainfall applied so that the resulting routing and accumulation of flood water can be reviewed as shown below (Figure 7).

Figure 6: Surface Water Flood Depth (metres) – 1 in 1,000 year scenario

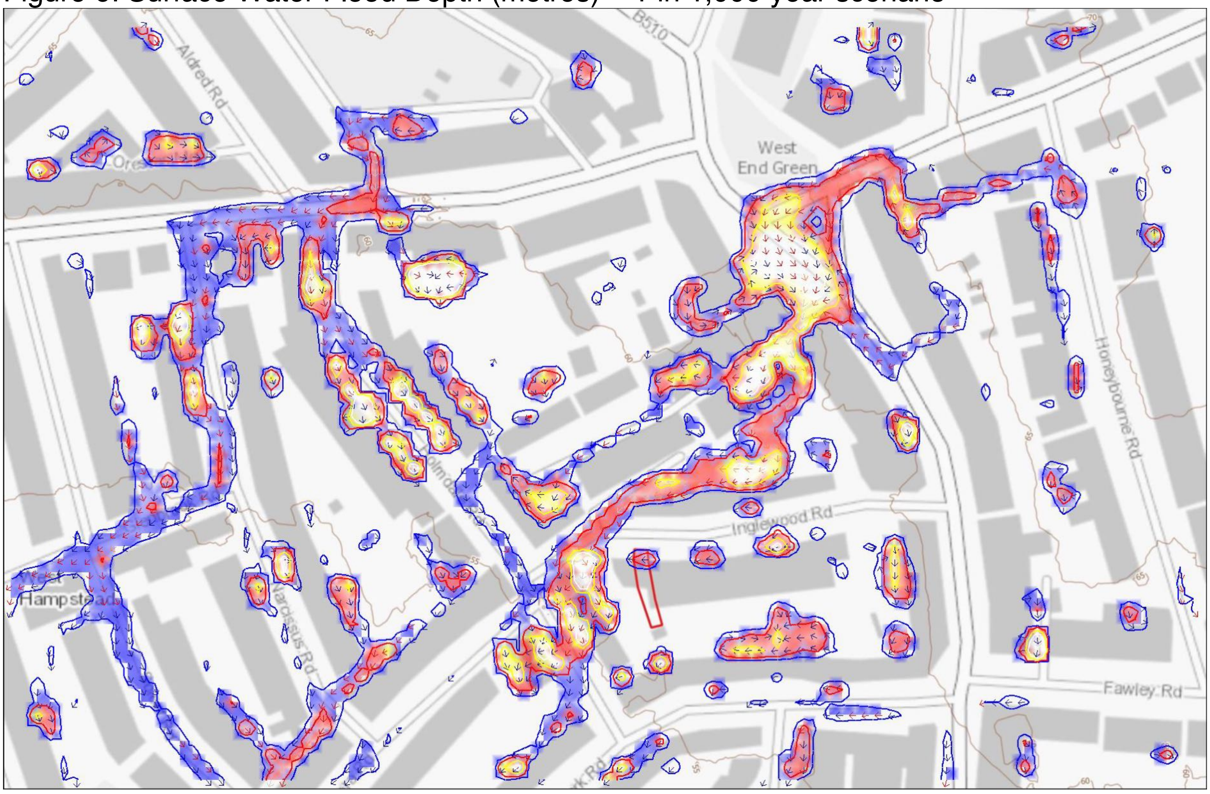


Figure 7: Surface Water Deluge – routing and accumulation of 50mm depth rainfall

The route of overland flow shown on Figure 7 is similar to that shown on Figure 6, but with a more defined pathway around the rear of the terrace of properties to the north of Inglewood Road as expected. In conclusion, it is considered that there is a low risk of surface water flooding to the subject property. The localised accumulation of water at the north of the property would occur at the external stair access to the basement level.

The London Borough of Camden's Strategic Flood Risk Assessment (SFRA) advises that historically there have been significant flood events in 1975 and 2002 and mapping shows areas that were affected. The SFRA notes that '*where streets are shown to have experienced flooding during the 1975 and 2002 flood events, this mapping is relatively coarse in scale and does not allow a distinction between, for example, an entire street flooding, or an isolated section of road flooding as a result of a blocked gully*'.

Figure 3.iv in Appendix B of the SFRA shows that Inglewood Road and all the connecting roads (Holmdale Road, West End Lane, etc) were all affected by the 2002 surface water flood event.

Reservoir

The Long-Term Flood Risk Map for Reservoir Flooding (Figure 8) does not show the subject property to be in the extent of flooding that could occur in the event of breach failure of a reservoir. This is considered to be the largest area that might be flooded if a reservoir were to fail and release the water it holds. Since this is a prediction of a credible worst-case scenario, it's unlikely that any actual flood would be this large.

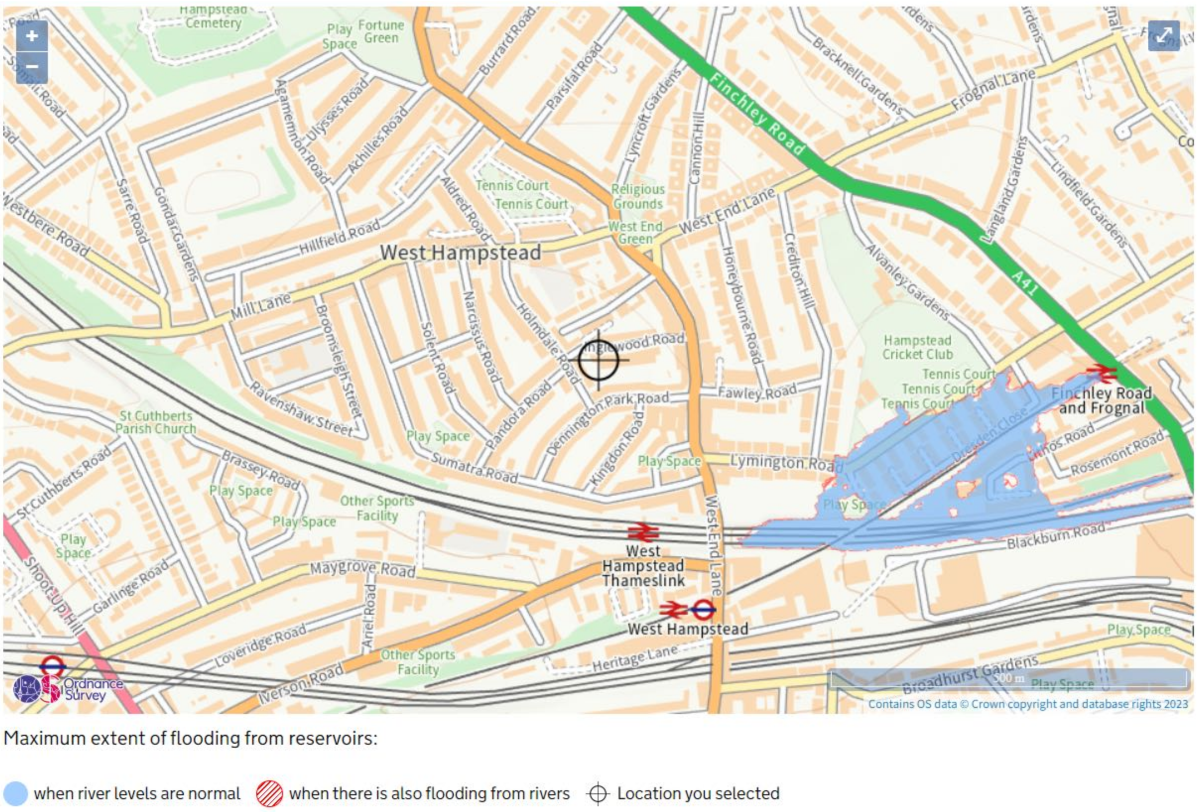


Figure 8: Long-Term Flood Risk Map - Reservoir[3]

[3] https://check-long-term-flood-risk.service.gov.uk/map?easting=525361&northing=185063&map=Reservoir

Groundwater
A desk top study has been undertaken to review online data sets.

British Geological Survey (BGS) maps do not record superficial deposits at or in the vicinity of the property location but do show bedrock geology to be London Clay Formation comprising Clay, Silt and Sand. The bedrock is designated[4] as '*unproductive*' and so similarly has an aquifer designation status relating to groundwater vulnerability[5] of '*unproductive*'.

The property is not located within a groundwater source protection zone.

Soilscape[6] mapping shows the property to be in an area with '*slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils*' with '*impeded drainage*' to '*stream network*'.

Due to the low permeability and unproductive nature of the underlying bedrock geology, it is considered that there is a negligible risk of ground water egress. The absence of mapped superficial deposits recorded in the area and the site investigation data suggest that near ground soils will therefore not contain groundwater other than in made ground where perched water may accumulate via infiltration of surface water sources. This has been confirmed by the site investigation.

Figure 4e in the Strategic Flood Risk Assessment (SFRA) for London Borough of Camden (LBC)[7] presents a map showing areas where there is an '*Increased Potential for Elevated Groundwater*'. The property is not located within such an area. The map also shows the locations of historic flooding from groundwater sources and Environment Agency groundwater flood incidents. The property is similarly not in proximity to these areas with the nearest being in the vicinity of Hillfield Road circa 0.47km to the northwest, whilst LBC have historic records of groundwater flooding to 7no properties along Lyncroft Gardens circa 0.35km northwards.

The route of a tributary to 'Westbourne', a lost river (Appendix 3, Figure 15) as shown in the 'Camden Geological, Hydrogeological and Hydrological Study, Guidance for Subterranean Development' (Arup, Nov 2010) follows a similar route to the area of groundwater flooding along Lyncroft Gardens.

There are no properties in the immediate vicinity that have been affected by groundwater flooding according to LBC records. The property is not within a Local Flood Risk Zone (LFRZ) (as shown on Figure 6 in appendix B of the SFRA). The area of Lyncroft Gardens to the north is shown as the 'Cannon Hill' Local Flood Risk Zone.

Sewer
There is a local sewer under Inglewood Road that will take runoff and effluent from the subject building and neighbouring properties.

Figure 9 is an extract from LBC (2003) Floods in Camden – Report of the Floods Scrutiny Panel. It shows the approximate route of the North-West Storm Relief Sewer in Camden.

---

[4] https://data.gov.uk/dataset/616469ae-3ff2-41f4-901f-6686feb1d5b6/aquifer-designation-dataset-for-england-and-wales

[5] https://data.gov.uk/dataset/42d7d021-538c-46e2-abbb-644e01c63551/groundwater-vulnerability-maps-2017-on-magic

[6] http://www.landis.org.uk/soilscapes/#

[7] LBC SFRA Report by URS, ref 47070547, Rev 2, dated July 2014

The Relief Sewer is located to the south east of the subject property, but in the event that its capacity is exceeded such as under a rainfall event similar to that in August 2002, subsequent overland routing of flood water would follow the prevailing terrain. As the trend of fall to ground levels is from north to south as per the direction of fall of sewer, it is considered that the subject property would be at low risk of flooding in the event of sewer exceedance.

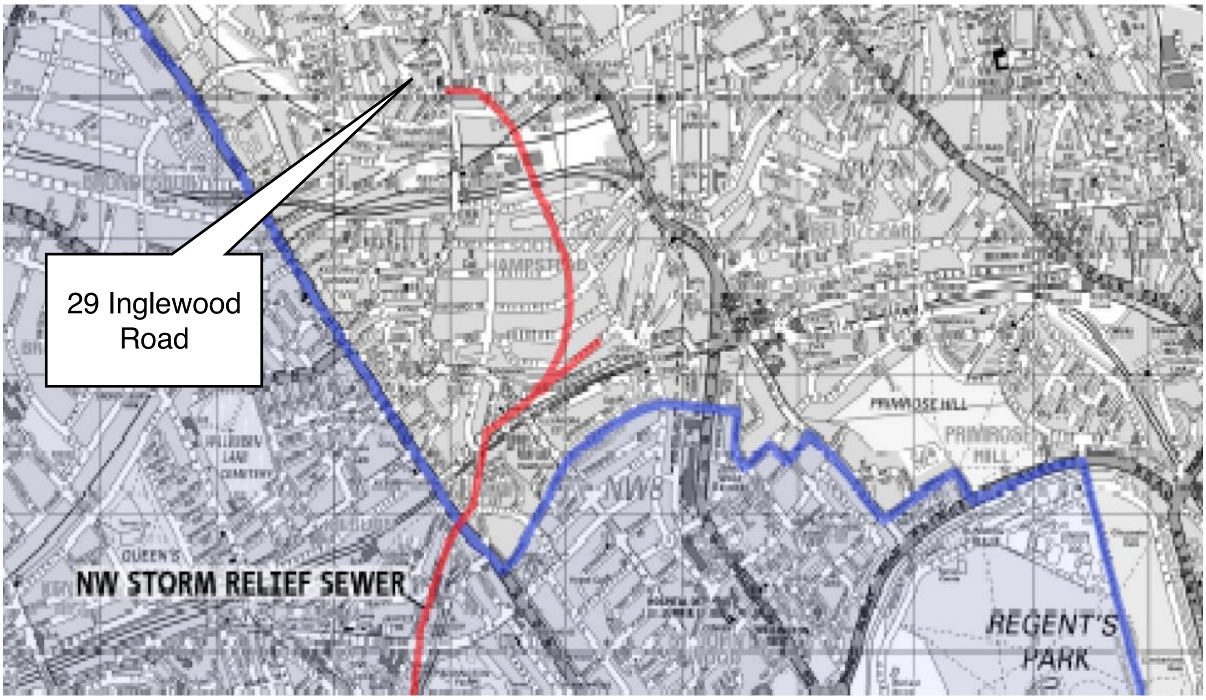


Figure 9: Map of North West Storm Relief Sewer in Camden

11.2 Risk of Flooding to and from the Development

From a review of the sources of flooding presented in the foregoing, it is considered that there is a low risk of flooding from all sources.

The predicted effects of climate change generally result in exacerbation of current day flooding due to increases in the rate and volume of flood water that can occur and the reduced frequency of flood events.

However, it is not considered that the effects of climate change will significantly alter the potential for flooding from the sources discussed other than locally in respect of surface water run-off management.

It follows that mitigation measures other than those inherent to standard building practice are not required, but a drainage strategy should be considered to account for the change in run-off areas that will result from the development proposals.

11.3 Drainage Strategy

Chapter 9 of The London Plan 2021 includes Policy SI 13 relating to Sustainable Drainage. It presents the following drainage hierarchy:

> *1) rainwater use as a resource (for example rainwater harvesting, blue roofs for irrigation).*
> *2) rainwater infiltration to ground at or close to source.*

3) rainwater attenuation in green infrastructure features for gradual release (for example green roofs, rain gardens).
4) rainwater discharge direct to a watercourse (unless not appropriate).
5) controlled rainwater discharge to a surface water sewer or drain.
6) controlled rainwater discharge to a combined sewer.

The SFRA provides guidance in relation to surface water management. Figure 4c of the SFRA presents a map showing the infiltration potential across the LBC based on BGS data. The property is in an area shaded to signify '*opportunities for bespoke infiltration SuDS*'.

However, given the low permeability soils at and in the vicinity of the property, disposal of surface water runoff to the ground would not be suitable. The increase in building footprint is small and roof area replaces paved area resulting in no change to runoff generated at the subject property for a given rainfall event.

Whilst the runoff area isn't increasing, the predicted effects of climate change over the lifetime of residential development is significant with up to 40% increase in rainfall intensity. As such the implementation of measures to manage rainfall at source within the property curtilage would be appropriate.

The development proposals do not appear to offer scope to provide green roof areas as there is a large, glazed roof light within the limited proposed flat roof area. The remaining pitch roof areas are to remain as existing. The existing and proposed basement level plans are overlaid with the topographical survey in Figure 10 and have been marked up to highlight the existing drainage chambers and surveyed (Appendix 5) and conjectured drain runs in green (due to limitations with the survey data due to camera access, for example).

The existing external stair access it to be retained at the front of the property and there is a gully located at the base of the existing rainwater pipe, to allow rain falling across this area to be drained. During the development works, as drainage infrastructure is cleaned / upgraded, a non-return valve should be added to the outgoing chamber.

The chamber in the rear yard area will become an internal chamber as a result of the proposals and so will require a double sealed cover in line with building regulations requirements. It is expected that this chamber will currently be relatively shallow in depth and that the pipe between existing chambers will therefore be quite steep. It will be necessary for a pipe to be laid crossing below the basement slab level at a flatter gradient and so increasing the pipe size may be required to maintain self-cleansing velocity of flow.

Figure 11 shows the existing and proposed roof layout plans to illustrate the change in roof area displacing paved area to the rear.

Whilst the main roof areas are unchanged by the proposals, runoff could be diverted into a rainwater harvesting system for re-use in the property, subject to technical and financial considerations. This method of source control would provide good interception of rainfall for regular events but cannot be relied on for management of extreme events where high intensity or prolonged rainfall occurs. Therefore, the need to implement another form of SuDS technique may be required to balance discharge from the property drainage system so that the status quo of existing flow is maintained or ideally reduced.

The roof area shaded in purple can feasibly be drained separately to the foul water drainage and so attenuation of flow could be accommodated to mitigate the effects of increases in rainfall intensity due to the predicted effects of climate change. Current guidance[8] for peak rainfall intensity increase allowances states that the drainage system should be designed for an upper end allowance so that there is no increase in flood risk elsewhere and the development will be safe from surface water flooding. Planning Practice Guidance[9] for the National Planning Policy Framework assigns a 100 year design life to residential development, which corresponds to development with a lifetime between 2061 and 2125 (2070s epoch). The property is situated in the London Management Catchment where the upper end allowance for the 2070s epoch is 35% and 40% for 1 in 30 year and 1 in 100 year events respectively.

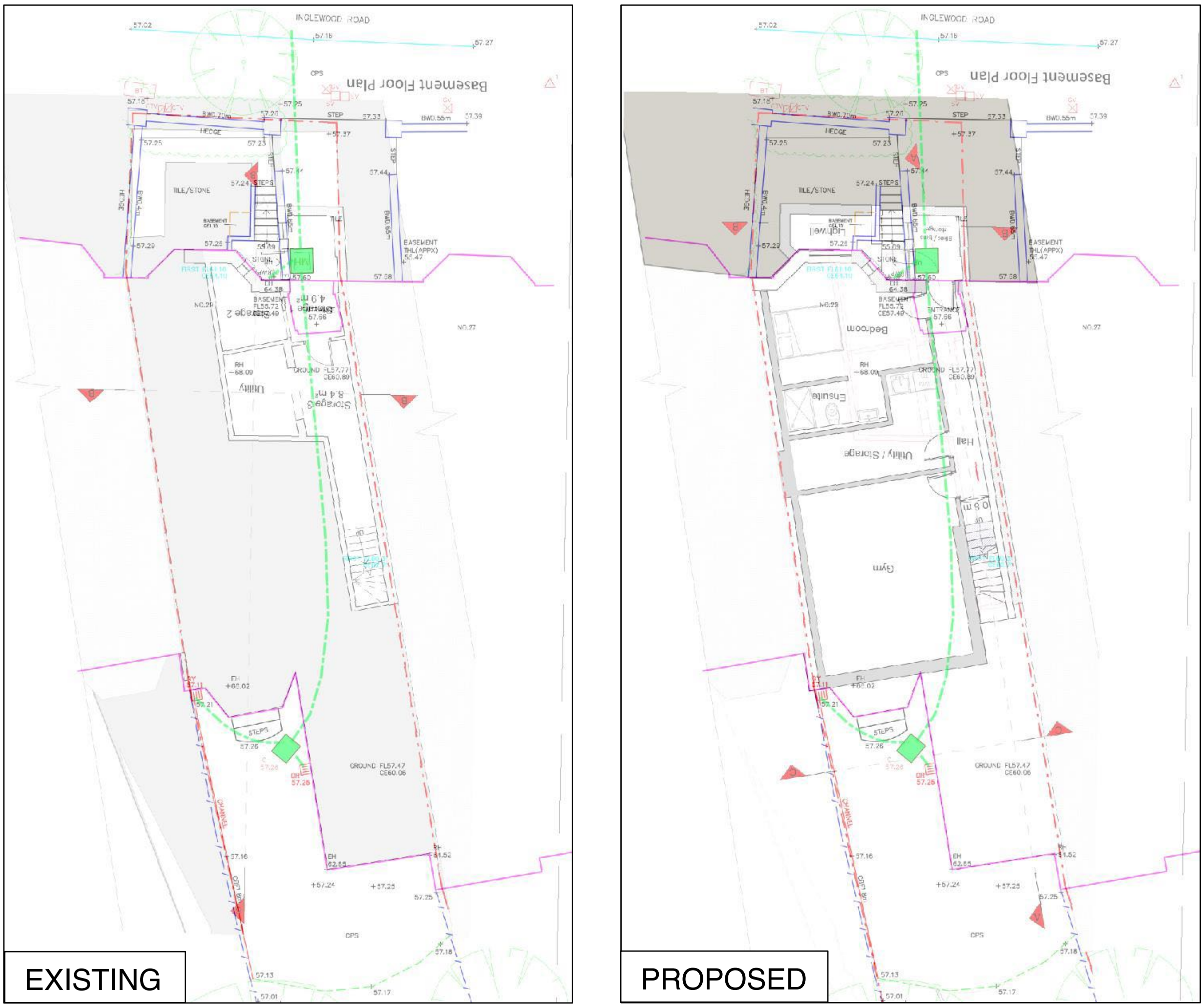


Figure 10: Drainage Arrangements

On the basis that the existing drainage is unrestricted, a pre-development discharge rate of approximately 1.2l/s would occur under a rainfall intensity of 50mm/hr for the areas (87sqm) highlighted above. Section 9.13.12 of The London plan 2021 advises that '*development proposals should aim to get as close to greenfield run-off rates as possible depending on site conditions*'. LBC Local Plan Policy CC3 also advises that development is required to '*utilise Sustainable Drainage Systems (SuDS) in line with the drainage hierarchy to achieve a greenfield run-off rate where feasible*'.

[8] https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#peak-rainfall-intensity-allowance

[9] https://www.gov.uk/guidance/flood-risk-and-coastal-change#what-is-lifetime-of-development

Figure 11: Roof Areas

A greenfield runoff rate of qbar = 11.3l/s/ha has been determined, which for the overall site area of approximately 0.019ha (190sqm) is equivalent to 0.21l/s. This is a very low rate that would not be practical to achieve due to the low size of flow control aperture that would be needed which would be inherently susceptible to blockage.

Therefore, the lowest practical flow rate should be used. For instance, 2 layers of 20no Permavoid (or similar) geo-cellular units forming a shallow tank (0.3m high and 10.1sqm plan area) could be sited below the rear paving area. A capacity of 2.87m^3 would be available (allowing standard 95% void capacity). A protected orifice in a preformed chamber (eg Turtle Enviro Oriflo model OFCC500) of 31mm diameter can limit flow to 1.2l/s under 0.35m head. The drainage calculations (Appendix 5) show that this arrangement would be adequate.

In principle, the above is a viable drainage strategy that demonstrates that the increase in flow from the property drainage due to the predicted effects of climate change over the lifetime of development can be mitigated via attenuation using a simple protected orifice and shallow geo-cellular units.

11.4 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 mitigate the effects of climate change that would otherwise increase flow due to the predicted increases in rainfall intensity over the next 100years.

12.0 Ground Movement Assessment

12.1 Introduction

The adjacent No.27 Inglewood Road has an existing basement. Deep foundations to both the subject building and neighbouring building will reduce both the magnitude of ground movements generated by the proposed basement and the impacts of those movements on nearby structures.

In order to undertake a conservative assessment, foundations to the other neighbouring buildings have been assumed to be shallow for the purposes of the BIA.

12.2 Assessment Methodologies

A ground movement assessment (GMA) has been completed utilising industry standard software (Oasys XDisp). Using the data from the analysis, an assessment has been made of the potential impact on neighbouring buildings in accordance with the Burland Scale. Calculations and GMA outputs are provided in Appendix 6.

12.3 Ground Movements Generated by Proposed Development

The following construction processes are likely to give rise to the majority of ground movements:

1. Installation of the underpins.
2. Excavation of the new basement.

Based on the guidance provided in CIRIA C760 for embedded retaining walls, ground movements resulting from installation of underpinned walls and excavation in front of the walls have been estimated. Whilst its noted that the guidance is intended for use with embedded walls, the methodology provides predicted ranges of movement that are consistent with movements generated during underpinning.

In order to be conservative, the depth of existing foundations has been ignored and the depth of underpinning and excavation has been taken from ground level. This approach should over-estimate movements compared to those generated by the actual works.

For movement due to the underpin installations, the magnitudes of the movements are dependent on the total retaining wall depth. Maximum vertical movements occur at the wall itself. C760 indicates movements will be 0.05% of the wall depth, with negligible vertical movement at one and a half times the wall depth from the wall. On this basis, maximum vertical movements due to wall installation of <2mm are predicted with vertical movements extending to a maximum of <6m from the wall.

Anticipated maximum horizontal movements due to wall installation are 0.05% of the wall depth, with negligible horizontal movement one and a half times the wall depth from the wall. Maximum horizontal movements are therefore predicted to be <2mm with horizontal movements extending to a maximum of <6m from the wall.

For movements due to excavation in front of the retaining wall, 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, with negligible movement three and a half times excavation depth from the wall. Maximum vertical movements due to excavation of <4mm are predicted, extending <13m from the wall.

Anticipated maximum horizontal movement due to excavation are 0.15% of the excavation depth, with negligible horizontal movements four times the excavation depth from the wall. Maximum horizontal movements are predicted to be <6mm, extending 14m from the wall.

A summary of ground movement predictions obtained using Oasys XDisp are reported in Appendix 6, presented as contour plots. The calculations take account of the combined vertical and horizontal movements from both installation and excavation. The predicted ground movements are at ground level.

12.4 Adjacent Structures, Highway and Utility Assets

Three buildings are identified as being within the potential zone of influence from the proposed basement construction works:

- 25 Inglewood Road
- 27 Inglewood Road
- 31 Inglewood Road

The potential damage impacts to the buildings within the zone of influence have been assessed.

The footway (with underlying utilities) is located 3.00m from the proposed basement at the closest point; the highway with underlying utilities is located 5.00m from the proposed basement at its closest point.

Although not integral to the purpose of this assessment, it should be noted that during the construction works the adjacent structures will be monitored for movements as required by Party Wall Agreements and any highway or utility asset protection agreements. The results of this monitoring provide a comprehensive feedback loop to the assessment models. This will allow contingency actions to be undertaken, if necessary, to limit movements.

12.5 Sensitivity Analysis

To provide a sensitivity check of the methodology adopted, the movement values predicted have been compared with:

- the typical range of movements reported by underpinning contractors, which is between 5mm and 10mm vertical / horizontal for an underpin constructed in a single lift;
- consideration of a 'low stiffness' construction methodology (i.e. without the use of temporary propping to restrain movements), which indicates approximately 16mm to 18mm vertical / horizontal movements (if ignoring the depth of existing foundations). The conservative 'low stiffness' range of movements could be considered a worst-case scenario, if propping was omitted for instance.

12.6 Estimates of Ground Movement using Oasys XDisp

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 geometries of the site have been imported into XDisp and ground movements modelled based on C760.

The displacement profiles and damage assessments derived using XDisp assume greenfield movements and predict movements at ground level. In relation to all buildings, the movements derived will be an overestimate of movement both with respect to adjacent foundations and assets, which are located at a depth greater than existing street levels.

12.7 Estimates of Movement due to Heave

The excavation of a maximum 3.50m of soil will generate an unloading of around <70kPa (this is conservative, considering the CMS reports a void below the existing suspended ground floor areas). The basement will have a ground bearing slab, locally thickened where required to transfer point and strip loads. It is likely that the ground within the excavation will experience a net unload, rather than load. This will result in a measure of short term heave and long term swelling of the underlying London Clay, which theoretically takes a number of years to complete.

A proportion of the soil heave pressure will be dissipated in the short term / during excavation, before the base slab is cast, due to undrained deformation and other short term effects. In the long term, as the clay swells, the base slab will have a pressure exerted on it.

The magnitude of the long term ground heave pressures exerted on the slab will depend on the magnitude of heave deformation / stress relaxation which occurs prior to the base slab being constructed and how much the slab deflects as a result of the applied heave pressures. If no relaxation occurs before the base slab is cast and the slab is not allowed to deflect (i.e. the base slab is wished in place and fully rigid) then the total heave pressure will be exerted on the slab.

If the ground is allowed to heave / relax prior to casting the base slab, or the slab is flexible, then the soil heave pressure will reduce.

Experience suggests that heave movements tend largely to be restricted to within the basement excavation and it is not anticipated that the changes in loading at basement level will have a significant impact on the neighbouring structures. It should also be noted that CIRIA C760 empirical movement calculations are considered to include short term heave movements and the structure is designed to accommodate long term pressures.

12.8 Impact Assessment of Neighbouring Buildings, Highway and Utilities

The ground movements have been used to assess the resultant potential damage that may be experienced by neighbouring structures. 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 11.

Based on the ground movements calculated, the following impacts are predicted in accordance with the Burland Scale:

- 25 Inglewood Road – Category 1 (Very Slight)
- 27 Inglewood Road – Category 1 (Very Slight)
- 31 Inglewood Road – Category 1 (Very Slight)

The maximum movements predicted to be experienced at the footway are 3mm vertically / 5mm horizontally. This magnitude of movement will cause negligible impact to surfacing or underlying utilities.

It is recommended that structural movement monitoring is undertaken during the works and mitigation actions implemented if movement trends indicate predicted impacts and structural movement tolerances could be exceeded.

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 11: Damage Categories on the Burland Scale

13.0 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.

13.1 Geology and Land Stability

The site is underlain by the London Clay Formation. This formation typically comprises firm to stiff clay of medium to high strength and is a suitable bearing stratum for the proposed development's foundations. This has been confirmed by the site investigation.

The risk of movement and damage to this development due to shrink and swell of the London Clay is negligible, considering the depth of the proposed 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 and stiff propping of the basement. Damage Impact to adjacent structures will be limited to a maximum of Very Slight (Category 1 in accordance with the Burland Scale). It is recommended that structural movement monitoring is undertaken and mitigation actions implemented if ground movement trends indicate structural movement tolerances could be exceeded.

Movements to the highway / utilities are considered to be very small, such that they would cause negligible impact. Consultation with relevant asset owners is recommended to ensure that appropriate design and mitigation measures can be provided for the development such that impacts to the highway and utilities are maintained within the agreed limits.

13.2 Hydrogeology and Groundwater Flow

The London Clay is designated as Unproductive Strata. There is a very low risk of groundwater flooding or potential for impacting the wider hydrogeological environment.

The Construction Method Statement requires appropriate propping and mitigation measures to be implemented, including the use of sump pumping, which will be controlled by the Contractor and supervised by the Engineer, and there will be no impacts to stability during construction or in the permanent case as a result of encountering shallow perched water.

13.3 Hydrology and Surface Water Flow

There is a 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.

13.4 Residual Risks and Mitigation

As a contingency, and in accordance with best practice, a structural movement monitoring plan should be set out at design stage. Monitoring should include precise levelling, reflective survey targets or other appropriate instrumentation as determined by the Engineer being installed on adjacent structures and the highway. This should be agreed under the Party Wall Act and as part of any asset protection agreements required.

Appendix 1 Site Location and Exploratory Hole Plan

Figure 1 Site Location

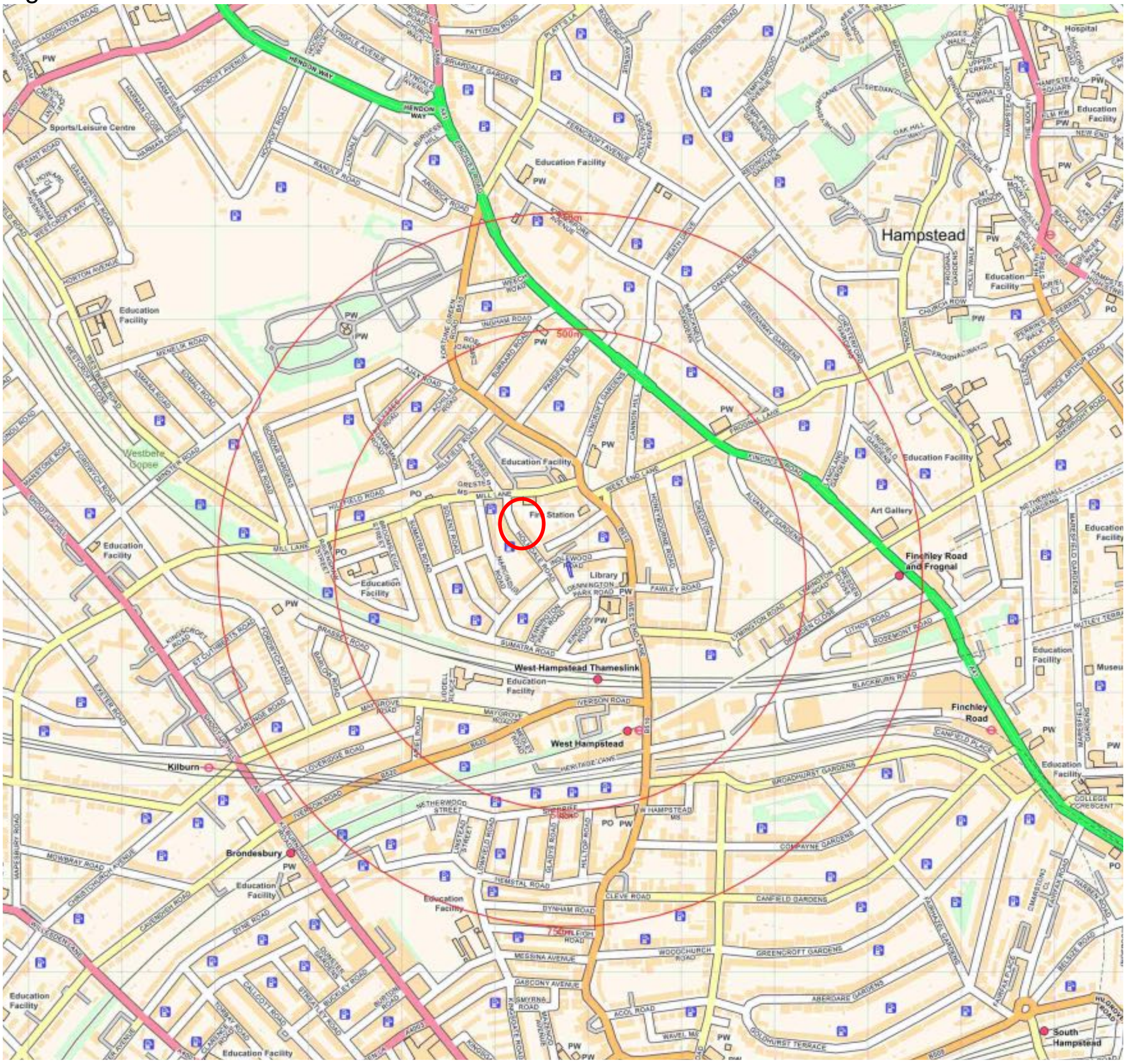
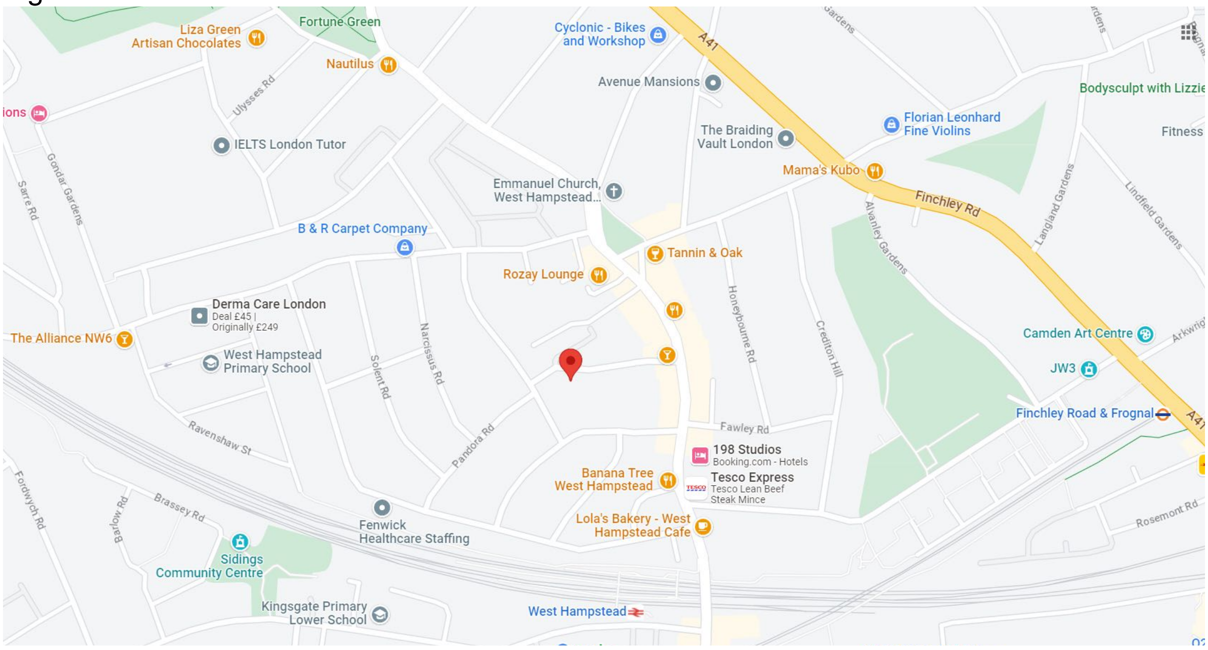


Figure 2: Exploratory Hole Plan (over page)

Appendix 2 Survey and Development Drawings

Appendix 3 Desk Study References

Figure 3 Site Location Plan



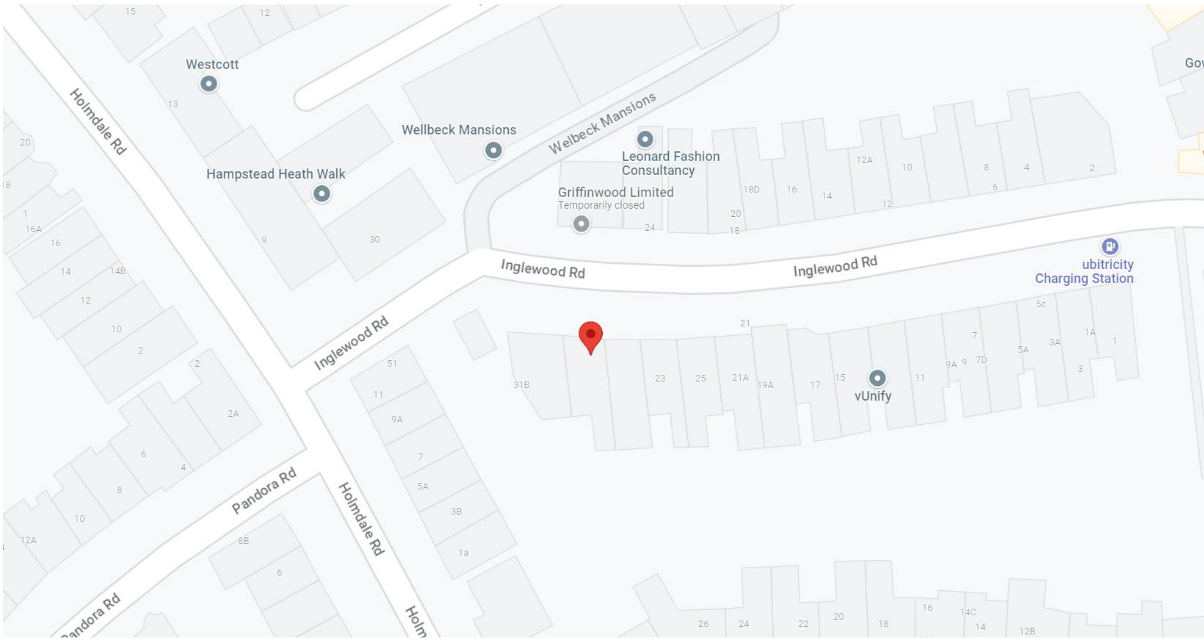


Figure 4 Historical Map Extract, OS 1:2,500 1870-1871

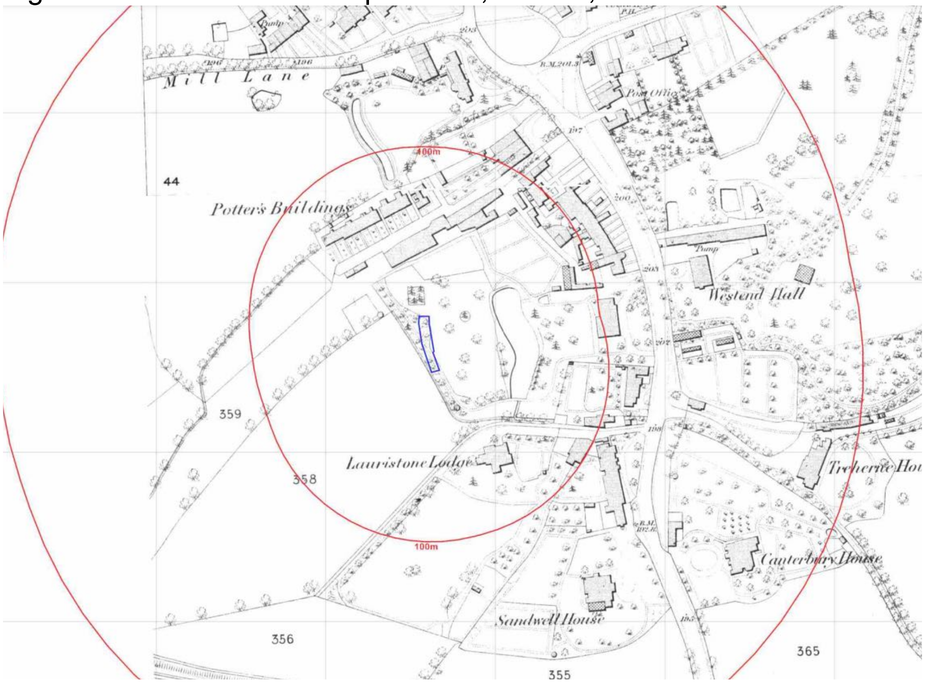


Figure 5 Historical Map Extract, OS 1:1,056 1896

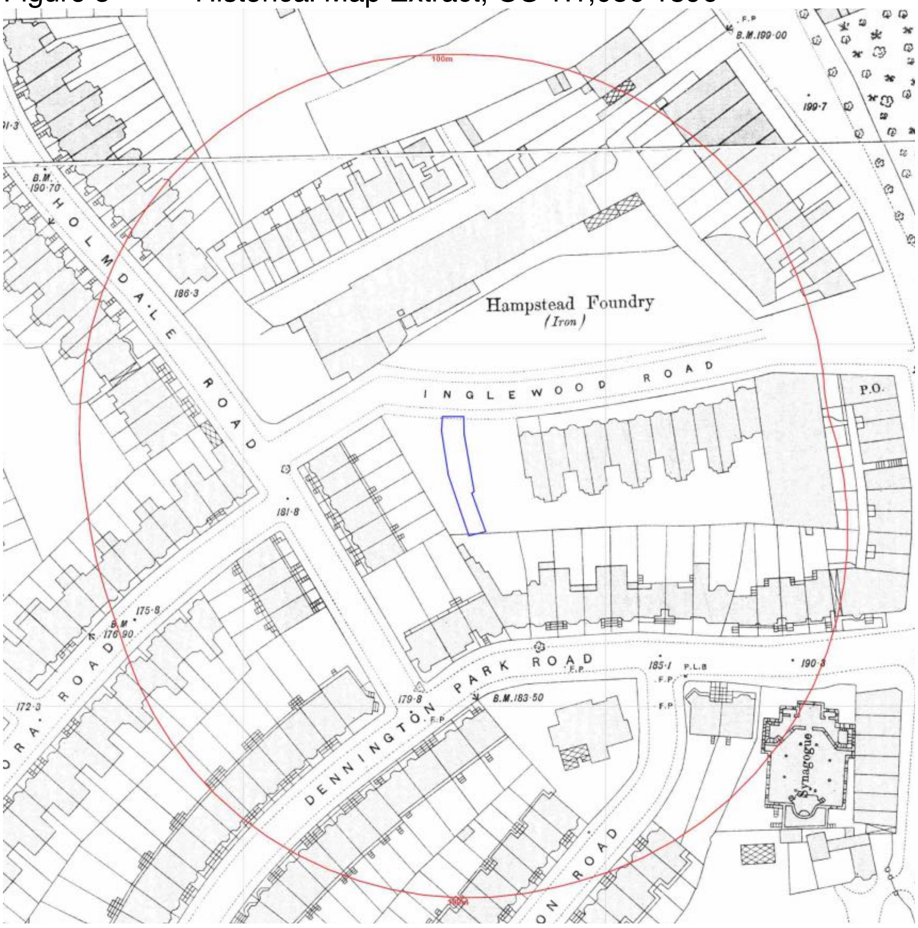


Figure 6 Historical Map Extract, OS 1:2,500 1915

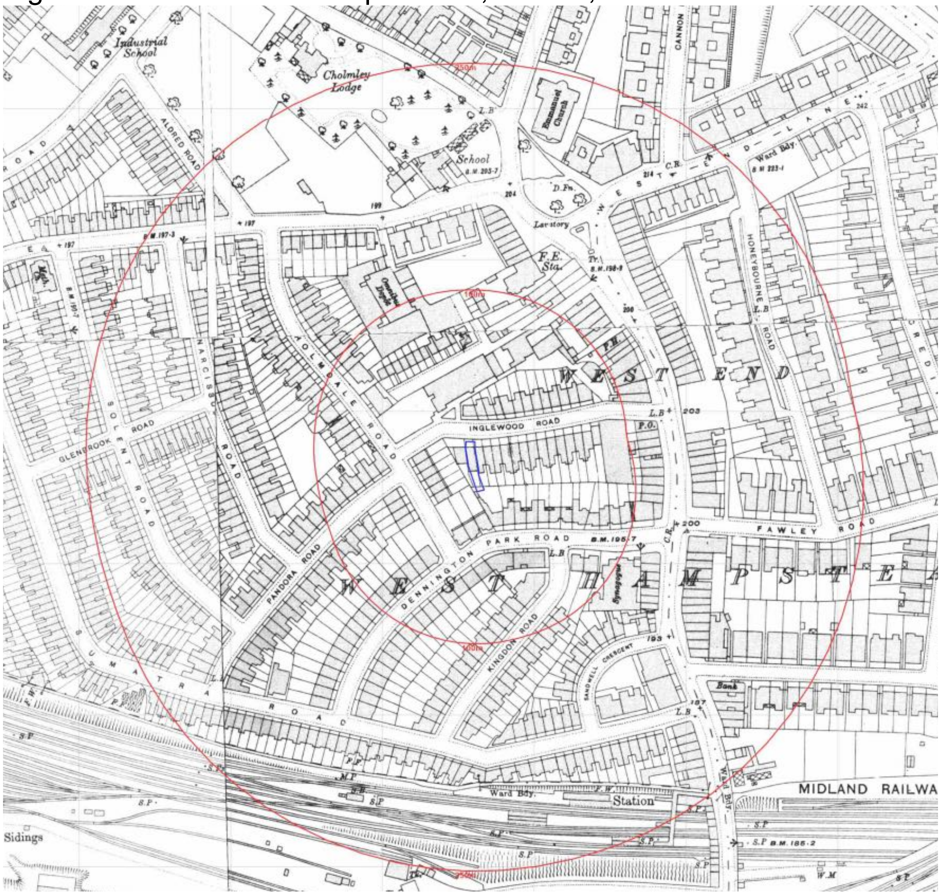


Figure 7 Historical Map Extract, OS 1:1,250 1953

Figure 8 Historical Map Extract, OS 1:1, 250 1991

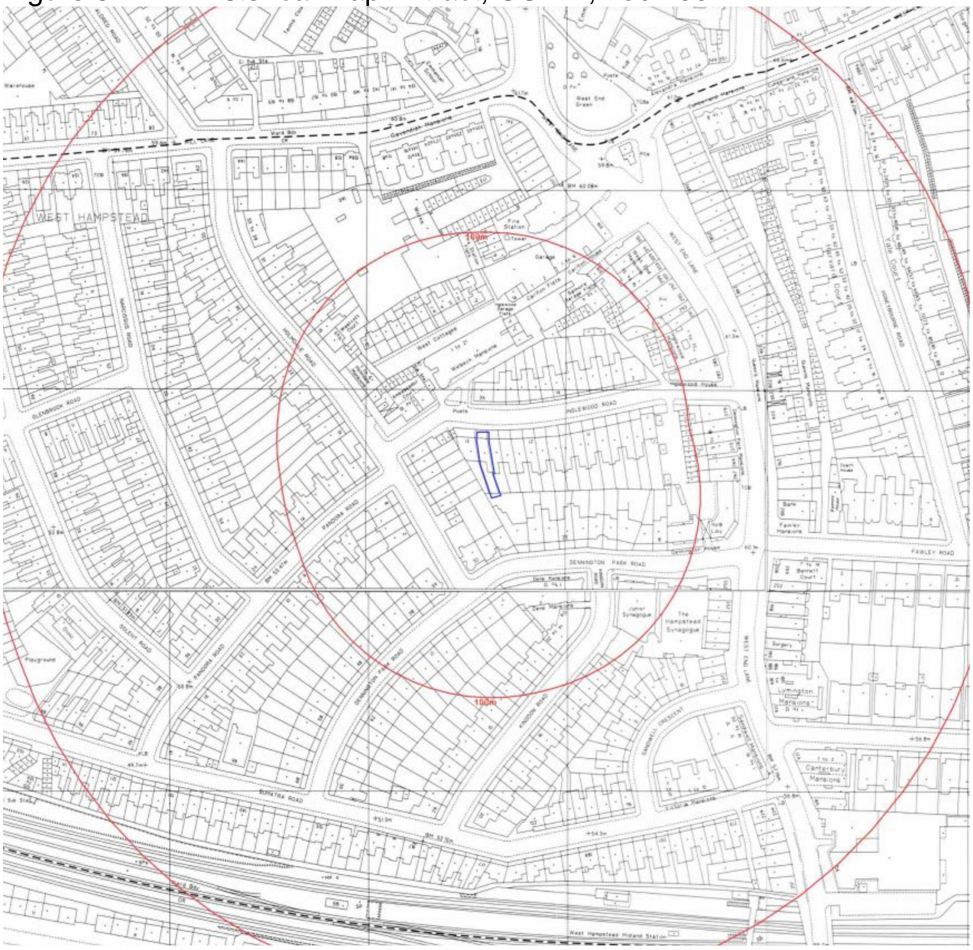
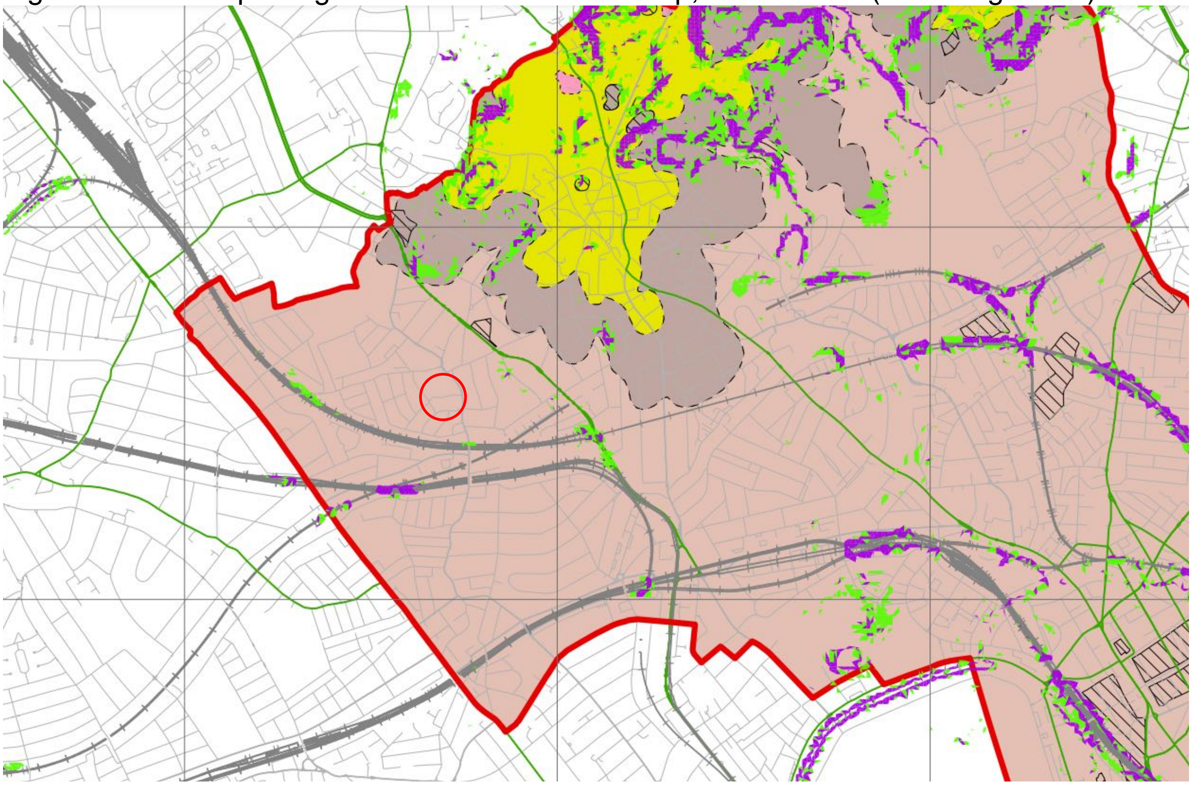


Figure 9 WW2 Bomb Damage Map Extract

Figure 10 Slope Angle and Worked Ground Map, LB Camden (GHHS figure 16)



Slopes in green, 7 – 10 degrees; Slopes in purple, >10 degrees.

Figure 11 Geological Map Extract, BGS (Geology of Britain Viewer)

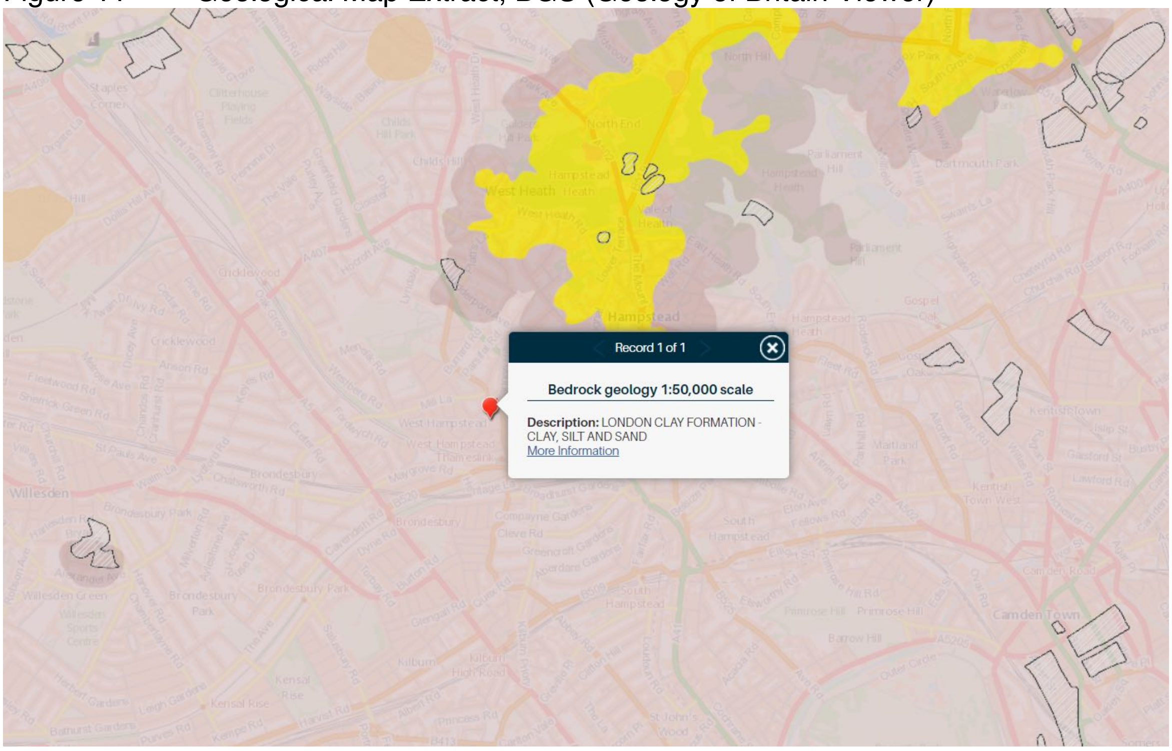


Figure 12 Flooded Streets Map, LB Camden (GHHS Figure 15)

Figure 13 Flood Risk Map, Environment Agency (Surface Water Flood Risk)

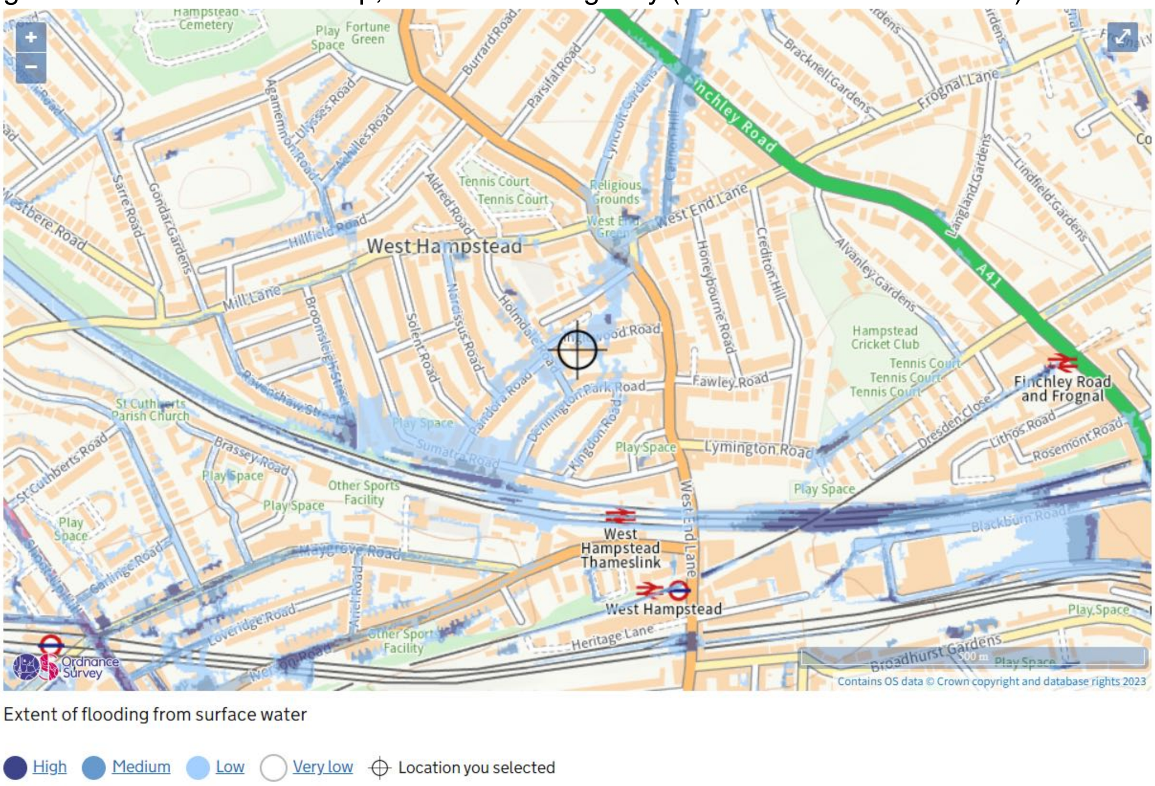


Figure 14 Groundwater Source Protection Zone, LB Camden (GHHS Figure 8)

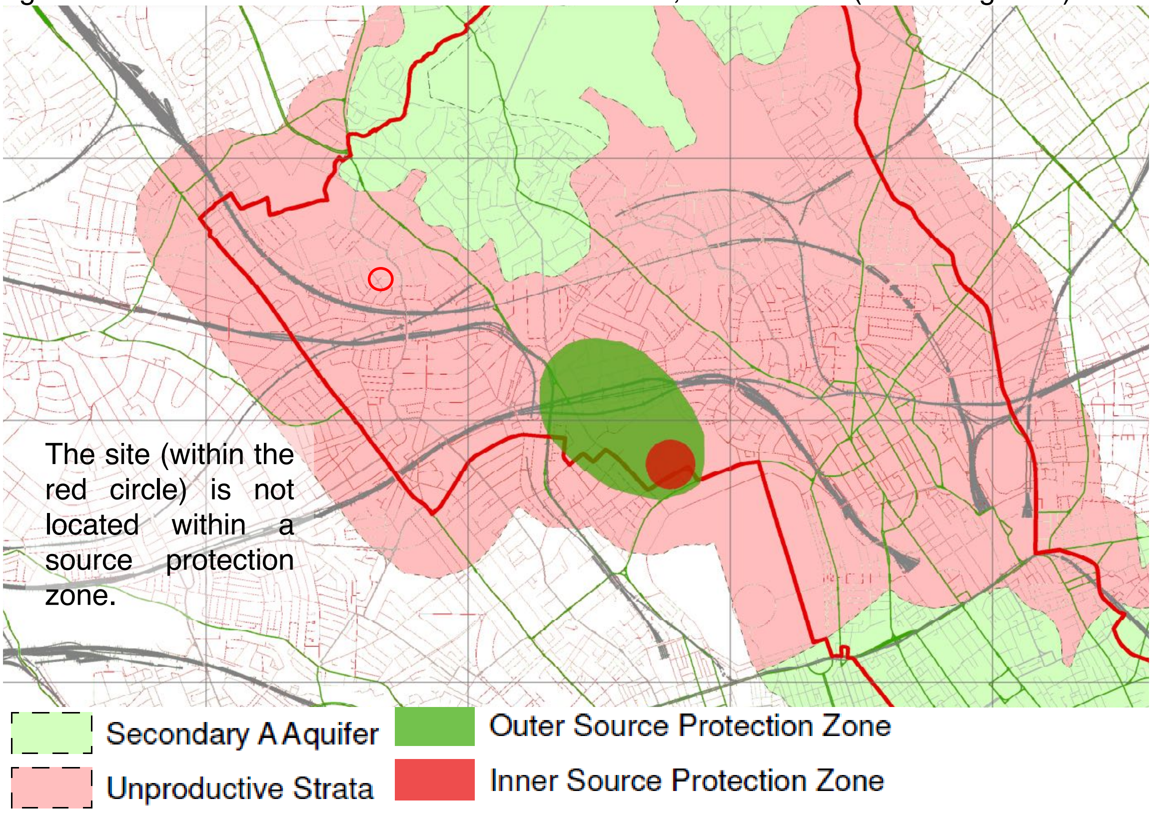


Figure 15 Lost Rivers of London, Barton (LB Camden GHHS Figure 11)

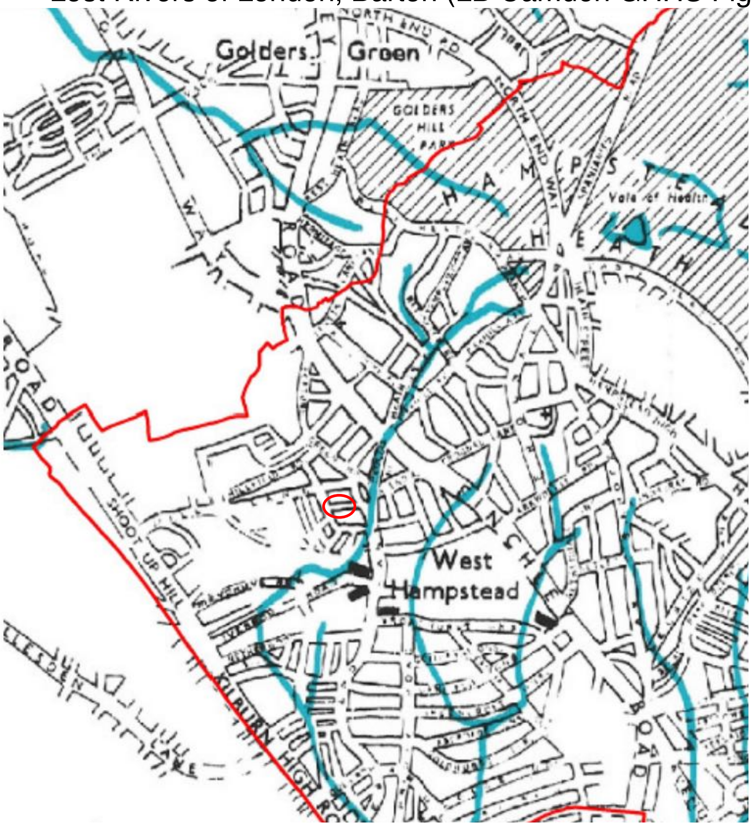
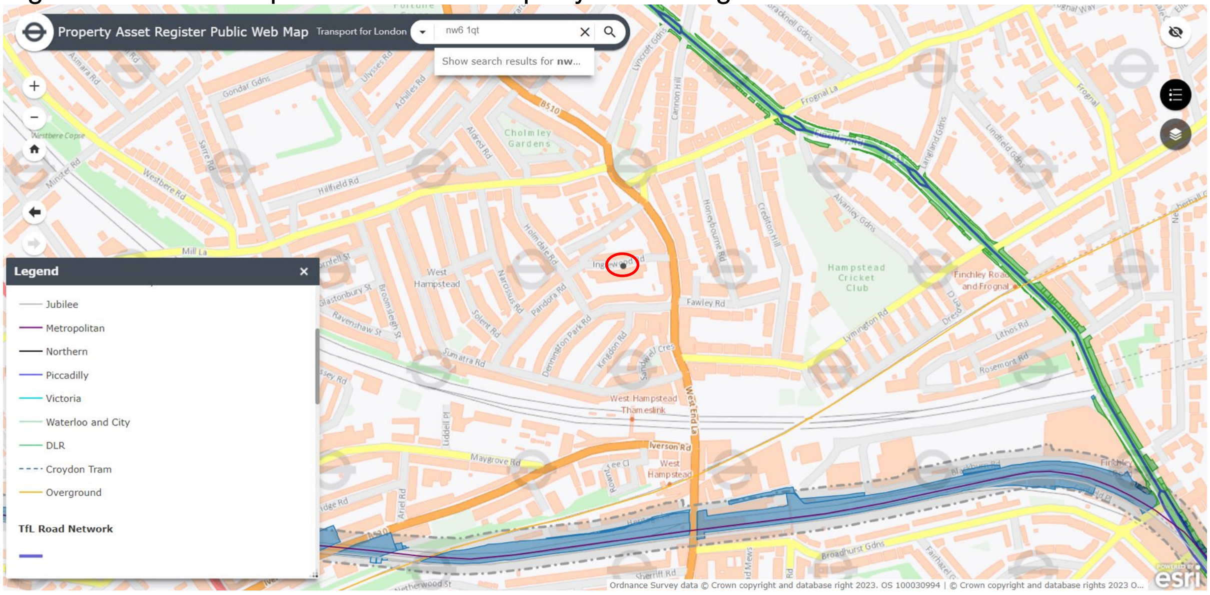


Figure 16 Transport for London Property Asset Register



Appendix 4 Site Investigation Data

Appendix 5 Drainage Calculations

Appendix 6 GMA Outputs

Appendix 7 Risk Classification Matrix

Risk Classification Matrix (C552 CIRIA, 2001)

Classification of Consequence

Classification	Definition
Severe	Short term (acute) risk to human health likely to result in 'significant harm' as defined by the Environment Protection Act 1990, Part IIA. Short term risk of pollution (note; Water Resources Act contains no scope for considering significant pollution) of sensitive water resource. Catastrophic damage to building/property. A short term risk to a particular ecosystem, or organism forming part of such ecosystem. (Note the definitions of ecological systems within the Draft Circular on Contaminated Land DETR, 2000).
Medium	Chronic damage to human health ('significant harm', as defined in DETR, 2000). Pollution of sensitive water resources (note; Water Resources Act contains no scope for considering significant pollution). A significant change in a particular ecosystem, or an organism forming part of such an ecosystem. (Note the definitions of ecological systems within the Draft Circular on Contaminated Land DETR, 2000).
Mild	Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services ('significant harm', as defined in DETR, 2000). Damage to sensitive buildings/structures/services or the environment.
Minor	Harm, although not necessarily significant harm, which may result in a financial loss, or expenditure to resolve. Non-permanent health effects to human health (easily prevented by means such as persona protective clothing etc). Easily repairable effects of damage to buildings, structures and services.

Classification of Probability

Classification	Definition
High likelihood	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution.
Likely	There is a pollutant linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low Likelihood	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period that such an event would take place, and is even less likely in the shorter term.
Unlikely	There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term.

Classification of Probability

		Consequence			
		Severe	**Medium**	**Mild**	**Minor**
Probability	**High Likelihood**	Very High Risk	High Risk	Moderate Risk	Moderate / Low Risk
	Likely	High Risk	Moderate Risk	Moderate / Low Risk	Low Risk
	Low Likelihood	Moderate Risk	Moderate / Low Risk	Low Risk	Very Low Risk
	Unlikely	Moderate / Low Risk	Low Risk	Very Low Risk	Very Low Risk

Appendix 8 References and Guidance

1. London Boroughs Publication (undated). A Guide to Help Developers Meet Planning Requirements
2. WCC (2001). Contaminated Land Inspection Strategy
3. Environment Agency/Defra (2002). Contaminated Land Statutory Guidance (April 2012)
4. BS 10175 (2011) Investigation of Potentially Contaminated Sites. Code of Practice
5. BS5930 (2007) Code of Practice for Site Investigations
6. BS 5667-11:2009. Water Quality Sampling. Part 11: Guidance on Sampling of Groundwaters
7. Department of the Environment Industry Profiles
8. Environment Agency/Defra (2002). Sampling Strategies for Contaminated Land (CLR4)10
9. Environment Agency/Defra (2002). Priority Contaminants for the Assessment of Land (CLR8)11
10. CIRIA (2007). Assessing Risks Posed by Hazardous Ground Gases to Buildings
11. BS 8485:2015. Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for New Buildings
12. NHBC (2007). Guidance on the Evaluation of Development Proposals on Sites Where Methane and Carbon dioxide are Present
13. Landfill Gas Industry Code of Practice (Todeka Ltd, 2012). The Management of Landfill Gas
14. CL:AIRE / CIEH (2008), Guidance on Comparing Soil Contamination Data with a Critical Concentration, May 2008
15. CL:AIRE / EIC (2009), The Soil Generic Assessment Criteria for Human Health, December 2009
16. Environment Agency (2003), Review of Rate & Transport of Selected Contaminants in the Environment, Report P5-079-TR1
17. Environment Agency (2004), Model Procedures for the Management of Land Contamination, September 2004, ISBN: 1844322955
18. Environment Agency (2008a), Compilation of Data for Priority Organic Pollutants, Report SC050021/SR7, November 2008
19. Environment Agency (2009a), Human Health Toxicological Assessment of Contaminants in Soil, Report SC050021/SR2, January 2009
20. Environment Agency (2009b), CLEA Software (Version 1.04) Handbook (and Software), Report SC050021/SR4, January 2009
21. Environment Agency (2009c), Updated Technical Background to the CLEA Model, Report SC050021/SR3, January 2009
22. Environment Agency (2009d), A Review of Body Weight and Height Data Used in the CLEA Model, Report SC050021/Final Technical Review 1, January 2009
23. Nathanial et. al., (2009), The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment (2nd edition), Land Quality Press, Nottingham, ISBN 0-9547474-7-X
24. USEPA (2004), User's Guide for Evaluating Subsurface Vapour Intrusion into Buildings
25. Environment Agency (2012). Groundwater Protection: Principles and Practice (GP3)
26. Water Framework Directive (2000/60/EC)
27. Groundwater Regulations (2009)
28. Drinking Water Quality Standards England & Wales 2000 (Amended 2004, DWS)
29. World Health Organisation (WHO) Petroleum Products in Drinking Water
30. Environmental Quality Standards (EQS). The River Basin Districts Typology, Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Directions 2010
31. Environment Agency (2006). Remedial Targets Methodology. Hydrogeological Risk Assessment for Land Contamination
32. Environment Agency (2013, 3rd edition). Technical Guidance WM2. Hazardous Waste: Interpretation of the Definition and Classification of Hazardous Waste
33. DEFRA (2012). Guidance on the Legal Definition of Waste and its Application

[10] This document has been withdrawn but is considered to remain useful in proving technical background for designing ground investigation works.

[11] This document has been withdrawn but is considered to remain useful in proving technical background for designing ground investigation works.

Appendix 9 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 (Jyothin Sethi) and for reference by the London Borough of Camden.

The advice and opinions in this report should be read and relied on only in the context of the report as a whole, taking account of the terms of reference agreed with the client. The findings are based on the information made available to Milvum Engineering Services at the date of the report (and will have been assumed to be correct) and on current UK standards, codes, technology and practices as at that time. They do not purport to include any manner of legal advice or opinion. New information or changes in conditions and regulatory requirements may occur in future, which will change the conclusions presented here.

This report is confidential to the client. The client may submit the report to regulatory bodies, where appropriate. Should the client wish to release this report to any other third party for that party's reliance, Milvum Engineering Services may, by prior written agreement, agree to such release, provided that it is acknowledged that Milvum Engineering Services accepts no responsibility of any nature to any third party to whom this report or any part thereof is made known. Milvum Engineering Services accepts no responsibility for any loss or damage incurred as a result, and the third party does not acquire any rights whatsoever, contractual or otherwise, against Milvum Engineering Services except as expressly agreed with Milvum Engineering Services in writing.