DESK STUDY, GROUND INVESTIGATION, BASEMENT IMPACT ASSESSMENT & GROUND MOVEMENT ASSESSMENT REPORT

FOR

35 TEMPLEWOOD AVENUE
LONDON
NW3 7UY

JOMAS ASSOCIATES LTD

SITE INVESTIGATION & SURVEYS
LAND DEVELOPMENT SUPPORT

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Report Title: **Geotechnical Desk Study, Ground Investigation, Basement Impact Assessment & Ground Movement Assessment for 35 Templewood Avenue, London, NW3 7UY**

Report Status: **Final v2**

Job No: **P1019J1129**

Date: **08 November 2018**

Quality Control: Previous Release

Version	*Date*	*Issued By*
Final v1.0	10 August 2017	RS
Final v1.1	07 November 2017	PSw
Final v1.2	1st August 2018	PSw

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EXECUTIVE SUMMARY

Kirsty Mitchell ("The Client") has commissioned Jomas Associates Ltd ('JOMAS'), to prepare a Basement Impact Assessment for a site referred to as 35 Templewood Avenue, London NW3 7UY. A basement excavation is proposed beneath the existing residential building.

The aim of this report is to assess whether the ground conditions within the local area represent an impediment to the proposed development.

It should be noted that the table below is an executive summary of the findings of this report and is for briefing purposes only. Reference should be made to the main report for detailed information and analysis.

Desk Study	
Current Site Use	The site currently consists of a large residential house with lower ground floor level. There is also an atrium style building which formerly housed a swimming pool.
Proposed Site Use	Relocation of the swimming pool to the north to separate it from the main building. Extension of the existing basement to fully underlie the current structure and include an area currently occupied by the swimming pool.
Site History	On the earliest available map (1870) the site is shown to be undeveloped. The site is shown with a single residential property encroaching onto the western art of the site by the map dated 1915. This development is part of a larger residential development. No significant changes occur until the map dated 1966 when the building is no longer shown and two new buildings are shown on site (including the circular building – atrium). By the map dated 1979, another building is shown on site. The map dated 2002 then only shows the circular building on site with all other buildings no longer shown. By most recent maps dated 2010-14 a new building resembling the sites current configuration is shown. The surrounding area has been in use almost exclusively for residential properties, with heathland to the north.
Site Setting	The British Geological Survey indicates that the site is directly underlain by solid deposits of the Bagshot Formation, identified as a Secondary A aquifer. No artificial deposits are reported within the site. A review of the EnviroInsight Report indicates that there are no Environment Agency Zone 2 or Zone 3 flood zones within 500m of the site. There are no abstractions reported within1km of the site. The nearest detailed river entry / surface water feature is reported 152m N of the site as a tertiary river.
Potential Sources	• Potential for Made Ground associated with previous development operations – on site (S1) • Potential asbestos impacted soils from demolition of previous buildings – on site (S2)
Potential Receptors	• Construction workers (R1) • Maintenance workers (R2) • Neighbouring site users (R3) • Future site users (R4) • Building foundations and on site buried services (water mains, electricity and sewer) (R5) • Controlled waters - secondary A aquifer (R6)

Preliminary Risk Assessment	The risk estimation matrix indicates a **low** risk as defined above. A high risk has been designated due to possible asbestos in the ground. No significant potential sources of contamination were identified during the desk based assessment. It is recommended that a number of soil samples obtained during the geotechnical investigation are analysed for a suite of general contaminants to confirm the lack of contamination within the site. No potential sources of ground gas have been noted, as a consequence ground gas monitoring is not considered to be necessary. However, groundwater will be required for basement design. Consequently, it may be appropriate to measure ground gas concentrations at the same time to confirm that there is not an issue.
Potential Geological Hazards	The Groundsure data identifies only a negligible to low risk – for full details see Section 3

Screening and Scoping	
Subterranean (Groundwater) Flow	The investigation should confirm if the site is directly above the Secondary A Aquifer. Groundwater levels should be determined so they can be compared to the relative depths of the basement
Land Stability	The driveway down from road level is noted to be greater than 7° however this is an engineered slope that will have been designed with a suitable factor of safety. It is therefore considered that investigation to specifically investigate and model the slope is not required. Following the investigation an assessment relating to groundwater management and excavation stability should be undertaken
Surface Flow and Flooding	No specific investigation required

Ground Investigation	
Ground Conditions	The results of the ground investigation revealed a ground profile comprising Made Ground (up to at least 1m thick), overlying orange to brown slightly sandy Clay (Bagshot Formation) to the base of the boreholes up to 5mbgl.
Environmental Considerations	Following generic risk assessments, an elevated concentration of lead was reported in WS1 at 0.50mbgl. A single sample (WS2 at 0.50mbgl) tested positive for asbestos in the form of chrysotile – loose fibres/loose fibrous debris. This was quantified at 0.017%, below the limit at which fibres are considered hazardous for disposal purposes. It should be noted that for the

Ground Investigation	
	purposes of human health assessment there is no level of asbestos below which it is deemed the materials are "safe". Results of WAC testing indicate that waste soils meet the criteria for disposal as "inert" waste. The receiving facility may also consider the Lead concentration prior to confirming they are able to accept the waste soils. The site proposal indicates that parts of the site will remain covered by a combination of the proposed building footprint and hard surfacing. Where this is the case, no formal remedial measures are considered necessary in terms of human health, as the building and hard surfacing are expected to provide a barrier to potential receptors. In areas of soft landscaping, certified clean topsoil will be required. Further testing may be undertaken to confirm if the Lead concentrations and asbestos persists across the topsoil/made ground existing on site. The site is underlain by solid deposits of the Bagshot Formation, defined as a Secondary A aquifer. No groundwater was encountered during intrusive works or subsequent monitoring visits. There are no source protection zones in close proximity to the site and the nearest surface water feature is a tertiary river 152m N of site. As a result, the risk to controlled waters is considered low. Calculating the Gas Screening Value using worst case results indicates Characteristic Situation 1. This would indicate that no special precautions are required. Assuming that the basement development is constructed to the necessary standards and guidelines it would provide a minimum of 2.5 gas protection points. As with any ground investigation, the presence of further hotspots between sampling points cannot be ruled out. Should any contamination be encountered, a suitably qualified environmental consultant should be informed immediately, so that adequate measures may be recommended. The above conclusions are made subject to approval by the statutory regulatory bodies.
Geotechnical Considerations	It is assumed that the retaining wall will be installed using "underpinning" type construction methods. Based upon the information obtained to date, it is considered that conventional foundations may be suitable for the proposed development. It is considered that an allowable bearing capacity of 150kPa at 4.0m bgl is possible. It should be born in mind that the estimated allowable bearing capacity was calculated for a depth of 4.0mbgl. Due to the presence of an existing lower ground floor level at approximately 1.5mbgl, the foundations are likely to be formed deeper than 4.0mbgl (2.5m below the existing lower ground floor level). The exact allowable bearing capacity that could be achieved would need to be reviewed on receipt of initial foundation design. During the retaining wall design a check against sliding failure would need to be made. This may alter the above recommendations. Given that there is to be a basement formed on the site underneath an existing lower ground level, it is expected that the finished floor level would be approximately 4.5m – 5.0m below current ground level.

Ground Investigation	
	Excavations will be required at the site for services and construction works. These are anticipated to remain stable for the short term only. It is recommended that the stability of all excavations should be assessed during construction. The sides of any excavations into which personnel are required to enter, should be assessed and where necessary fully supported. The basement excavation will be located beneath an existing structure. The progression of the basement excavation will need to consider the potential impact to existing structures both on and off site and provide adequate and appropriate support. Throughout the investigation and subsequent monitoring, groundwater was not observed. Subject to seasonal variations, it is not considered likely that significant quantities groundwater would be encountered during site works. Any encountered groundwater could be readily dealt with by conventional pumping from a sump. This would need to be assessed at the time of construction. Based on the results of chemical testing, the required concrete class for the site is DS-3 assuming an Aggressive Chemical Environment for Concrete classification of AC-3 within the Made Ground and DS-1 AC-1s within the Bagshot Formation in accordance with the procedures outlined in BRE Special Digest 1. Given that there is to be a basement formed on the site underneath an existing lower ground level, it is expected that the finished floor level would be approximately 4.5m – 5.0m below current ground level. If a cantilever retaining wall is utilised then a ground bearing floor slab could be used. Such a floor slab would also need to be suitably reinforced, to prevent buckling from the loadings imposed by the retaining wall. The floor slab (and basement walls) would need to be constructed to conform to BS: 8102 (2009). Given that at the time of undertaking the works there was very limited access to and around the site it is recommended that further works are undertaken using a restricted access cable tool rig. It is likely that such a hole would need to be positioned on the garage access slope.

Basement Impact Assessment	
Impact Assessment	The overall assessment of the site is that the creation of a basement for the existing development should not adversely impact the site or its immediate environs, providing measures are taken to protect surrounding land and properties during construction. The proposed basement excavation will be within 5m of a public pavement. It is also laterally within 5m of neighbouring properties. Unavoidable lateral ground movements associated with the basement excavations must be controlled during temporary and permanent works so as not to impact adversely on the stability of the surrounding ground and any associated services. During the construction phase, careful and regular monitoring will need to be undertaken to ensure that the property above, is not adversely affected. This may mean that the property needs to be suitably propped and supported. From the studies that have been undertaken so far it is concluded that the construction of the building should not present a problem for ground water. It is concluded that this site can be successfully developed without causing any problems to the subterranean drainage.

Ground Movement Assessment	
Impact Assessment	The majority of the facades fall within Category 0, representative of a *Negligible* damage classification. Three structures / facades have been classified as Category 1, representative of *Very Slight* damage classification. No damage category higher than this has been assessed. In addition to the above, assessments were carried out to quantify the potential impact of the proposed development on the adjacent roadway. It was found that the ground movements at both West Heath Road and Templewood Avenue are generally <1mm. In the area close to the proposed car lift, movements were up to 8mm, decreasing to 0mm on the opposite side of the road. The risk of damage to the adjacent roadways as a result of the proposed works is considered to be low. However, it may be prudent for the contractor to allow for localised *making good* of any minor surface defects – particularly in the area immediately adjacent to the proposed car lift. The results of the impact assessment on the Thames Water assets carried out using XDISP have been presented in Chapter 16. All assets comply with the Thames Water screening criteria with the exception of certain isolated peak values of tensile strain of Sewer 2 under Templewood Avenue, which is the result modelling simplifications. These spikes in curvature/deformation have been ignored as they are not representative of a realistic behaviour of the asset. It is concluded that the impact on the Thames Water assets due to the redevelopment proposals is negligible.

1 INTRODUCTION

1.1 Terms of Reference

1.1.1 Kirsty Mitchell (“The Client”) has commissioned Jomas Associates Ltd (‘Jomas’), to prepare a Desk Study, Ground Investigation and Basement Impact Assessment at a site referred to as 35 Templewood Avenue, London, NW3 7UY.

1.1.2 Jomas' work has been undertaken in accordance with email proposal dated 14th June 2017.

1.2 Proposed Development

1.2.1 The proposed development involves the construction of a new single-storey basement, which will deepen and locally extend the footprint of the existing basement at 35 Templewood Avenue. The site under investigation is bounded to the north and east by W Heath Road and Templewood Avenue, respectively. Also, the properties located at 9 W Heath Rd (Grade II listed - Schreiber House) and 33 Templewood Avenue are found in the west and south, respectively.

1.2.2 The swimming pool has a glass domed roof and is a listed building. This was previously a part of the neighbouring Schreiber House. It is proposed to carefully dismantle the swimming pool structure and to reconstruct it to the north of its current position. Refer to Purcell Existing Fabric Assessment / Existing Methodology Report (Feb 2018) for details of the proposed method of re-constructing the swimming pool.

1.2.3 The existing lower ground floor (which is present over much of the existing building footprint) formation level is between 111 and 112 mOD and the proposed excavation slab formation level is approximately 108 mOD.

1.2.4 A new basement is also proposed below the entire footprint of the building. The new basement will also extend beyond the existing building footprint at the front garage entrance and at the rear section into the area where the existing swimming pool is. This new basement will be used for parking, a gymnasium, sauna, steam room and pump house.

1.2.5 For the purpose of geotechnical assessment, it is considered that the project could be classified as a Geotechnical Category (GC) 2 site in accordance with BS EN 1997 Part 1. GC 2 projects are defined as involving:

- Conventional structures.
- Quantitative investigation and analysis.
- Normal risk.
- No difficult soil and site conditions.
- No difficult loading conditions.
- Routine design and construction methods.

1.2.6 This will be reviewed at each stage of the project

1.3 Objectives

1.3.1 The objectives of Jomas’ investigation were as follows:

- To present a description of the present site status, based upon the published geology, hydrogeology and hydrology of the site and surrounding area;
- To review readily available historical information (i.e., Ordnance Survey maps and database search information) for the site and surrounding areas;
- To conduct an intrusive investigation, to assess ground conditions and obtain geotechnical parameters to inform preliminary foundation design;
- To assess the potential impacts that the proposal may have on ground stability, the hydrogeology and hydrology on the site and its environs.

1.4 Scope of Works

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

- A walkover survey of the site;
- A desk study, which included the review of a database search report (GeoInsight Report, attached in Appendix 2) and historical Ordnance Survey maps (attached in Appendix 3);
- An intrusive investigation to assess the underlying ground conditions;
- A basement impact assessment;
- The compilation of this report, which collects and discusses the above data, and presents an assessment of the site conditions, conclusions and recommendations.

1.5 Scope of Basement Impact Assessment (BIA)

1.5.1 Jomas has based the methodology of the BIA on the guidance given in the London Borough of Camden document “Camden Planning Guidance Basements” (CPGB) (March 2018). This document has been used as it is generally accepted that this gives the best available guidance on the practicalities regarding how to the undertake a BIA.

1.5.2 The CPGB differentiates between Lower ground floors and basements. Noting that storeys built partially below ground are common around London and especially in Camden, in particular in historic buildings. To be considered a lower ground floor and not a basement the storey must typically:

- Have a significant proportion above the prevailing ground level,
- Be accessible from the outside of the building at the front and rear of the property,
- Form part of the original fabric of a building, and Form part of the character of the area.

1.5.3 The proposed development does not meet these criteria so would be deemed a basement and require a BIA

1.5.4 Jomas’ BIA covers most items required under CPGB, with the exception of;

- Plans and sections to show foundation details of adjacent structures – no access to adjacent properties was possible.
- Programme for enabling works, construction and restoration
- Evidence of consultation with neighbours

- Construction Sequence Methodology
- Proposals for monitoring during construction.
- Drainage assessment

1.5.5 This Jomas BIA also takes into account the Campbell Reith pro forma BIA produced on behalf of and published by the London Borough of Camden as guidance for applicants to ensure that all of the required information is provided.

1.5.6 This version of the Desk Study, Ground Investigation and Basement Impact Assessment, includes both the previously issues Ground Movement Assessment and incorporates comments and alterations following the audit of the report by CampbellReith on behalf of the London Borough of Camden.

1.5.7 A number of the requirements set out in the London Borough of Camden document CPGB will need to be addressed in a construction management plan, this stage is not within the scope of work that Jomas Associates have been commissioned.

1.6 Supplied Documentation

1.6.1 A number of reports previously and concurrently prepared by third parties were supplied to Jomas Associates at the time of this revision to the original report. Table 1.1 details the documents supplied:

Table 1.1: Supplied Reports

Title	Author	Reference	Date
Structural Methodology Statement For Basement Development At No. 35 Templewood Avenue, London NW3 7UY	Barrett Mahony Consulting Engineers	16.848 – RP – 02	27 July 2018
Heritage Assessment 35 Templewood Avenue, London	WYG	A100862	December 2016

1.7 Limitations

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

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

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

2 SITE SETTING & HISTORICAL INFORMATION

2.1 Site Information

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

Table 2.1: Site Information

Name of Site	-
Address of Site	35 Templewood Avenue London NW3 7UY
Approx. National Grid Ref.	525822,186364
Site Area (Approx)	0.10 hectares
Site Ownership	Unknown
Site Occupation	A residential building
Local Authority	London Borough of Camden
Proposed Site Use	Residential with basement

2.2 Walkover Survey

2.2.1 The site was visited by a Jomas Engineer on 20th June 2017. The following information was noted while on site.

Table 2.2: Site Description

Area	Item	Details
On-site:	**Current Uses:**	Site is a currently a residential detached house with a rear garden. There is also a glass atrium which is a listed building, this once housed a swimming pool.
	Evidence of historic uses:	None noted.
	Surfaces:	The majority of the site is covered by building footprint with a garden to the rear.
	Vegetation:	There are several large trees surrounding the property of various species. The most significant is probably an approx. 15m eucalyptus tree situated in the eastern section of the site. The garden area mainly consists of turf and flower bed cover.
	Topography/Slope Stability:	There is a lower ground floor level at which there is a garage. The site slopes downwards from the main road at ground level to this garage. The main garden is also at a higher level to the rear decking area at lower ground floor level.
	Drainage:	Standard drainage observed

Area	Item	Details
	Services:	The site appears to be connected to normal statutory services.
	Controlled waters:	There is a very small man-made pond to the rear of the decking area at lower ground floor level.
	Tanks:	No tanks were observed on site.
Neighbouring land:	**North:**	West Heath Road and Hampstead Heath
	East:	Templewood Avenue and Residential.
	South:	Residential.
	West:	Residential.

2.2.2 Photos taken during the site walkover are provided in Appendix 1.

2.3 Historical Mapping Information

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

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

Table 2.3: Historical Development

Dates and Scale of Map	Relevant Historical Information	
	On Site	Off Site
1870/74 1:1,560 1:2,500 1:10,560	Site consists of heathland in the north and field in the south. The is a small road or footpath running through the site from east to west accompanied by a row of trees.	Buildings present 50m E and SE of site (Part of West Heath Village) **Sand Pit** 250m E of site. Reservoir 250m NW of site. Hampstead (town) to SE of site.
1894/96 1:1,560 1:2,500 1:10,560	Site is vacant and devoid of any features.	Residential house built 50m W of site. Road immediately N of site. Reservoir 250m NW of site is now identified as 'Leg of Mutton Pond'. **Sand Pit** 250m E of site is no longer shown.
1915/20 1:2,500 1:10,560	Site consists of about ¼ of a larger residential estate. A building encroaches onto the western part of the site.	Further residential development to area S of site.
1938 1:10,560	No significant changes	No significant changes

Dates and Scale of Map	Relevant Historical Information	
	On Site	Off Site
1951/53 1:1,250 1:2,500 1:10,560	No significant changes	Spring identified 200m NE of site.
1955/58 1:1,250 1:10,560	No significant changes	School identified 250m S of site.
1966/69 1:2,500 1:10,560	Former building on site has been demolished. A circular building is shown on site as well as part of another building encroaching on site from the south.	No significant changes
1973/76 1:1,250 1:10,000	No significant changes	Building part of Charing Cross Hospital is shown 80m E of site. Electrical sub-station 50m SE of site.
1979/81 1:1,250	Additional small building shown in W of site.	Building 150m SE of site demolished and wooded area shown in its place.
1991 1:1,250	No significant changes	Building part of Charing Cross Hospital has been redeveloped into 'Heath Park gardens'. Residential development 100-250m SE of site.
2002 1:10,000	Site consists of circular building only – nothing else.	No significant changes
2010/14 1:10,000	Site is shown to have a new building built to the SE of the circular building.	No significant changes

2.3.4 The it is noted from the Heritage Assessment (WYG – 2016) that the swimming pool has been out of use for several years due to structural and functional issues. The "Structural Methodology Statement For Basement Development" (Barrett Mahony Consulting Engineers – July 2018) notes that there is an existing glass domed building within the garden, which houses a sunken swimming pool. The swimming pool structure was constructed in 1968 following the construction of the adjacent Schreiber House. The swimming pool was originally linked to Schreiber House, but is presently linked to the existing structure at the subject site, following a change in ownership. The Schreiber House and the swimming pool are Grade II listed.

2.4 Previous Site Investigations

2.4.1 No previous site investigation reports were provided at the time of writing.

2.5 Unexploded Ordnance

2.5.1 Publicly available information has been assessed regarding the risk of Unexploded Ordnance affecting the site.

2.5.2 The initial data indicates that there is a low-moderate risk.

2.5.3 Low-moderate risk regions are those that show a bomb density of up to 50 bombs per 1km^2 and that may contain potential WWII targets. Compared to areas outside of London, this still presents a significant risk.

2.5.4 This does not comprise a full UXO risk assessment, and a full threat assessment is recommended.

3 ENVIRONMENTAL SETTING

3.1.1 The following section summarises the principal geological resources of the site and its surroundings. The data discussed herein is generally based on the information given within the Groundsure Report (in Appendix 2).

3.2 Solid and Drift Geology

3.2.1 Information provided by the British Geological Survey indicates that the site is directly underlain by solid deposits of the Bagshot Formation. An extract of the BGS description of the Bagshot Formation is provided below:

> *"pale yellow-brown to pale grey or white, locally orange or crimson, fine- to coarse-grained sand that is frequently micaceous and locally clayey, with sparse glauconite and sparse seams of gravel. The sands are commonly cross-bedded but some are laminated. Thin beds and lenses of laminated pale grey to white sandy or silty clay or clay ('pipe-clay') occur sporadically, becoming thicker towards the top of the formation. A thick clay bed, the Swinley Clay Member, is included at the top."*

3.2.2 Superficial and artificial deposits are not reported within the site. Given the site history, a thickness of Made Ground should be expected.

3.3 British Geological Survey (BGS) Borehole Data

3.3.1 As part of the assessment, the BGS archives regarding publicly available borehole records were searched. No publicly available borehole records were available within 250m of the site boundary.

3.4 Hydrogeology & Hydrology

3.4.1 General information about the hydrogeology of the site was obtained from the Environment Agency website.

Groundwater Vulnerability

3.4.2 Since 1 April 2010, the EA's Groundwater Protection Policy uses aquifer designations that are consistent with the Water Framework Directive. This comprises;

- **Secondary 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. These are generally aquifers formerly classified as minor aquifers;

- **Secondary B** - predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers.

- **Secondary Undifferentiated** - has been assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.

- **Principal Aquifer** – this is a formation with a high primary permeability, supplying large quantities of water for public supply abstraction.
- **Unproductive Strata** - These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

Source Protection Zones (SPZ)

3.4.3 In terms of aquifer protection, the EA generally adopts a three-fold classification of SPZs for public water supply abstraction wells.

- Zone I - or 'Inner Protection Zone' is located immediately adjacent to the groundwater source and is based on a 50-day travel time. It is designed to protect against the effects of human activity and biological/chemical contaminants that may have an immediate effect on the source.
- Zone II - or 'Outer Protection Zone' is defined by a 400-day travel time to the source. The travel time is designed to provide delay and attenuation of slowly degrading pollutants.
- Zone III - or 'Total Catchment' is the total area needed to support removal of water from the borehole, and to support any discharge from the borehole.

Hydrology

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

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

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

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

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

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

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

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

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

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

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

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

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

Table 3.1: Summary of Hydrogeology & Hydrology

Feature		On Site	Off Site	Potential Receptor?
Aquifer	**Superficial:**	-	Secondary A (398m NE of site)	X
	Solid:	Secondary A	Unproductive (456m S of site)	✓
Source Protection Zone		None	No SPZs within 500m of the site.	X
Abstractions		None	No groundwater, surface water or potable water abstractions within 1km of the site.	X
Surface Water Features/Detailed River Networks		None	3No. surface water features within 250m of the site. Nearest 152m N of site. 4No. detailed river networks within 500m of the site. Nearest is a tertiary river 152m N of site.	✓
Flood Risk	**EA Flood Zone 2**	No		
	EA Flood Zone 3	No		
	RoFRaS	Very low		
	Flood Defences	There are no areas benefiting from Flood Defences within 250m of the study site		
	BGS	The BGS has a 'low' confidence that there is a potential for 'clearwater' flooding at the site; this is also described as a 'limited potential'		

3.5 Radon

3.5.1 The site is reported not to lie within a Radon affected area, as less than 1% of properties are above the action level.

3.5.2 Consequently, no radon protective measures are necessary in the construction of new dwellings or extensions as described in publication BR211 (BRE, 2007).

4 GEOLOGICAL HAZARDS

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

Table 4.1: Geological Hazards

Potential Hazard	Site check Hazard Rating	Details	Further Action Required?
Shrink swell	Negligible	Ground conditions predominantly non-plastic. No special actions required to avoid problems due to shrink-swell clays. No special ground investigation required, and increased construction costs or increased financial risks are unlikely likely due to potential problems with shrink-swell clays.	No
Landslides	Very low	Slope instability problems are unlikely to be present. No special actions required to avoid problems due to landslides. No special ground investigation required, and increased construction costs or increased financial risks are unlikely due to potential problems with landslides.	No
Ground dissolution soluble rocks	Negligible	Soluble rocks are present, but unlikely to cause problems except under exceptional conditions. No special actions required to avoid problems due to soluble rocks.	No
Compressible deposits	Negligible	No indicators for compressible deposits identified. No special actions required to avoid problems due to compressible deposits. No special ground investigation required, and increased construction costs or increased financial risks are unlikely due to potential problems with compressible deposits.	No
Collapsible Rock	Very Low	Deposits with the potential to collapse when loaded and saturated are unlikely to be present. No special ground investigation required.	No
Running sand	Low	Possibility of running sand problems after major changes in ground conditions. Normal maintenance to avoid leakage of water-bearing services or water bodies (ponds, swimming pools) should reduce likelihood of problems due to running sand. For new build - consider possibility of running sand into trenches or excavations if water table is high or sandy strata are exposed to water. Avoid concentrated water inputs to site. Unlikely to be an increase in construction costs due to potential for running sand. For existing property - no significant increase in insurance risk due to running sand problems is likely.	No

Potential Hazard	Site check Hazard Rating	Details	Further Action Required?
Coal mining	No	There are no coal mining areas identified within 1000m of the site boundary.	No
Non-coal mining	No	-	No
Brine affected areas	No	-	No

4.1.2 In addition, the GeoInsight report notes the following:

- 5No. historical surface ground working features are reported within 250m of the site. Nearest reported 110m south of the site for unspecified ground workings.
- No. historical underground working features are reported within 1km of the site.
- No BGS Current Ground Working Features are reported within 1km of the site.
- No railway lines (active, historical or planned) or railway tunnels have been identified within 250m of the site boundary.

4.1.3 It is recommended that a geotechnical ground investigation is undertaken to help allow foundation design.

5 HYDROLOGY AND FLOOD RISK

5.1 Hydrology and Flood Risk

5.1.1 In accordance with the NPPF Guidance, below is a review of flood risks posed to and from the development and recommendations for appropriate design mitigation where necessary. Specific areas considered are based on the requirements laid out in the "Camden Guidance for Subterranean Development". This document is generally considered to be the most comprehensive Local Authority Guidance in the London area.

Table 5.1: Flood Risks

Flood Sources	Site Status	Comment on flood risk posed to / from the development
Fluvial / Tidal	Site is not within 250m of an Environment Agency Zone 2 or zone 3 floodplain. Risk of flooding from rivers and the sea (RoFRaS) rating very low.	The proposed basement is under the existing building footprint, as well as extending out laterally as part of an extension to the main building. The swimming pool will be moved and as such extending the main dwelling into the swimming pools' current position and to the south east corner As such there is relatively large increase in impermeable areas and hence additional SUDS may be required.
Groundwater	The BGS considers the area to have a limited potential for clearwater flooding.	Basement will be fully waterproofed as appropriate to industry standard. During the walkover, no evidence of groundwater ingress was noted into the existing basement or through the retaining walls supporting the ground either side of the access to the underground car park. Low Risk
Artificial Sources	Very small isolated man-made pond (~3x2m wide) on site. No artificial sources of groundwater / surface water identified within 250m of site.	Basement will be fully waterproofed as appropriate to industry standard. Low Risk
Surface Water / Sewer Flooding	The nearest surface water feature is identified as a tertiary river 152m N of site. Condition, depth and location of surrounding infrastructure uncertain.	An increase in impermeable areas is anticipated –SUDS may be required Development will utilise existing connection to sewers, gravity drainage and non-return valves. The new swimming pool will likely utilise the original drainage under Scheiber House. Development unlikely to significantly increase the peak flow / volume of discharge from the site: Low Risk
Climate Change	Included in the flood modelling extents	Development will not significantly increase the peak flow and volume of discharge from the site

	Site not within climate change flood extent area	Low risk posed to and from the development

5.1.2 Based on the available data, the site is in considered to be at low risk from identified potential sources of flooding. The basement can be constructed and operated safely in flood risk terms without increasing flood risk elsewhere and is therefore considered NPPF compliant.

5.2 Surface Water Flood Risk

5.2.1 Based on EA mapping, the site and highways surrounding the site are not within an area identified as a high risk for surface water flooding potential; site itself not likely to be inundated.

5.3 Slight Increase in Impermeable Areas

5.3.1 The swimming pool is to be reconstructed in a new location and the main building and basement extended onto the area previously occupied by the swimming pool.

5.3.2 It is likely that there will be a slight increase in impermeable areas and hence further SUDS may be required.

5.4 Hydrogeology

5.4.1 The baseline hydrogeology of the site is based on available hydrogeological mapping, including the BGS online mapping, and generic information obtained from the Groundsure Report.

5.4.2 The available data indicates that the geology of the area consists of Bagshot Formation. The BGS considers that there is ‘limited potential’ for clearwater flooding in the area.

5.5 Sequential and Exception Tests

5.5.1 The Sequential Test aims to ensure that development does not take place in areas at high risk of flooding when appropriate areas of lower risk are reasonably available.

Sequential Test: within FZ1 and no additional dwelling hence pass by default.

5.5.2 Paragraph 19 of PPS25 recognizes the fact that wider sustainable development criteria may require the development of some land that cannot be delivered through the sequential test. In these circumstances, the Exception Test can be applied to some developments depending on their vulnerability classification (Table D.2 of PPS25). The Exception Test provides a method of managing flood risk while still allowing necessary development to occur.

Exception Test: FZ1 hence pass by default and low risk posed to and from other sources

5.6 Flood Resilience

5.6.1 In accordance with general basement flood policy and basement design, the proposed development will utilize the flood resilient techniques recommended in the

NPPF Technical Guidance where appropriate and also the recommendations that have previously been issued by various councils.

5.6.2 These include:

- Basement to be fully waterproofed (tanked) and waterproofing to be tied in to the ground floor slab as appropriate: to reduce the turnaround time for returning the property to full operation after a flood event.
- Plasterboards will be installed in horizontal sheets rather than conventional vertical installation methods to minimise the amount of plasterboard that could be damaged in a flood event
- Wall sockets will be raised to as high as is feasible and practicable in order to minimise damage if flood waters inundate the property
- Any wood fixings on basement / ground floor will be robust and/or protected by suitable coatings in order to minimise damage during a flood event
- The basement waterproofing where feasible will be extended to an appropriate level above existing ground levels.
- The concrete sub floor as standard will likely be laid to fall to drains or gullies which will remove any build-up of ground water to a sump pump where it will be pumped into the mains sewer. This pump will be fitted with a non-return valve to prevent water backing up into the property should the mains sewer become full
- Insulation to the external walls will be specified as rigid board which has impermeable foil facings that are resistant to the passage of water vapour and double the thermal resistance of the cavity.

6 LAND CONTAMINATION ASSESSMENT

6.1 Industrial and Statutory Consents

6.1.1 The Groundsure EnviroInsight Report provides information on various statutory and industrial consents on and in the vicinity of the site. The following section summarises the information collected from the available sources.

Table 6.1: Industrial and Statutory Consents

Type of Consent/Authorisation	On site	Off-site (within 500m of site, unless stated otherwise)	Potential to Impact on Site from a land contamination perspective
Discharge Consents.	None	1No.; reported 444m SE of the site for unspecified trade discharges.	X
Water Industry Act Referrals	None	None reported within 500m of the site.	X
Red List Discharges	None	None reported within 500m of the site.	X
List 1 and List 2 Dangerous Substances	None	None reported within 500m of the site.	X
Control of Major Accident Hazards (COMAH) and Notification of Installations Handling Hazardous Substances (NIHHS) Sites.	None	None reported within 500m of the site.	X
Planning Hazardous Substance Consents	None	None reported within 500m of the site.	X
Category 3 or 4 Radioactive substances Authorisations	None	None reported within 500m of the site.	X
Pollution Incidents (List 2).	None	None reported within 500m of the site.	X
Pollution Incidents (List 1)	None	None reported within 500m of the site.	X
Contaminated Land Register Entries and Notices.	None	None reported within 500m of the site.	X
Registered Landfill Sites.	None	None reported within 500m of the site.	X
Waste Treatment and/or Transfer Sites.	None	None reported within 500m of the site.	X
Fuel Station Entries	None	None reported within 500m of the site.	X
Current Industrial Site Data.	None	1No. reported within 250m of site. Identified as an electricity sub-station 39m SE of the site.	X

6.2 Landfill and Made Ground

6.2.1 According to the Environment Agency there are no licensed landfill sites within 1km of the site.

6.3 Environmental Risk - Legislative Framework

6.3.1 A qualitative risk assessment has been prepared for the site, based on the information collated. This highlights the potential sources, pathways and receptors. Intrusive investigations will be required to confirm the actual site conditions and risks.

6.3.2 Under Part IIA of the Environmental Protection Act 1990, the statutory definition of contaminated land is:

"*land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that:*

(a) significant harm is being caused or there is a significant possibility of such harm being caused; or

(b) pollution of controlled waters is being, or is likely to be, caused."

6.3.3 The Statutory Guidance provided in the DEFRA Circular 01/2006 lists the following categories of significant harm:

- death, disease, serious injury, genetic mutation, birth defects or the impairment of reproduction functions in human beings;
- irreversible adverse change, or threat to endangered species, affecting an ecosystem in a protected area (i.e. site of special scientific interest);
- death, serious disease or serious physical damage to pets, livestock, game animals or fish;
- a substantial loss in yield or value of crops, timber or produce; and
- structural failure, substantial damage or substantial interference with right of occupation to any building.

6.3.4 Contaminated land will only be identified when a 'pollutant linkage' has been established.

6.3.5 A 'pollutant linkage' is defined in Part IIA as:

"A linkage between a contaminant Source and a Receptor by means of a Pathway".

6.3.6 Therefore, this report presents an assessment of the potential pollutant linkages that may be associated with the site, in order to determine whether additional investigations are required to assess their significance.

6.3.7 In accordance with the National Planning Policy Framework, where development is proposed, the developer is responsible for ensuring that the development is safe and suitable for use for the purpose for which it is intended, or can be made so by remedial action. In particular, the developer should carry out an adequate investigation to inform a risk assessment to determine:

- whether the land in question is already affected by contamination through source – pathway – receptor pollutant linkages and how those linkages are represented in a conceptual model;
- whether the development proposed will create new linkages, e.g. new pathways by which existing contaminants might reach existing or proposed receptors and whether it will introduce new vulnerable receptors; and
- what action is needed to break those linkages and avoid new ones, deal with any unacceptable risks and enable development and future occupancy of the site and neighbouring land.

6.3.8 A potential developer will need to satisfy the Local Authority that unacceptable risk from contamination will be successfully addressed through remediation without undue environmental impact during and following the development.

6.4 Conceptual Site Model

6.4.1 On the basis of the information summarised above, a conceptual site model (CSM) has been developed for the site. The CSM is used to guide the investigation activities at the site and identifies potential contamination sources, receptors (both on and off-site) and exposure pathways that may be present. The identification of such potential "pollutant linkages" is a key aspect of the evaluation of potentially contaminated land.

6.4.2 The site investigation is then undertaken in order to prove or disprove the presence of these potential source-pathway-receptor linkages. Under current legislation an environmental risk is only deemed to exist if there are proven linkages between all three elements (source, pathway and receptor).

6.4.3 This part of the report lists the potential sources, pathways and receptors at the site, and assesses based on current and future land use, whether pollution linkages are possible.

6.4.4 Potential pollutant linkages identified at the site are detailed below:

Table 6.2: Potential Sources, Pathways and Receptors

Source(s)	Pathway(s)	Receptor(s)
• Potential for Made Ground associated with previous development operations – on site (S1) • Potential asbestos impacted soils from demolition of previous buildings – on site (S2)	• Ingestion and dermal contact with contaminated soil (P1) • Inhalation or contact with potentially contaminated dust and vapours (P2) • Leaching through permeable soils, migration within the vadose zone (i.e., unsaturated soil above the water table) and/or lateral migration within surface water, as a result of cracked hard standing or via service pipe/corridors and surface water runoff. (P3) • Horizontal and vertical migration of contaminants within groundwater (P4) • Permeation of water pipes and attack on concrete foundations by aggressive soil conditions (P5)	• Construction workers (R1) • Maintenance workers (R2) • Neighbouring site users (R3) • Future site users (R4) • Building foundations and on site buried services (water mains, electricity and sewer) (R5) • Controlled waters - secondary A aquifer (R6)

6.5 Qualitative Risk Estimation

6.5.1 Based on information previously presented in this report, a qualitative risk estimation was undertaken.

6.5.2 For each potential pollutant linkage identified in the conceptual model, the potential risk can be evaluated, based on the following principle:

Overall contamination risk = Probability of event occurring x Consequence of event occurring

6.5.3 In accordance with CIRIA C552, the consequence of a risk occurring has been classified into the following categories:

- Severe
- Medium
- Mild
- Minor

6.5.4 The probability of a risk occurring has been classified into the following categories:

- High Likelihood
- Likely
- Low Likelihood
- Unlikely

6.5.5 This relationship can be represented graphically as a matrix (Table 6.3).

Table 6.3: Overall Contamination Risk Matrix

		Consequence			
		Severe	**Medium**	**Mild**	**Minor**
Probability	**High Likelihood**	Very high risk	High risk	Moderate risk	Low risk
	Medium	High risk	Moderate risk	Moderate risk	Low risk
	Low Likelihood	Moderate risk	Moderate risk	Low risk	Very low risk
	Unlikely	Low risk	Low risk	Very low risk	Very low risk

6.5.6 The risk assessment process is based on guidance provided in CIRIA C552 (2001) *Contaminated Land Risk Assessment – A Guide to Good Practice*. Further information including definitions of descriptive terms used in the risk assessment process is included in Appendix 4.

6.5.7 The degree of risk is based on a combination of the potential sources and the sensitivity of the environment. The risk classifications can be cross checked with reference to Table A4.4 in Appendix 4.

6.5.8 Hazard assessment was also carried out, the outcome of which could be:

- Urgent Action (UA) required to break existing source-pathway-receptor link.
- Ground Investigation (GI) required to gather more information.
- Watching Brief there is no evidence of potential contamination but the possibility of it exists and so the site should be monitored for local and olfactory evidence of contamination.
- No action required (NA)

6.5.9 The preliminary risk assessment for the site is presented in Table 6.4 overleaf.

Table 6.4: Preliminary Risk Assessment for the Site

Sources	Pathways	Receptors	Consequence	Probability of pollutant linkage	Risk Estimation	Hazard Assessment
• Potential for Made Ground associated with previous development operations – on site (S1) • Potential asbestos impacted soils from demolition of previous buildings – on site (S2)	• Ingestion and dermal contact with contaminated soil (P1) • Inhalation or contact with potentially contaminated dust and vapours (P2) • Leaching through permeable soils, migration within the vadose zone (i.e., unsaturated soil above the water table) and/or lateral migration within surface water, as a result of cracked hard standing or via service pipe/corridors and surface water runoff. (P3) • Horizontal and vertical migration of contaminants within groundwater (P4) • Permeation of water pipes and attack on concrete foundations by aggressive soil conditions (P5)	• Construction workers (R1) • Maintenance workers (R2) • Neighbouring site users (R3) • Future site users (R4) • Building foundations and on site buried services (water mains, electricity and sewer) (R5) • Controlled waters - secondary A aquifer (R6)	Mild Severe for asbestos	Low Medium for asbestos	Low risk High risk for asbestos	GI

6.5.10 It should be noted that the identification of potential pollutant linkages does not necessarily signify that the site is unsuitable for its current or proposed land use. It does however act as a way of focussing data collection at the site in accordance with regulatory guidance in CLR 11.

6.6 Outcome of Risk Assessment

6.6.1 It is understood that the proposed development comprises the excavation of a basement below the existing lower ground floor of a residential property.

6.6.2 The risk estimation matrix indicates a **low** risk as defined above. A high risk has been designated due to possible asbestos in the ground.

6.6.3 No significant potential sources of contamination were identified during the desk based assessment. It is recommended that a number of soil samples obtained during the geotechnical investigation are analysed for a suite of general contaminants to confirm the lack of contamination within the site.

6.6.4 No potential sources of ground gas have been noted, as a consequence ground gas monitoring is not considered to be necessary. However, groundwater will be required for basement design. Consequently, it may be prudent to measure ground gas concentrations at the same time to confirm that there is not an issue.

6.7 List of Key Contaminants

6.7.1 The possible contamination implications for both on-site and off-site sources have been assessed based on the information presented in the report. This has been achieved using guidance publications by the Environment Agency, together with other sources.

6.7.2 It is recommended that samples are taken and analysed for a broad suite of determinants, including asbestos, to confirm the low risk determination for the site.

6.7.3 It is also recommended that testing is undertaken to help categorise the material that will be excavated for waste disposal options.

7 SCREENING AND SCOPING ASSESSMENT

7.1 Screening Assessment

7.1.1 Screening is the process of determining whether or not there are areas of concern which require a BIA for a particular project. This was undertaken in previous sections by the site characterisation. Scoping is the process of producing a statement which defines further matters of concern identified in the screening stage. This defining is in terms of ground processes in order that a site specific BIA can be designed and executed by deciding what aspects identified in the screening stage require further investigation by desk research or intrusive drilling and monitoring or other work.

7.1.2 The scoping stage highlights areas of concern where further investigation, intrusive soil and water testing and groundwater monitoring may be required.

7.1.3 This Jomas BIA also takes into account the Campbell Reith pro forma BIA produced on behalf of and published by the London Borough of Camden as guidance for applicants to ensure that all of the required information is provided. Within the pro forma a series of tables have been used to identify what issues are relevant to the site.

7.1.4 Each question posed in the tables is completed by answering "Yes", "No" or "Unknown" based on the information obtained so far from the Desk Study. Any question answered with "Yes" or "Unknown" is then subsequently carried forward to the scoping phase of the assessment.

7.1.5 The results of the screening process for the site are provided in Table 5.1 below. Where further discussion is required the items have been carried forward to scoping.

7.1.6 The numbering within the questions refers the reader to the appropriate question / section in the London Borough of Camden BIA pro forma

7.1.7 It should also be noted that the Royal Borough of Kensington and Chelsea may not place the same importance on the issues identified in the London Borough of Camden's guidance documents. . It should be noted that the pro forma is mainly concerned with the pond chain on Hampstead Heath, if other ponds / waterbodies may similarly affect the development Jomas will indicate this.

7.1.8 A Site Investigation is undertaken where necessary to establish base conditions and the impact assessment determines the impact of the proposed basement on the baseline conditions, taking into account any mitigating measures proposed.

Table 7.1: Screening Assessment

Query	Y / N	Comment
Subterranean (Groundwater) Flow (see London Borough of Camden BIA Pro Forma Section 4.1.1)		
1a) Is the site located directly above an aquifer?	Yes	The site is directly underlain by a Secondary A aquifer.
1b) Will the proposed basement extend below the surface of the water table?	Unknown	Groundwater is anticipated within the Bagshot Formation underlying the site.

Query	Y / N	Comment
2) Is the site within 100m of a watercourse, well (disused or used) or a potential spring line?	No	Nearest such feature identified as a spring 200m NE of site.
3) Is the site within the catchment of the pond chains on Hampstead Heath?	Yes	According to Figure 14 of Arup GSD, the site is within the "Golders Hill Chain Catchment" and therefore part of the catchment of the pond chains on Hampstead Heath
4) Will the proposed basement development result in a change in the proportion of hard surfaced/paved areas?	Yes	The proposed development is to add a basement under an existing building, as well as extending out laterally as part of an extension to the main building. In addition, the swimming pool is to be moved and the building extended to the area currently occupied by the pool.
5) As part of the site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or SUDS)?	No	There is no reason to believe that more water than at present will be or could be discharged to the ground.
6) Is the lowest point of the proposed excavation (allowing of any drainage and foundation space under the basement floor) close to, or lower than, the mean water level in any local pond (not just the pond chains on Hampstead Heath or spring line?	No	Very small man-made ornamental pond on site currently at lower ground floor level. This pond is however lined and will not be a source of water to the local groundwater
Slope Stability ((see London Borough of Camden BIA Pro Forma Section 4.2)		
1) Does the existing site include slopes, natural or manmade, greater than 7 degrees? (approximately 1 in 8)	Yes	The driveway down from road level leads to lower ground floor level garage.
2) Will the proposed re-profiling of landscaping change slopes at the property to more than 7 degrees? (approximately 1 in 8)	No	It is not considered that new slopes of greater than 1 in 8 will be created.
3) Does the developments' neighbouring land include railway cuttings and the like, with a slope greater than 7 degrees? (approximately 1 in 8)	No	Surrounding land is mostly residential in nature.
4) Is the site within a wider hillside setting in which the general slope is greater than 7 degrees? (approximately 1 in 8)	No	Surrounding land is generally level.
5) Is the London Clay the shallowest strata at the site?	No	The site is directly underlain by the Bagshot Formation (Sand).
6) Will any trees be felled as part of the proposed development and/or are any works proposed within any tree protection zones where trees are to be retained?	No	No trees will be felled as part of this development.

Query	Y / N	Comment
7) Is there a history of seasonal shrink-swell subsidence in the local area, and/or evidence of such effects at the site?	No	The site is directly underlain by the Bagshot Formation (Sand). The site is reported to be in area at negligible risk from shrink-swell clays. It is possible that clays may be present as part of the Bagshot Formation however these would be expected to have a low volume change potential due to the materials sand content.
8) Is the site within 100m of a watercourse or a spring line?	No	Closest water course is 152m away,
9) Is the site within an area of previously worked ground?	No	However the site has previously been developed with previous buildings demolished.
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?	Unknown	The basement will extend into a Secondary A aquifer, although it is not known how high the water table is. This will be confirmed during the site investigation.
11) Is the site within 50m of the Hampstead Heath ponds?	No	
12) Is the site within 5m of a highway or pedestrian 'right of way'?	Yes	The site faces onto a pavement and road on the north and east sides. It is known that the proposed new location of the swimming pool places at a distance of 2m from the northern boundary with West Heath Road.
13) Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Unknown	The new basement foundations may increase the differential depth of foundations relative to neighbouring properties however this is dependent on the type of foundations used at the neighbouring properties and this is currently unknown. It should also be noted that that the current property has an existing basement and the new proposed basement will essentially extend the existing foundation.
14) Is the site over (or within the exclusion of) any tunnels e.g. railway lines?	No	There are no reports of railway lines or tunnels within close proximity of the site.
Surface Flow and Flooding (see London Borough of Camden BIA Pro Forma Section 4.3)		
1) Is the site within the catchment of the pond chains on Hampstead Heath?	No	Very small man-made ornamental pond on site. Pond is lined and is not considered a risk,
2) As part of the site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially different from the existing route?	Yes	The proposed development is to add a basement under an existing building , as well

Query	Y / N	Comment
3) Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?	Yes	as extending out laterally as part of an extension to the main building. In addition ,the swimming pool is to be moved and the building extended to the area currently occupied by the pool.
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	No surface waters in the area to be impacted.
5) Will the proposed basement result in changes to the quality of surface waters being received by adjacent properties or downstream watercourses?	No	No surface waters in the area to be impacted.
6) Is the site in an area identified to have surface water flood risk according to either the Local Flood Risk Management Strategy or Strategic Flood Risk Assessment or is it at risk from flooding, for example because the proposed basement is below the static water level of a nearby surface water feature?	No	No nearby surface water features and not within an EA flood zone.

7.2 Scoping

7.2.1 Scoping is the activity of defining in further detail the matters to be investigated as part of the BIA process. Scoping comprises of the definition of the required investigation needed in order to determine in detail the nature and significance of the potential impacts identified during screening.

7.2.2 The potential impacts for each of the matters highlighted in Table 7.1 above are discussed in further detail below together with the requirements for further investigations. Detailed assessment of the potential impacts and recommendations are provided where possible.

<u>Subterranean (Groundwater) Flow</u>

7.2.3 The investigation should confirm the ground conditions beneath the site including if the site is directly above an aquifer (the Secondary A Aquifer) and groundwater levels.

7.2.4 This can then confirm the relative depths of the basement to the groundwater levels as well as the relevant levels between the ponds on Hampstead Heath and the basement.

7.2.5 Ideally a minimum of three groundwater monitoring wells should be installed to allow groundwater table to be triangulated. However, it is acknowledged that this may not be possible.

7.2.6 A review of the ground conditions encountered may mean that a qualitied assessment of the likelihood of groundwater moving between the site and these ponds could be undertaken.

<u>Land Stability</u>

7.2.7 The driveway down from road level leads to lower ground floor level garage is noted to be greater than 7°. The Groundsure report has noted that there is at “very low” risk of land instability issues. It should also be noted that the driveway is not a natural slope but is an engineered slope and as such will have been designed taking into account the ground conditions and with a suitable factor of safety. It is therefore considered that investigation works to specifically investigate and model the slope is not required.

7.2.8 The investigation should also determine the possibility of encountering groundwater and the possibility of Made Ground and/or sand immediately beneath the site. Therefore any issues relating to groundwater management and excavation stability.

7.2.9 It is recommended that details of any basement associated with Schreiber House are determined. Given that the swimming pool was originally part of this property it is likely that a basement is present. As the property is a Grade II listed building it may be possible to find documentary evidence for the basement without requiring full survey access to the building.

Surface Flow and Flooding

7.2.10 The investigation should provide information that could be used with the SUDs Toolkit if required, to assess the need for SUDs.

8 GROUND INVESTIGATION

8.1 Rationale for Ground Investigation

8.1.1 The site investigation has been undertaken generally in accordance with Contaminated Land Report 11, BS10175, NHBC Standards Chapter 4.1, and other associated Statutory Guidance. If required, further targeted investigations and remedial option appraisal would be dependent on the findings of this site investigation.

8.1.2 The soil sampling rationale for the site investigation was developed with reference to EA guidance 'Secondary Model Procedure for the Development of Appropriate Soil Sampling Strategies for Land Contamination' (Technical Report P5-066/TR).

8.1.3 The sampling proposal was designed in order to gather data representative of the site conditions, to investigate the sources identified in the CSM and to address the issues identified in the Screening and Scoping section of the BIA.

8.2 Scope of Ground Investigation

8.2.1 The ground investigation was undertaken on 27th June 2017 and consisted of:

- 2No. window sample boreholes to 6.0mbgl.
- 1No. Hand excavated trial pits.

8.2.2 The work was undertaken in accordance with BS: 5930 'Code of Practice for Site Investigation' and BS: 10175 'Investigation of Potentially Contaminated Sites'. All works were completed without incident.

8.2.3 The investigation focused on collecting data on the following:

- Quality of Made Ground/ natural ground within the site boundaries;
- Presence of groundwater beneath the site (if any), perched or otherwise;

8.2.4 A summary of the fieldwork carried out at the site, with justifications for exploratory hole positions, are offered in Table 8.1 below.

Table 8.1: Scope of Intrusive Investigation

Investigation Type	No. of Exploratory Holes Achieved	Exploratory Hole Designation	Depth Achieved (mBGL)	Justification
Hand Dug Trial Pits	1	HTP3	Up to 1mbgl	To investigate existing building foundations
Window Sample Boreholes	2	WS1-WS2	Up to 5mbgl	Investigate shallow ground condition and collect samples for chemical and geotechnical laboratory testing. To allow insitu geotechnical testing.
Monitoring Well	2	WS1-WS2	Up to 5mbgl	Combined soil gas and groundwater monitoring well.

8.2.5 The exploratory holes were completed to allow soil samples to be taken in the areas of interest identified in Table 8.1 above. In all cases, all holes were logged in accordance with BS:5930 (2015).

8.2.6 Exploratory hole positions were positioned as shown in the exploratory hole location plan presented in Appendix 1. The exploratory hole records are included in Appendix 5.

8.2.7 Installations were finished with a steel cover flush to the ground surface.

8.3 Trial Pits to Expose Foundations

8.3.1 A single hand excavated pit was undertaken to expose existing foundations.

8.3.2 HTP3 was excavated on the outside of the building on the north-eastern side of the house at lower ground floor level. The pit was extended to 1mbgl, exposing a “step” of 0.30m width. The top of the step was measured to 0.50m depth; the base of the step could not be proven, but extended to at least 1mbgl at the base of the pit.

8.3.3 HTP1 could not be carried out due to the flooring and cupboards etc. present.

8.3.4 HTP2 was attempted twice (HTP2a and HTP2b) neither hole could get through the exceptionally thick concrete flooring of the garage,

8.3.5 Copies of the stratigraphical logs and sketches of the foundations can be found in Appendix 5.

8.4 Sampling Rationale

8.4.1 Our soil sampling rationale for the site investigation was developed with reference to EA guidance ‘Secondary Model Procedure for the Development of Appropriate Soil Sampling Strategies for Land Contamination’ (Technical Report P5-066/TR).

8.4.2 The exploratory holes were positioned by applying a combined non-targeted sampling strategy.

8.4.3 Soil samples were taken from across the site at various depths as shown in the exploratory hole logs.

8.4.4 JOMAS’ engineers normally collect samples at appropriate depths based on field observations such as:

- appearance, colour and odour of the strata and other materials, and changes in these;
- the presence or otherwise of sub-surface features such as pipework, tanks, foundations and walls; and,
- areas of obvious damage, e.g. to the building fabric.

8.4.5 A number of the samples were taken from the top 0-1m to aid in the assessment of the pollutant linkages identified at the site. In addition, some deeper samples were taken to aid in the interpretation of fate and transport of any contamination identified.

8.4.6 Samples were stored in cool boxes (<4^{o}C) and preserved in accordance with laboratory guidance.

8.4.7 Disturbed samples were collected for geotechnical analysis.

8.4.8 Groundwater strikes noted during drilling, are recorded within the exploratory hole records in Appendix 5.

8.5 Sampling Limitations

8.5.1 4No. hand excavated trial pits were proposed along with 4No. window sample boreholes. Only 1No. pit and 2No. boreholes could be completed due to time and access constraints. The information obtained is considered sufficient for this assessment.

8.5.2 The base of the foundation could not be proven at HTP1 as it extended beyond the depth that was possible to excavate by hand without shoring, for health and safety purposes.

8.6 In-situ Geotechnical Testing

8.6.1 In-situ geotechnical testing included Standard Penetration Tests (SPT) to determine a 'N' value. This has been used to determine a relative density description of granular materials and has been used to help determine the undrained shear strength of cohesive materials.

8.7 Laboratory Analysis

8.7.1 A programme of laboratory testing, scheduled by Jomas, was carried out on selected samples of Made Ground and natural strata.

<u>Chemical Testing</u>

8.7.2 Soil samples were submitted to i2 Analytical (a UKAS and MCerts accredited laboratory), for analysis.

8.7.3 The samples were analysed for a wide range of contaminants as shown in Table 8.2 below:

Table 8.2: Chemical Tests Scheduled

	No. of tests	
Test Suite	**Made Ground / Topsoil**	**Natural**
Jomas Suite 3	3	0
Total Organic Carbon	2	0
Water Soluble Sulphate	3*	3
Asbestos	2	0
Waste Acceptance Criteria	1	0

**Tested for as part of Jomas Suite S3*

8.7.4 The determinands contained in the basic suite are as detailed in Table 8.3 below:

Table 8.3: Basic Suite of Determinands

DETERMINAND	LIMIT OF DETECTION (mg/kg)	UKAS ACCREDITATION	TECHNIQUE
Arsenic	1	Y (MCERTS)	ICPMS
Cadmium	0.2	Y (MCERTS)	ICPMS
Chromium	1	Y (MCERTS)	ICPMS
Chromium (Hexavalent)	4	Y (MCERTS)	Colorimetry
Lead	1	Y (MCERTS)	ICPMS
Mercury	0.3	Y (MCERTS)	ICPMS
Nickel	1	Y (MCERTS)	ICPMS
Selenium	1	PENDING	ICPMS
Copper	1	Y (MCERTS)	ICPMS
Zinc	1	Y (MCERTS)	ICPMS
Boron (Water Soluble)	0.2	Y (MCERTS)	ICPMS
pH Value	0.1 units	Y (MCERTS)	Electrometric
Sulphate (Water Soluble)	0.0125g/l	Y (MCERTS)	Ion Chromatography
Total Cyanide	1	Y (MCERTS)	Colorimetry
Speciated PAH	0.05/0.80	Y (MCERTS)	GCFID
Phenols	1	Y (MCERTS)	HPLC
Total Petroleum Hydrocarbons (banded)	-	N	Gas Chromatography

8.7.5 To support the derivation of appropriate tier 1 screening values, 2No samples were analysed for total organic carbon.

8.7.6 Laboratory test results are summarised in Section 10, with raw laboratory data included in Appendix 6.

Geotechnical Laboratory Testing

8.7.7 In addition to the contamination assessment, soil samples were submitted to the UKAS Accredited laboratory of i2 Analytical for the following assessment:

- 4No. Moisture Content Determinations
- 4No. Atterberg Limits
- 1No. Particle Size Distribution

8.7.8 All testing was in accordance with BS 1377.

8.7.9 The pH and sulphate results from the chemical testing were used for concrete classification purposes.

8.7.10 In-situ geotechnical testing included Standard Penetration Tests (SPT) to determine a 'N' value. This has been used to determine a relative density description of granular materials and has been used to help determine the undrained shear strength of cohesive materials.

8.7.11 The results of the geotechnical laboratory testing are presented as Appendix 7 and discussed in Section 14 of this report.

9 GROUND CONDITIONS

9.1 Soil

9.1.1 Ground conditions were logged in accordance with the requirements of BS: 5930 (2015). Detailed exploratory hole logs are provided in Appendix 5. The ground conditions encountered are summarised in Table 9.1 below, based on the strata observed during the investigation.

Table 9.1: Ground Conditions Encountered

Stratum and Description	Encountered from (m bgl)	Base of strata (m bgl)	Thickness range (m)
Brown slightly clayey gravelly sand. Gravel consists of flint, brick and glass. (MADE GROUND) Encountered to base of HTP3.	0.0	0.70 - >1.00 Terminal depth in HTP3	0.70 - >1.00
Orange to brown slightly sandy CLAY. (BAGSHOT FORMATION – CLAY) Encountered to base of both boreholes.	0.70 - 1.00	>4.50 - >5.00	>1.10 - >3.50
Medium dense orange to brown clayey fine to medium SAND. (BAGSHOT FORMATION – SAND) Encountered within WS1 only.	3.10	3.90	0.80

9.1.2 Given the materials expected on site and the descriptions of these materials, provided by the BGS, (See Section 3.2), it is considered that the material observed in the exploratory holes represents Made Ground overlying cohesive deposits of the Bagshot Formation - Clay with some pockets of granular Bagshot Formation - Sand.

9.2 Hydrogeology

9.2.1 Groundwater was not reported during drilling of the exploratory holes.

9.2.2 During the post drilling monitoring both WS1 and WS2 were reported as being dry to the base of the wells at 4.89m and 4.56m bgl respectively.

9.3 Physical and Olfactory Evidence of Contamination

9.3.1 Visual or olfactory evidence of contamination was not observed during the course of the investigation.

10 RISK ASSESSMENT – ANALYTICAL FRAMEWORK

10.1 Context and Objectives

10.1.1 This section seeks to evaluate the level of risk pertaining to human health and the environment which may result from both the existing use and proposed future use of the site. It makes use of the site investigation findings, as described in the previous sections, to evaluate further the potential pollutant linkages identified in the desk study. A combination of qualitative and quantitative techniques is used, as described below.

10.1.2 The purpose of generic quantitative risk assessment is to compare concentrations of contaminants found on site against screening level generic assessment criteria (GAC) to establish whether there are actual or potential unacceptable risks. It also determines whether further detailed assessment is required. The approaches detailed all broadly fit within a tiered assessment structure in line with the framework set out in the Department of Environment, Food and Rural Affairs (DEFRA), EA and Institute for Environment and Health Publication, Guidelines for Environmental Risk Assessment and Management.

10.1.3 It should be noted that the statistical tests carried out in this report in accordance with CL:AIRE and CIEH (2008) recommendations, are for guidance purposes only and the conclusions of this report should be approved by the local authority prior to any redevelopment works being undertaken.

10.2 Analytical Framework – Soils

10.2.1 There is no single methodology that covers all the various aspects of the assessment of potentially contaminated land and groundwater. Therefore, the analytical framework adopted for this investigation is made up of a number of procedures, which are outlined below. All of these are based on a Risk Assessment methodology centred on the identification and analysis of Source – Pathway – Receptor linkages.

10.2.2 The CLEA model provides a methodology for quantitative assessment of the long term risks posed to human health by exposure to contaminated soils. Toxicological data have been used to calculate Soil Guideline Values (SGV) for individual contaminants, based on the proposed site use; these represent minimal risk concentrations and may be used as screening values.

10.2.3 In the absence of any published SGVs for certain substances, or where the assumptions made in generating the SGVs do not apply to the site, JOMAS have derived Tier 1 screening values for initial assessment of the soil, based on available current UK guidance including the LQM/CIEH generic assessment criteria. Site-specific assessments are undertaken wherever possible and/or applicable. All assessments are carried out in accordance with the CLEA protocol.

10.2.4 CLEA requires a statistical treatment of the test results to take into account the normal variations in concentration of potential contaminants in the soil and allow comparisons to be made with published guidance.

10.2.5 The assessment criteria used for the screening of determinands within soils are identified within Table 10.1.

Table 10.1: Selected Assessment Criteria – Contaminants in Soils

Substance Group	Determinand(s)	Assessment Criteria Selected
Organic Substances		
Non-halogenated Hydrocarbons	Total Petroleum Hydrocarbons (TPHCWG banded)	S4UL
	Total Phenols	S4UL
Polycyclic Aromatic Hydrocarbons (PAH-16)	Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benz(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-cd)pyrene, Dibenz(a,h)anthracene, Benzo(ghi)perylene	S4UL
Volatile Organic Compounds (VOCs/sVOCs).	Toluene, Ethylbenzene	S4UL
	Benzene, Xylenes	S4UL
Inorganic Substances		
Heavy Metals and Metalloids	Arsenic, Cadmium, Chromium, Lead, Mercury, Nickel, Selenium, Copper, Zinc	S4UL
	Copper, Zinc, Nickel	BS: 3882 (2015).
Cyanides	Free Cyanide	CLEA v1.06
Sulphates	Water Soluble Sulphate	BRE Special Digest 1:2005

10.3 BRE

10.3.1 The BRE Special Digest 1:2005, ‘Concrete in Aggressive Ground’ is used with soluble sulphate and pH results to assess the aggressive chemical environment of future underground concrete structures at the site.

10.4 Site Specific Criteria

10.4.1 The criteria adopted in the selection of correct screening criteria from published reports as previously described, are provided within Tables 10.2.

Table 10.2: Site Specific Data

Input Details	Value
Land Use	Residential with plant uptake
Soil Type	Clay
pH	8
Soil Organic Matter	1%

10.4.2 A pH value of ‘8’ has been used for the derivation of generic screening criteria as 7.74 was the mean pH value of samples analysed.

10.4.3 As the published reports only offer the option of selecting an SOM value of 1%, 2.5% or 6%, an SOM value of 1% has been used for the generation of generic assessment criteria, as 0.5% was the mean value obtained from laboratory analysis.

10.4.4 It is understood that the proposal for the site is to excavate a basement beneath the existing lower ground floor of the residential property.

11 GENERIC QUANTITATIVE RISK ASSESSMENT

11.1 Screening of Soil Chemical Analysis Results – Human Health Risk Assessment

11.1.1 To focus on the contaminants of potential concern (COPC), the results have been compared with the respective SGV/GAC. Those contaminants which exceed the SGV/GAC are considered to be the COPC. Those which do not exceed the respective SGV/GAC are not considered to be COPC and as such do not require further assessment in relation to the proposed development of the site.

11.1.2 Laboratory analysis for soils are summarised in Tables 11.1 to 11.3. Raw laboratory data is included in Appendix 6.

Table 11.1: Soil Laboratory Analysis Results – Metals, Metalloids, Phenol, Cyanide

Determinand	Unit	No. samples tested	Screening Criteria		Results (mg/kg)		No. Exceeding
			Source	Value (mg/kg)	Min	Max	
Arsenic	mg/kg	4	S4UL	37	5.9	20	0
Cadmium	mg/kg	4	S4UL	11	<0.2	0.5	0
Chromium	mg/kg	4	S4UL	910	9.3	32	0
Lead	mg/kg	4	S4UL	200	39	1000	1No.; WS1 at 0.50mbgl
Mercury	mg/kg	4	S4UL	40	<0.3	1.0	0
Nickel	mg/kg	4	S4UL	180	8.0	14	0
Copper	mg/kg	4	S4UL	2400	9.4	56	0
Zinc	mg/kg	4	S4UL	3700	37	150	0
Total Cyanide [B]	mg/kg	4	CLEA v 1.06	33	<1.0	<1.0	0
Selenium	mg/kg	4	S4UL	250	<1.0	<1.0	0
Water Soluble Boron	mg/kg	4	S4UL	290	0.6	1. 2	0
Phenols	mg/kg	4	S4UL	120	<1.0	<1.0	0

Table 11.2: Soil Laboratory Analysis Results – Polycyclic Aromatic Hydrocarbons (PAHs)

Determinand	Unit	No. Samples Tested	Screening Criteria		Result (mg/kg)		No. Exceeding
			Source	Value (mg/kg)	Min	Max	
Naphthalene	mg/kg	4	S4UL	2.3	<0.05	<0.05	0
Acenaphthylene	mg/kg	4	S4UL	170	<0.05	<0.05	0
Acenaphthene	mg/kg	4	S4UL	210	<0.05	<0.05	0
Fluorene	mg/kg	4	S4UL	170	<0.05	<0.05	0
Phenanthrene	mg/kg	4	S4UL	95	<0.05	0.75	0

Determinand	Unit	No. Samples Tested	Screening Criteria		Result (mg/kg)		No. Exceeding
			Source	Value (mg/kg)	Min	Max	
Anthracene	mg/kg	4	LQM GAC	2400	<0.05	<0.05	0
Fluoranthene	mg/kg	4	S4UL	280	<0.05	1.6	0
Pyrene	mg/kg	4	S4UL	620	<0.05	1.4	0
Benzo(a)anthracene	mg/kg	4	S4UL	7.2	<0.05	0.75	0
Chrysene	mg/kg	4	S4UL	15	<0.05	0.98	0
Benzo(b)fluoranthene	mg/kg	4	S4UL	2.6	<0.05	0.98	0
Benzo(k)fluoranthene	mg/kg	4	S4UL	77	<0.05	0.69	0
Benzo(a)pyrene	mg/kg	4	S4UL	2.2	<0.05	0.94	0
Indeno(123-cd)pyrene	mg/kg	4	S4UL	27	<0.05	0.60	0
Dibenz(ah)anthracene	mg/kg	4	S4UL	0.24	<0.05	0.13	0
Benzo(ghi)perylene	mg/kg	4	S4UL	320	<0.05	0.60	0
Total PAH	mg/kg	4	-	-	<0.80	9.45	-

Table 11.3: Soil Laboratory Analysis– Total Petroleum Hydrocarbons (TPH)

TPH Band	Unit	No. Samples Tested	Screening Criteria		Result (mg/kg		No. Exceeding
			Source	Value (mg/kg)	Min	Max	
C_8-C_{10}	mg/kg	4	S4UL	27	<0.1	<0.1	0
>C_{10}-C_{12}	mg/kg	4	S4UL	74	<2.0	<2.0	0
>C_{12}-C_{16}	mg/kg	4	S4UL	140	<4.0	<4.0	0
>C_{16}-C_{21}	mg/kg	4	S4UL	260	<1.0	11	0
>C_{21}-C_{35}	mg/kg	4	S4UL	1100	<10	46	0

*lowest of aliphatics/aromatics used.

11.2 Asbestos in Soil

11.2.1 2No. samples of the Made Ground were screened in the laboratory for the presence of asbestos. The results of the analysis is summarised below in Table 11.4 below

Table 11.4: Asbestos Analysis – Summary

Sample	Screening result.	Quantification Result (%)	Comments
HTP3 – 0.20mbgl	None Detected	N/A	N/A
WS2 – 0.50mbgl	Detected	0.017	Chrysotile – loose fibres and loose fibrous debris

11.2.2 The results reported an asbestos content of below 0.1%, the fibre content at which arisings are considered hazardous for the purpose of disposal.

11.2.3 It should be noted that for the purposes of human health assessment there is no level of asbestos below which it is deemed the materials are "safe".

11.3 Screening of Soil Chemical Analysis Results – Potential Risks to Plant Growth

11.3.1 Zinc, copper and nickel are phytotoxins and could therefore inhibit plant growth in soft landscaped areas. Concentrations measured in soil for these determinands have been compared with the pH dependent values given in BS:3882 (2015).

11.3.2 Adopting a pH value of greater than 7, as indicated by the results of the laboratory analysis, the following is noted;

Table 11.5: Soil Laboratory Analysis Results – Phytotoxic Determinands

Determinand	Threshold level (mg/kg)	Min (mgkg)	Max (mg/kg)	No. Exceeding
Zinc	300	37	150	0
Copper	200	9.4	56	0
Nickel	110	8.0	14	0

11.4 Screening for Water Pipes

11.4.1 The results of the analysis have been assessed for potential impact upon water supply pipes. Table 11.6 below summarises the findings of the assessment:

Table 11.6: Screening Guide for Water Pipes

Determinand	Threshold adopted for PE (mg/kg)	Value for site data (mg/kg)	
		Min	Max
Total VOCs	0.5	N/A	N/A
BTEX	0.1	N/A	N/A
MTBE	0.1	N/A	N/A
EC5-EC10	1	<0.1	<0.1
EC10-EC16	10	<6.0	<6.0
EC16-EC40	500	<11	57
Naphthalene	5	<0.05	<0.05
Phenols	2	<1.0	<1.0

11.4.4 Determinands marked "N/A" were not analysed for as no evidence of their presence was obtained from the Desk Study.

11.5 Waste Characterisation and Disposal

11.5.1 The following comments are given as guidance and should be confirmed by the waste disposal facility accepting the waste. The waste disposal facility may have their own classification methodology and are under no obligation to honour the comments given below.

11.5.2 A single sample from WS2 at 1mbgl was submitted to a UKAS and MCERTS accredited laboratory for Waste Acceptance Criteria testing. The results indicate that soil arisings meet the criteria for disposal at an “inert waste landfill”.

11.5.3 Additional chemical testing of samples as outlined in Tables 11.1 – 11.3 above, confirmed that TPH were reported at <500mg/kg; PAH were reported at <100mg/kg.

11.5.4 Asbestos fibres were detected in a single sample and quantified at 0.017%. This is below the limit of 0.1% - the fibre content at which arisings are considered hazardous for the purpose of disposal.

11.5.5 However, the receiving facility will need to review the Total Lead concentrations reported to confirm if the waste is acceptable.

12 SOIL GAS RISK ASSESSMENT

12.1 Soil Gas Results

12.1.1 Three return monitoring visits have been undertaken to monitor wells installed within the boreholes at the site for groundwater levels. In addition, ground gas concentrations were also recorded to confirm the comments made in Section 5.5.

12.1.2 Wells were installed into WS1 and WS2 during JOMAS' investigation on the 27th June 2017 and were monitored on 3rd, 10th and 19th June 2017.

12.1.3 A complete set of monitoring results is included in Appendix 8 and summarised below in Table 12.1.

Table 12.1: Summary of Gas Monitoring Data

Hole No.	CH_4 (%)	CO_2 (%)	O_2 (%)	H_2S (ppm)	VOCs (ppm)	Peak Flow Rate (l/hr)	Depth to water (m bgl)	Depth of installation (m bgl)
WS1	0.0-0.1	1.0-1.7	19.5-19.8	0	1-40	0.0-0.5	Dry	4.89
WS2	0.0-0.1	0.6-0.9	19.8-20.2	0	1-51	0.0-0.4	Dry	4.56

12.2 Screening of Results

12.2.1 Methane was reported to a maximum concentration 0.1% v/v. The carbon dioxide was noted to a maximum concentration of 1.7%. Oxygen levels during the monitoring visit ranged between 19.5% v/v and 20.2% v/v. Volatile organic compounds (VOCs) were noted at levels peaking at 51ppm, though the reading stabilised at 20ppm. Carbon monoxide and hydrogen sulphide were not noted.

12.2.2 The atmospheric pressure was noted to range between 993 and 1007mb, with the pressure trend rising and falling at different visits.

12.2.3 In the assessment of risks posed by hazardous ground gases and selection of appropriate mitigation measures, BS84985 (2015) identifies four types of development, termed Type A to Type D.

12.2.4 Type A buildings are defined as

> *"private ownership with no building management controls on alterations to the internal structure, the use of rooms, the ventilation of rooms or the structural fabric of the building. Some small rooms present. Probably conventional building construction (rather than civil engineering). Examples include private housing and some retail premises."*

12.2.5 Type A has been adopted as the relevant category for the proposed development.

12.2.6 The soil gas assessment method is based on that proposed by Wilson & Card (1999), which was a development of a method proposed in CIRIA publication R149 (CIRIA, 1995). The method uses both gas concentrations and borehole flow rates to define a characteristic situation based on the limiting borehole gas volume flow for methane and carbon dioxide. In both these methods, the limiting borehole gas volume flow is renamed as the Gas Screening Value (GSV).

12.2.7 The Gas Screening Value (litres of gas per hour) is calculated by using the following equation

GSV = (Concentration/100) X Flow rate

Where concentration is measured in percent (%)
and flow rate is measured in litres per hour (l/hr)

12.2.8 The Characteristic Situation is then determined from Table 8.5 of CIRIA C665.

12.2.9 To accord with C665, worst case conditions are used in the calculation of GSVs for the site. These have been summarised below in Table 12.2

12.2.10 A worst-case flow rate of 0.5/hr (maximum reported) will be used in the calculation of GSVs for the site.

Table 12.2: Summary of Gas Monitoring Data

Gas	Concentration (v/v %)	Peak Flow Rate (l/hr)	GSV (l/hr)	Characteristic Situation (after CIRIA C665)
CO_2	1.7	0.5	0.0085	1
CH_4	0.1	0.5	0.0005	1

12.2.11 The result of the GSV calculation would indicate that the site may be classified as Characteristic Situation 1, where no special precautions are required.

12.2.12 Due to the construction of a basement, the basement floor and walls will need to be constructed and water proofed such that they conform to BS: 8102 (2009), Grade 3 waterproofing. This would provide 2.5 protection points in accordance with BS: 8584 (2015).

13 SUMMARY OF RESULTS

13.1 Risk Assessment - Land Quality Impact Summary

13.1.1 Following the site investigation, the following is noted:

- It is understood that the proposed development will comprise the excavation of a basement below the existing ground floor level of the residential property.

- Following generic risk assessments, an elevated concentration of lead was reported in WS1 at 0.50mbgl.

- A single sample (WS2 at 0.50mbgl) tested positive for asbestos in the form of chrysotile – loose fibres/loose fibrous debris. This was quantified at 0.017%, below the limit at which fibres are considered hazardous for disposal purposes. It should be noted that for the purposes of human health assessment there is no level of asbestos below which it is deemed the materials are "safe".

- Results of WAC testing indicate that waste soils meet the criteria for disposal as "inert" waste. The receiving facility may also consider the Lead concentration prior to confirming they are able to accept the waste soils.

- The site proposal indicates that parts of the site will remain covered by a combination of the proposed building footprint and hard surfacing. Where this is the case, no formal remedial measures are considered necessary in terms of human health, as the building and hard surfacing are expected to provide a barrier to potential receptors. In areas of soft landscaping, certified clean topsoil will be required. Further testing may be undertaken to confirm if the Lead concentrations and asbestos persists across the topsoil/made ground existing on site.

- The site is underlain by solid deposits of the Bagshot Formation, defined as a Secondary A aquifer. No groundwater was encountered during intrusive works or subsequent monitoring visits, with wells extending beyond 4.5mbgl. There are no source protection zones in close proximity to the site and the nearest surface water feature is a tertiary river 152m N of site. As a result, the risk to controlled waters is considered low.

- Calculating the Gas Screening Value using worst case results indicates Characteristic Situation 1. This would indicate that no special precautions are required. Assuming that the basement development is constructed to the necessary standards and guidelines it would provide a minimum of 2.5 gas protection points.

- As with any ground investigation, the presence of further hotspots between sampling points cannot be ruled out. Should any contamination be encountered, a suitably qualified environmental consultant should be informed immediately, so that adequate measures may be recommended.

13.1.2 The above conclusions are made subject to approval by the statutory regulatory bodies.

13.2 Review of Pollutant Linkages Following Site Investigation

13.2.1 The site CSM has been revised and updated from that suggested in the desk study in view of the ground investigation data, including soil laboratory analysis results. Table 13.1 highlights whether pollutant linkages identified in the original CSM are still relevant following the risk assessment, or whether pollutant linkages, not previously identified, exist.

Table 13.1: Plausible Pollutants Linkages Summary

Potential Source (from desk study)	Pathway	Receptor	Relevant Pollutant Linkage?	Comment
• Potential for Made Ground associated with previous development operations – on site (S1) • Potential asbestos impacted soils from demolition of previous buildings – on site (S2)	• Ingestion and dermal contact with contaminated soil (P1) • Inhalation or contact with potentially contaminated dust and vapours (P2)	• Construction workers (R1) • Maintenance workers (R2) • Neighbouring site users (R3) • Future site users (R4) • Building foundations and on site buried services (water mains, electricity and sewer) (R5)	Y	see 13.1 above for remedial measures. The findings of this report should be included in the construction health and safety file, with adequate measures put in place for the protection of construction and maintenance workers.
	• Leaching through permeable soils, migration within the vadose zone (i.e., unsaturated soil above the water table) and/or lateral migration within surface water, as a result of cracked hardstanding or via service pipe/corridors and surface water runoff. (P3) • Horizontal and vertical migration of contaminants within groundwater (P4) • Permeation of water pipes and attack on concrete foundations by aggressive soil conditions (P5)	• Neighbouring site users (R3) • Building foundations and on site buried services (water mains, electricity and sewer) (R5) • Controlled Waters - Secondary A aquifer (R6)	X	Remedial measures not considered necessary. Contact should be made with relevant utility providers to confirm if upgraded materials are required.

14 GEOTECHNICAL ENGINEERING RECOMMENDATIONS

14.1 Ground Investigation Summary

14.1.1 Limited structural engineering design information, with respect to the type of construction and associated structural loadings, was provided at the time of preparing this report. Consequently, a detailed discussion of all the problems that may arise during the proposed redevelopment scheme is beyond the scope of this report.

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

14.1.3 As part of the redevelopment the swimming pool is to be reconstructed to the north of its current position. The reader is referred to the Purcell Existing Fabric Assessment / Existing Methodology Report (Feb 2018) for details of the proposed method of re-constructing the swimming pool.

14.1.4 It is understood that the proposed development comprises the construction of a new basement level beneath the existing lower ground floor and the extension of the basement into the area currently occupied by the existing swimming pool. The Barrett Mahony Consulting Engineers structural method statement indicates that the basement will be constructed using the underpinning method.

14.1.5 The proposed basement is to be constructed by means of underpinning technique in the following indicative key construction stages:

1. Establish site, repair any existing cracks and install monitoring equipment.
2. Install temporary propping to existing walls just above ground floor level.
3. Demolish existing ground floor structure.
4. Underpin perimeter walls in sequence.
5. Underpin internal walls in sequence.
6. Excavate to intermediate level and install temporary propping to underpins.
7. Excavate to formation level and place blinding.
8. Install buried drainage, heave board and cast basement slab.
9. Remove temporary props when basement slab has gained sufficient strength.
10. Install new ground floor structure.

14.1.6 In addition, a contiguous piled wall will be constructed at the south-east corner of the site to support the car lift excavation. The piled wall will be installed from the existing ground level and will be designed by the piling specialist. If further investigation is required post planning for this

14.2 Geotechnical Results Summary

14.2.1 A complete set of exploratory hole logs can be found in Appendix 5. Copies of the Geotechnical Laboratory Test Results can be found in Appendix 7.

14.2.2 The results of the ground investigation revealed a ground profile comprising Made Ground (up to at least 1m thick), overlying orange brown medium to high strength slightly sandy clay to the base of the boreholes at 5mbgl.

14.2.3 A summary of ground conditions obtained from the ground investigation and subsequent laboratory testing, is provided in Table 14.1 below.

Table 14.1: Laboratory Test Data Summary

Strata	Made Ground	Bagshot Formation - Clay	Bagshot Formation - Sand
Encountered from (m bgl)	GL	0.70 - 1.00	3.10
Base of strata (m bgl)	0.70 - 1.00	>4.50 - >5.00	3.90
Thickness range (m)	0.70 - 1.00	>1.10 - >3.50	0.80
SPT 'N' Value	-	4 - 52	22
Inferred Shear Strength (kPa)	-	18 - 234	-
Moisture content (%)		11 - 25	-
Liquid Limit (%)	-	37 - 59	-
Plastic Limit (%)	-	19 - 27	-
Corrected Plasticity Index (%)	-	18 - 32 (17 - 32)	-
NHBC Volume Change Classification	-	Low - Medium	-

*Typical result obtained in similar materials and noted in guidance.

14.2.4 It should be noted that this section is a geotechnical interpretation and discusses the findings of the ground investigation and the geotechnical implications of what was found. It is not a geotechnical design report. Geotechnical design will be carried out at a later stage by a third party.

14.3 Undrained Shear Strength

14.3.1 Standard Penetration Tests were undertaken at regular intervals throughout the drilling of the boreholes. The results of the SPTs have then been used along with the correlation suggested by Stroud (1974) to infer the undrained shear strength of the clays.

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

in which

c_u= mass shear strength (kN)

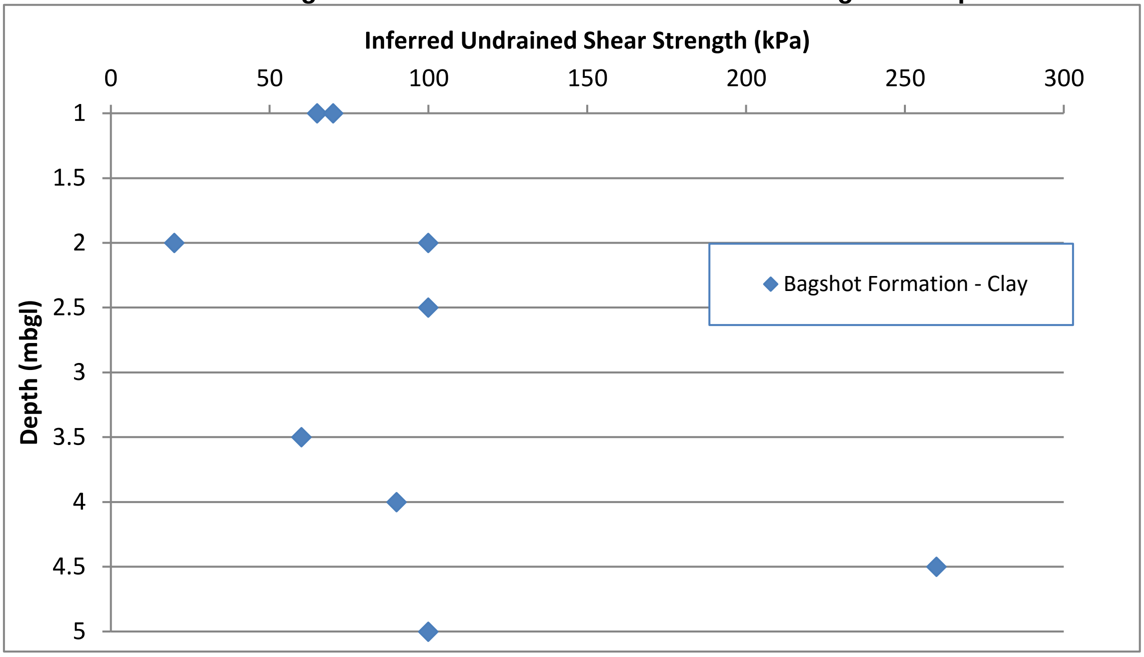
f_1 = constant

N = SPT Value achieved during boring operations

14.3.2 The constant f_1 is dependent on the plasticity of the material. For the Bagshot Formation - Clay the plasticity index has been shown to average 25% and therefore a value of 5 has been adopted.

14.3.3 The graph below shows the shear strength profile of the Bagshot Formation - Clay encountered at the site, based on the SPT to shear strength correlation described above.

Figure 14.1: Inferred Undrained Shear Strength vs Depth



14.3.4 An SPT 'N' value of 22 was reported for the layer of Bagshot Formation - Sand at 3.50mbgl. This is slightly higher than the values recorded in the clay at around the same depth.

14.4 Foundations

14.4.1 For details of the existing foundations, as exposed in HTP3 please refer to Section 8.3.

14.4.2 At the current time, it is not known how it is proposed to construct the basement. using "underpinning" type construction methods.

14.4.3 It is considered likely that an excavation circa 3.5m deep would be required to form the basement within.

14.4.4 Based upon the information obtained to date, it is considered that conventional foundations may be suitable for the proposed development. It is considered that an allowable bearing capacity of 150kPa at 4.0mbgl is possible.

14.4.5 It should be born in mind that the estimated allowable bearing capacity was calculated for a depth of 4.0mbgl. Due to the presence of an existing lower ground floor level at approximately 1.5mbgl, the foundations are likely to be formed deeper than 4.0mbgl (2.5m below the existing lower ground floor level).

14.4.6 The exact allowable bearing capacity that could be achieved would need to be reviewed on receipt of foundation design. A check against sliding failure would need to be made to the retaining wall design. This may alter the above recommendations.

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

14.5 Concrete in the Ground

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

14.5.2 In accordance with BRE Special Digest 1, as there are less than 10 results in the data set the highest value has been taken.

14.5.3 Table 14.2 summarises the analysis of the aggressive nature of the ground for each of the strata encountered within the ground investigation.

Table 14.2: Concrete in the Ground Classes

Stratum	No. Samples	pH range	WS Sulphate (highest) (mg/l)	Design Sulphate Class	ACEC Class
Made Ground	3	7.9 – 9.2	1860	DS-3	AC-3
Bagshot Formation - Clay	4	6.3 – 8.0	260	DS-1	AC-1s

14.6 Ground Floor Slabs

14.6.1 Given that there is to be a basement formed on the site underneath an existing lower ground level, it is expected that the finished floor level would be approximately 4.5m – 5.0m below current ground level.

14.6.2 If a cantilever retaining wall is utilised then a ground bearing floor slab could be used. In which case formations of the structures should be inspected by a competent person. Any loose or soft material should be removed and replaced with well-graded, properly compacted granular fill or lean mix concrete. The formation should be blinded if left exposed for more than a few hours or if inclement weather is experienced.

14.6.3 It should be noted that the BMCEUK structural method statement for the site indicates that the current floor slab is a suspended floor slab and that a similar floor slab has been allowed for.

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

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

14.7 Excavations and Temporary Retaining Structures

14.7.1 Excavations will be required at the site for services and construction works. These are anticipated to remain stable for the short term only.

14.7.2 It is recommended that the stability of all excavations should be assessed during construction. The sides of any excavations into which personnel are required to enter, should be assessed and where necessary fully supported. Given the proximity of the adjacent properties it is considered unlikely that excavations could be battered back to a safe angle.

14.7.3 The basement excavation will be located beneath an existing structure and extend into the area of the current swimming pool. The progression of the basement excavation will need to consider the potential impact to existing structures both on and off site and provide adequate and appropriate support.

14.7.4 The reconstruction of the pool will require an excavation of the existing garden area to approximately 4.5m below existing ground level at a distance of 2m from the northern boundary with West Heath Road. This will require appropriate temporary works to support the road boundary. It is likely that this would consist of a propped embedded retaining wall.

14.7.5 Temporary retaining walls will be required on the north and western sides at the new pool location, due to nearby site boundaries. It may be more economical for the contractor to install a circular sheet pile cofferdam, which would need to be 12-13m diameter to facilitate the excavation. These sheet piles are likely to be needed to be installed to circa 12mbgl. Such a feature could be designed to be part of the permanent design.

14.8 Permanent Retaining Walls

14.8.1 The retaining walls for the basement will be formed in short sections to underpin the existing walls. It is assumed that these would be constructed using the cast in-situ methodology.

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

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

14.8.4 At the current time insufficient structural information is available to allow details of the retaining wall to be determined. Given the obtained information it is considered that a friction angle for the materials could be taken as 0° in its undrained state.

14.8.5 Given the proposed depth of the basement it is considered that heave precautions will be required. Given the medium volume change potential of the underlying clays these should consist of 25mm void or the equivalent thickness of compressible material adjacent to the foundation.

14.8.6 As noted above temporary retaining walls would be needed for the swimming pool construction. Such a feature could be designed to be part of the permanent design.

14.8.7 Temporary retaining walls will be required on the north and western sides at the new pool location. If the sheet pile walls are left insitu it may be possible to utilise a lighter retaining wall design.

14.8.8 An alternative may be to use a secant piled wall. Such a wall could be designed to both act as a retaining wall for the adjacent highway and to act as a structural foundation for the pool.

14.8.9 All retaining walls (temporary and permanent) would need to be designed by a suitably experienced and qualified specialist.

14.9 Ground Movement

14.9.1 CIRIA C760 uses information on the damage to walls of buildings based on Burland et al (1977), Boscardin and Cording (1989) and Burland (2001) to categorise damage into 5 categories. A summary of Table 2.5 from CIRIA C760 is provided below.

Table 14.3: Summary of CIRIA C760 Table 2.5 (after Burland et al (1977), Boscardin and Cording (1989) and Burland (2001))

Category of damage		Description of Typical Damage	Approximate crack width (mm)	Limiting tensile strain (%)
0	Negligible	Hairline cracks of less than about 0.1mm are classes as negligible.	< 0.1	0.0-0.05
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	0.05-0.075
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 weather tightness. Doors and windows may stick slightly	<5	0.075-0.15
3	Moderate	The cracks require some opening up and can be patched by a mason. Recurrent cracks can be masked by suitable linings. Repointing of external brickwork and possibly a small amount of brickwork to be replaced. Doors and windows sticking. Service pipes may fracture. Weather-tightness often impaired.	5-15 or a number of cracks >3	0.15 – 0.3
4	Severe	Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Windows and frames distorted, floors sloping noticeably. Walls leaning or bulging noticeably, some loss of bearing in beams. Service pipes disrupted.	15-25 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 number of cracks	

14.9.2 The first three categories (namely Negligible, Very Slight and Slight categories) are generally regarded as acceptable for buildings where no structural damage is permissible.

14.9.3 It would be generally good practise to ensure that the design and construction should aim to limit damage to all buildings to a maximum of Category 2 (Slight) as set out in CIRIA Report 580.

14.9.4 However, using an underpinning methodology, it is considered that in the short term maintaining the category of damage to category 1 or less could be relatively easily achieved. It would be recommended that a full inspection of the property should be undertaken prior to starting work and a watching brief of the structure, the excavations and the adjacent structure is maintained during the works.

14.9.5 In the long term, a suitably designed and constructed retaining wall should provide sufficient support to ensure that post construction movement is minimal and the damage classification post construction of any cracks caused in the short term should not get worse. It is considered unlikely that new cracks would occur post construction.

14.10 Groundwater Control

14.10.1 Throughout the investigation and subsequent monitoring, groundwater was not encountered.

14.10.2 Subject to seasonal variations, it is not considered likely that significant quantities groundwater would be encountered during site works.

14.10.3 If groundwater is encountered, it is considered it could be readily dealt with by conventional pumping from a sump. This would need to be assessed at the time of construction. A pit should be excavated and left open to confirm the presence/absence of groundwater closer to the proposed construction period.

14.10.4 Due to the basement excavation occurring within the footprint of the existing structure it is considered unlikely that rainwater or surface water would ingress into the excavations. Any such waters that do should be dealt with using simple traditional sump and methods.

14.10.5 As noted above for the construction of the swimming pool retaining, structures to support the adjacent highway will be needed. It is likely that these would consist of a circular coffer dam formed from sheet piles. Such a feature would act as a groundwater exclusion system. Care would need to be taken to ensure that the excavation within the piled area does not breach through the underlying clay layer, otherwise it is possible that groundwater could enter through the base of the excavation. This could lead to “boiling” of the sands.

15 BASEMENT IMPACT ASSESSMENT

15.1 Proposed Changes to Areas of External Hardstanding

15.1.1 The proposed basement is beneath an existing building with other areas such as the swimming pool being moved. This will move areas of hard standing rather than increasing areas of hardstanding.

15.1.2 As demonstrated where there is soft landscaping at the surface this is clay at the surface, This means that even areas of soft landscaping will generally cause rainfall to run off rather than soak-in in a similar way that if the ground was covered by hard-standing.

15.1.3 It is not considered necessary to undertake any further investigations, studies or impact assessment in relation to the proposed changes to areas of external hard-standing.

15.2 Past Flooding

15.2.1 Planning Policy Statement PPS25 “Development and Flood Risk” seeks to protect development from flooding as well as preventing flooding. PPS25 states that developers are responsible for providing a flood risk assessment:

15.2.2 demonstrating whether any proposed development is likely to be affected by current or future flooding from any source;

- satisfying the local planning authority that the development is safe and where possible reduces flood risk overall;
- demonstrating whether the development will increase flood risk elsewhere;
- demonstrating measures proposed to deal with these effects and risks.

15.2.3 The .London Brough of Camden produced a document “Floods in Camden – Report of the Floods Scrutiny Panel” (June 2003) indicates that parts of Templewood Avenue flooded on the 7 August 2002

15.2.4 The report notes that historical research showed that the topography of Hampstead and the nature of summer thunderstorms make high rainfall levels and flooding events a recurring feature in Camden. These phenomena have a long history and have not been recently created by global warming. Comparisons are drawn in the report between the 1975 floods in Camden and those in 2002, showing marked similarities. Although Templewood Avenue did not flood in 1975.

15.2.5 Given the various flooding events discussed in the above report it follows that other flooding events in the future cannot be ruled out.

15.3 Geological Impact

15.3.1 The published geological maps indicate that the site is directly underlain by solid deposits of the Bagshot Formation. This was confirmed by the intrusive investigation.

15.3.2 At the depths that the basement would be constructed at, the Bagshot Formation is unlikely to be prone to seasonal shrinkage and swelling that arises due to changing water content in the soil. This is due to a lack of significant vegetation capable of removing water within the zone of influence and the lack of proven groundwater.

15.3.3 Given that at the time of undertaking the works there was very limited access to and around the site it is recommended that further works are undertaken using a restricted access cable tool rig. It is likely that such a hole would need to be positioned on the garage access slope.

15.4 Hydrology and Hydrogeology Impact

15.4.1 Based on all the information available at the time of writing, the risk of flooding from groundwater is considered to be low. The proposed basement is unlikely to have a detectable impact on the local groundwater regime. Appropriate water proofing measures should be included within the whole of the proposed basement wall/floor design as a precaution.

15.4.2 The proposed dwelling will lie outside of flood risk zones and is therefore assessed as being at a very low probability of fluvial flooding.

15.4.3 The only surface water feature on or in the immediate vicinity of the site is a very small man-made self-contained pond in the north-east of the site. It is therefore not anticipated that the site will make any impact upon the hydrology of the area.

15.4.4 The information available suggests that the site lies in an area that is not at risk of surface water flooding. Flooding via this source is therefore considered to be low.

15.4.5 The proposed basement construction is considered unlikely to create a reduction of impermeable area in the post development scenario.

15.4.6 No risk of flooding to the site from artificial sources has been identified.

15.5 Impacts of Basement on Adjacent Properties and Pavement

15.5.1 The proposed basement excavation will be within 5m of a public pavement. It is also within 5m of neighbouring properties.

15.5.2 Unavoidable lateral ground movements associated with the basement excavations must be controlled during temporary and permanent works so as not to impact adversely on the stability of the surrounding ground, any associated services and structures.

15.5.3 It is recommended that the site is supported by suitably designed temporary support with a basement box construction inside either the piles or the underpinning. This will ensure that the adjacent land is adequately supported in the temporary and permanent construction. Alternatively, the excavation should proceed in a manner that maintains the integrity of the ground on all sides.

15.5.4 Careful and regular monitoring of the structure will need to be undertaken during the construction phase to ensure that vertical movements do not adversely affect the above property with the “flying freehold”. If necessary the works may have to be carried out in stages with the above structure suitably propped and supported.

15.5.5 It will be necessary to ensure that the basements are designed in accordance with the NHBC Standards and take due cognisance of the potential impacts highlighted above. This may be achieved by ensuring best practice engineering and design of the proposed scheme by competent persons and in full accordance with the Construction (Design and Management) Regulations. This will include:

- Establishment of the likely ground movements arising from the temporary and permanent works and the mitigation of excessive movements;
- Assessment of the impact on any adjacent structures (including adjacent properties and the adjacent pavement with potential services);
- Determination of the most appropriate methods of construction of the proposed basements;
- Undertake pre-condition surveys of adjacent structures;
- Monitor any movements and pre-existing cracks during construction;
- Establishment of contingencies to deal with adverse performance;
- Ensuring quality of workmanship by competent persons.

15.5.6 Full details of the suitable engineering design of the scheme in addition to an appropriate construction method statement should be submitted by the Developer to London Borough of Camden.

16 GROUND MOVEMENT ASSESSMENT

16.1 Geometry of the Site

16.1.1 The proposed development involves the construction of a new single-storey basement, which will deepen and locally extend the footprint of the existing basement at 35 Templewood Avenue. As indicated in Figure 16.1, the site under investigation is bounded to the north and east by West Heath Road and Templewood Avenue, respectively. The properties located at 9 West Heath Rd (Grade II listed - Schreiber House) and 33 Templewood Avenue form the western and southern boundaries, respectively.

16.1.2 In addition, the Schreiber swimming pool – which is located within the site under consideration – is planned to be relocated approximately 10 m to the north. The general arrangement of the proposed basement, which covers the entire footprint of 35 Templewood Avenue, and the swimming pool relocation, are illustrated in Figure 16.2.

16.1.3 The existing lower ground floor (which is present over much of the existing building footprint) formation level is between 111 and 112 mOD and the proposed excavation slab formation level is 108 mOD. Figure 16.3 displays the north-south cross-section of the proposed development.

16.1.4 The GMA presented herein is concerned with the impact of the proposed development on:

1. the properties immediately adjacent to the site, namely the Schreiber House and 33 Templewood Avenue.
2. the Thames Water assets running adjacent to the site under West Heath Road and Templewood Avenue

Figure 16.1 Development site under consideration.

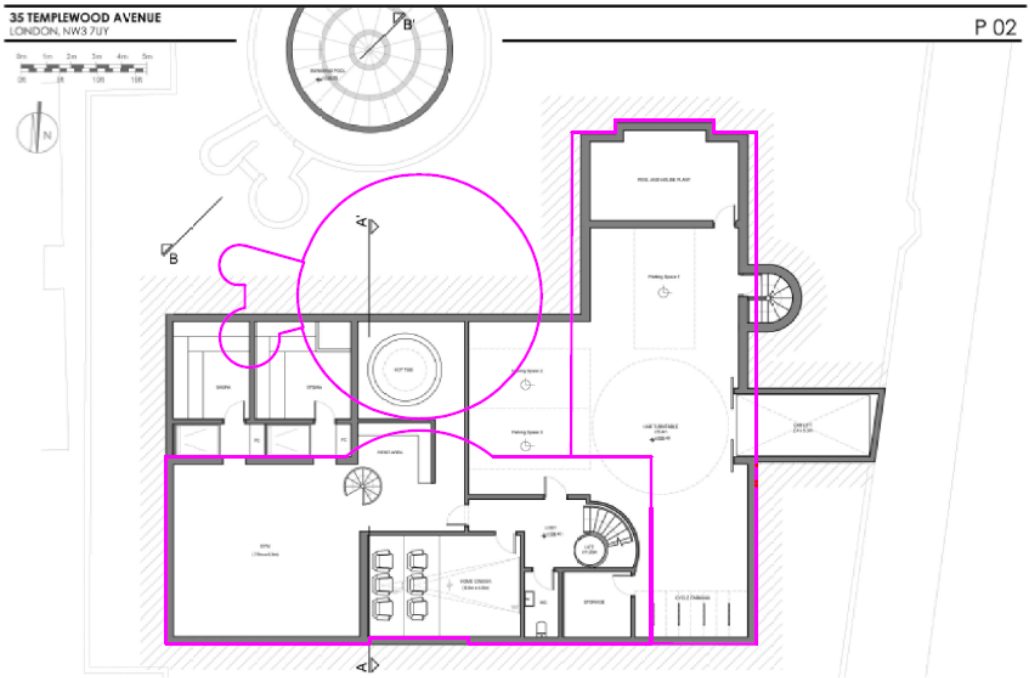


Figure 16.2: Proposed basement plan with existing layout marked in magenta.

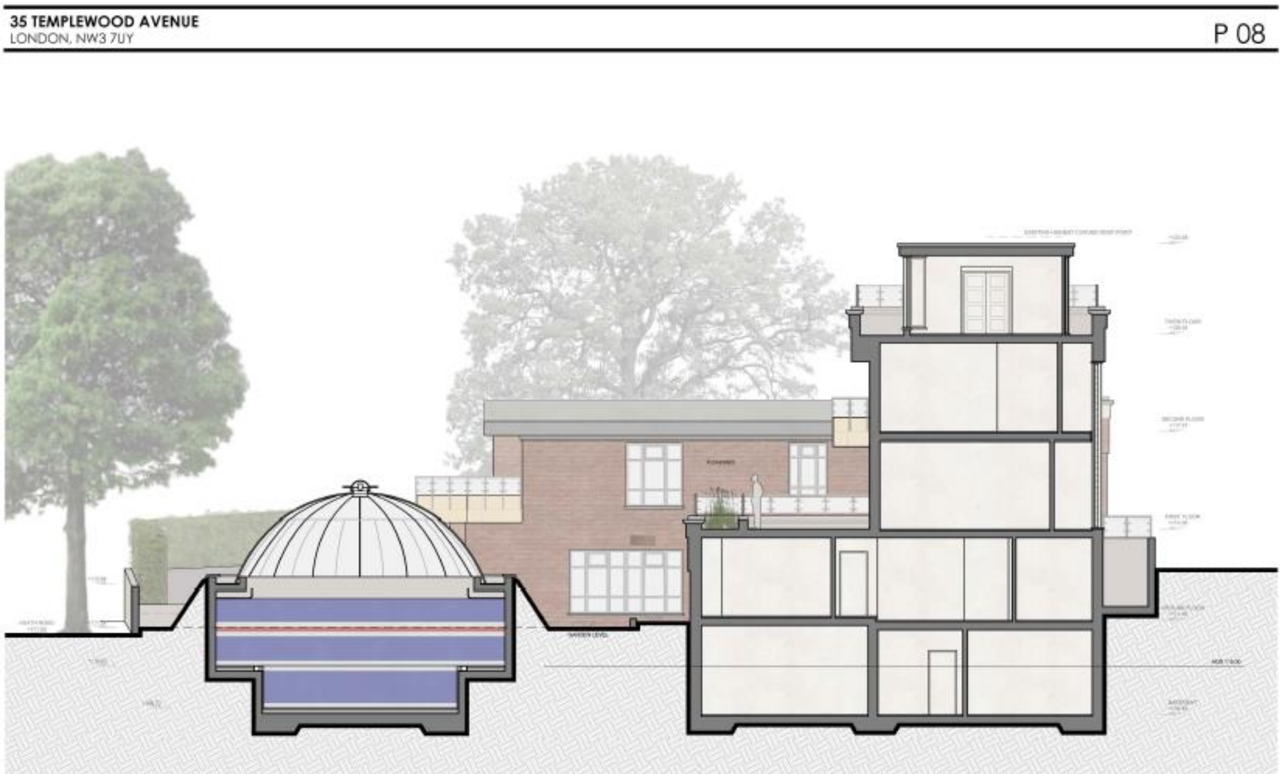


Figure 16.3: Proposed north-south section.

16.2 Proposed Under-Pinning and Piling Works

16.2.1 The proposed basement is to be constructed by means of an underpinning technique adopting the following indicative key construction stages:

1. Establish site, repair any existing cracks and install monitoring equipment.
2. Install temporary propping to existing walls just above ground floor level.
3. Demolish existing ground floor structure.
4. Underpin perimeter walls in sequence.
5. Underpin internal walls in sequence.
6. Excavate to intermediate level and install temporary propping to underpins.
7. Excavate to formation level and place blinding.
8. Install buried drainage, heave board and cast basement slab.
9. Remove temporary props when basement slab has gained sufficient strength.
10. Install new ground floor structure.

16.2.2 In addition, a contiguous piled wall will be constructed at the south-east corner of the site to support the car lift excavation. The piled wall will be installed from the existing ground level and will be designed by the piling specialist.

16.3 Thames Water Assets

16.3.1 Thames Water (TW) assets are present adjacent to the Site. The assets comprise a number of sewers and water mains. Details relating to these utilities are summarised in Figure 16.4 and Table 16.1. Their relative locations are based on the currently available survey information and Thames Water Asset Search Location Map.

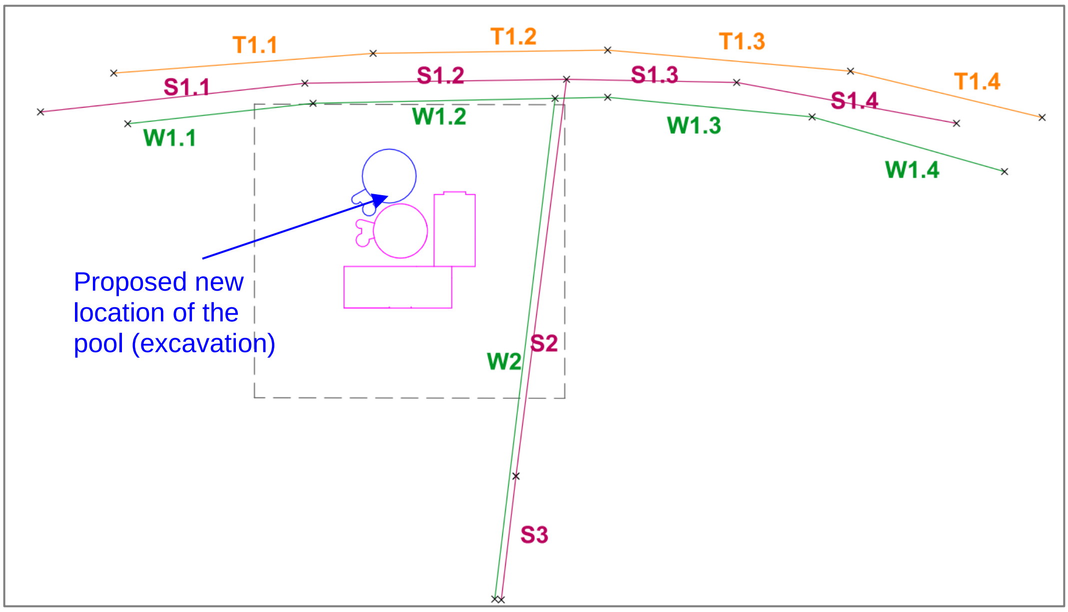


Figure 16.4: Location of the TW assets

Table 16.1: – Summary of the properties of the TW assets

Asset	Material	Location	Internal Diameter (mm)	Assumed Thickness (mm)	Dep Centr (m
Water Main WM1	Cast Iron	Templewood Avenue	177.8 (7'')	12.5	Gro le
Water Main WM2	Cast Iron	West Heath Road	101.6 (4'')	10	Gro le
Trunk Main T1	Cast Iron	Templewood Avenue	304.8 (12'')	15.5	Gro le
Sewer S1	Masonry	West Heath Road	914 X 610 (egg-shaped)	225	10
Sewer S2	Concrete (assumed)	Templewood Avenue	229	60	113 10 (decr tow junc witl

Sewer S3	Concrete (assumed)	Templewood Avenue	229	60	11

16.3.2 Assumptions have been made for some of the utilities for which no information was available in relation to the material/construction and lining thickness.

16.3.3 Sewer 1 has been assumed to be of masonry construction, given its non-circular shape. A lining thickness of 225mm was assumed for strain calculations. Sewer 2 has been conservatively assumed to be of unreinforced concrete construction as the criteria for concrete pipes is more stringent than vitrified clay. A lining thickness of 60mm was assumed for strain calculations.

16.3.4 The water mains and trunk main are labelled in the TW survey drawings as being of cast-iron construction.

16.3.5 All water mains have been assumed to be located at the ground surface. The assumptions made with regards to utilities for which no information is available should be confirmed/revised as appropriate during the design development.

16.3.6 The impact assessment on the Thames Water assets has been undertaken, focussing on the key deformation mechanisms and performance criteria applicable to the utility types noted. The assessment criteria are summarised in Figure 16.5. In addition to the criteria presented in the TW guidance documentation, a joint pull-out limit of 3 mm is generally considered acceptable for the pipes under consideration.

Table 1 - Assessment Criteria for Existing Thames Water Pipeline and Sewer Assets

PIPE TYPE	Diameter (mm)	Allowable Increase in Strain (□□)		Rotation (deg.)
		Tension	Compression	
Brick Sewer (red / yellow / blue brick)	N/A	500	25% of the allowable stress	N/A
Cast Iron Lead-yarn joints	N/A	100	1200	0.1
Ductile Iron (Lead-yarn gasket joints)	N/A	500	700	0.5
Ductile Iron (Rubber gasket joints)	N/A	500	700	2.0
Steel	N/A	450	450	1.5
Vitrified Clay	<125	80	400	0.5
	>125	80	400	See Table 2
Concrete (unreinforced)	<225	20	400	0.5
	225 – 750	40	400	See Table 2
	>750	60	400	

Table 2 - Maximum Rotation for Vitrified Clay and Concrete Pipes

Diameter (mm)	Rotation (deg.)
< 375	2.0
375 – 750	1.0
750 – 1400	0.5
> 1400	0.3

Figure 16.5: Thames Water Assessment Criteria (extract from Thames Waters' Guidance on Piling, Heavy Loads, Excavations, Tunnelling and Dewatering)

16.4 Ground Movement Assessment

16.4.1 *Assessment Details*

16.4.2 The assessment has been undertaken using proprietary spreadsheets and the commercially available software Oasys Pdisp and Xdisp, which consider the three-dimensional ground movement field induced by the proposed works.

16.4.3 Ground movements will arise as a result of various mechanisms which are mobilised as part of the implementation of the proposed scheme. In the first instance, the works will involve the removal of the existing ground floor structure having installed temporary propping to the existing walls. This initial strip phase will be followed by basement excavation operations and the underpinning of the masonry perimeter walls and application of the permanent works building loadings. Areas outside the existing building footprint will comprise reinforced concrete cantilever walls. The basement, underpinning and piled wall installation works, as well as the excavation process will induce ground movements arising from the overburden removal. The permanent condition loading will partially reinstate a portion of the removed overburden, yielding settlements across the foundation system.

16.4.4 These ground movements will extend over a given zone of influence surrounding the building footprint. The assessment presented herein adopts the normalised ground displacement curves reported in CIRIA C760 and general principles of elasticity. This procedure comprises the current industry standard/best practice for this type of analytical assessment.

16.4.5 A series of three-dimensional models of the proposed scheme have been developed in both software packages outlined previously and have been combined by means of superposition to represent the various ground displacement fields summarised above.

16.4.6 An indicative plot of the analytical model is presented below in Figure 16.6. The model includes a number of simplifications from geometrical and ground model perspectives. These simplifications represent a conservative scenario for the evaluation of ground movements along Templewood Avenue.

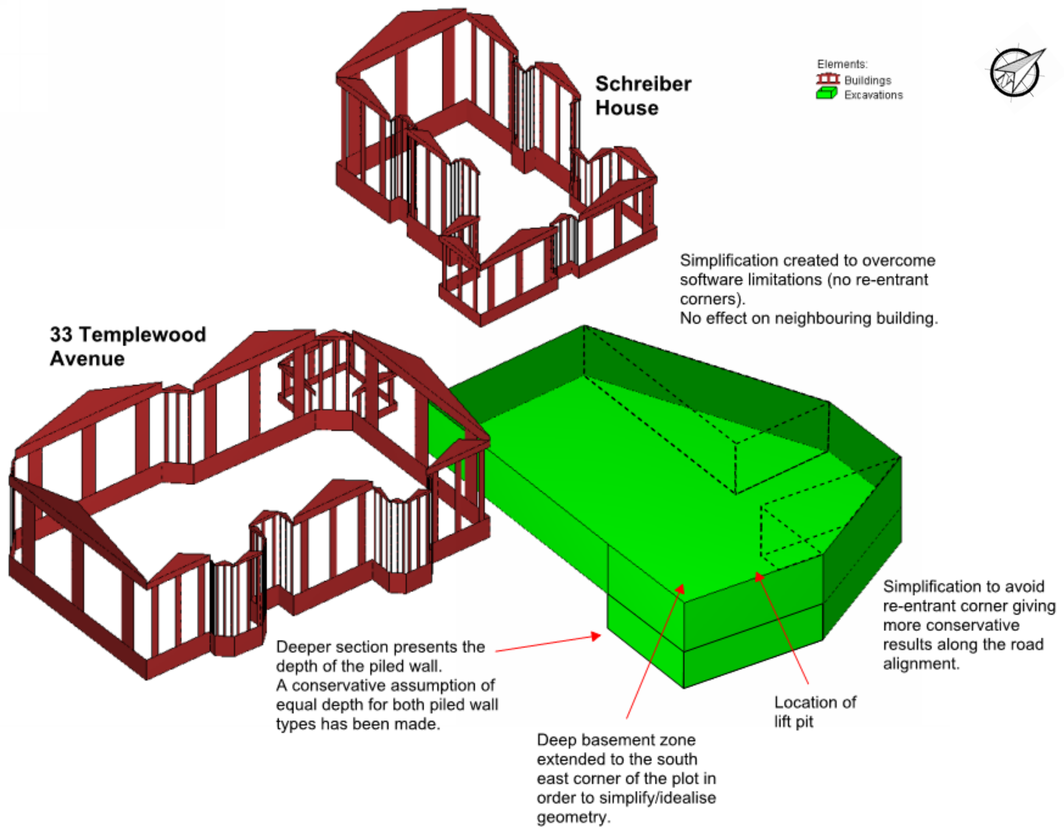


Figure 16.6: Indicative plot of the three-dimensional analytical model produced using the Oasys software suite (soil and Thames Water assets removed for clarity of presentation). Simplified excavation geometry shown in green.

16.4.7 *Ground Model*

16.4.8 An idealised ground model has been evaluated based on the site-specific ground investigation which comprised 2no window sample boreholes to 6.0mbgl and 1no hand excavated trial pit.

16.4.9 The thickness of Made Ground was observed in the boreholes to be typically less than 1m. It is assessed that the buildings adjacent to the proposed development site will be founded at ground surface. The thickness of the Bagshot Formation was not proven during the site investigation. Table 16.2 summarises the representative ground model adopted for ground movement assessment purposes.

Table 16.2: Summary of ground model and geotechnical parameters adopted for analysis purposes

Stratum	Top of stratum (mbgl)	Assumed Undrained Strength, S_u (kPa)	Undrained Young's Modulus, E_u (MPa)	Drained Young's Modulus, E' (MPa)
Made Ground	0.0	-	-	15.0
Bagshot Formation	1.0	45 + 9.5z [1]	20.3 + 4.3z [1]	16.2 + 3.4z [1]

Notes: 1. z is the depth in metres below top of the Bagshot Formation, which is assumed to be approx. 1.0m below existing ground level.

2. *Rigid boundary* assumed at -30 mbgl for analytical purposes (conservative level adopted capturing extensive zone of influence based on development width of around 10-12m).

3. The stiffness data (E_u and E') has been evaluated empirically taking into consideration the nature of the geotechnical/soil-structure interaction mechanisms and level of anticipated strain within the soil mass.

16.4.10 Analysis Methods

16.4.11 As outlined previously, two different scenarios have been considered in order to bound the potential ground movements arising from the proposed excavation works.

1. In the first option (***Method 1***), the *worst-case* heave condition was assessed by assuming that no lateral or downward ground movement takes place during the underpinning operations (effectively assuming a wished into place underpin solution).

   Heave movements arising from the proposed basement excavation were assessed using Oasys Pdisp.

   The proposed bulk excavation works and associated heave was modelled by applying an upward (unloading) stress at the formation level, which is equivalent to the total stress relief (approx. -80 kPa) imposed by the proposed depth of excavation beneath the existing basement and new location of the swimming pool.

   For the short-term analysis, representing the condition immediately following excavation, the soil mass was modelled using undrained stiffness parameters.

   In the long-term (representing the condition sometime after the building works are complete and excess pore pressures have dissipated), relaxation of the soil was captured by using drained soil parameters. The effect of increased building loads, associated with the proposed renovation works, were also incorporated in this phase.

   Figure 16.7 shows the geometry and intensity of the footing loads as applied in the Pdisp model. The permanent building loads were evaluated on the basis of an indicative load takedown based on the proposed floor arrangements provided.

   It is noted that only buildings and assets within the zone of influence of the proposed scheme have been modelled.

   It is also noted that the applied foundation loading has been taken conservatively as the allowable bearing pressure of 150 kPa upon which the foundations have been sized.

2. The second option (***Method 2***) assesses horizontal movements and ground settlements (as opposed to heave evaluated in Option 1) imposed by the proposed excavation and underpinning works.

   The horizontal and vertical ground movements due to underpin installation and mass excavation to formation level were evaluated using the normalised CIRIA C760 curves for ground movement, as implemented in Oasys Xdisp. Installation was modelled by adopting the CIRIA C760 curve for *Installation of planar diaphragm wall in stiff clay*. Bulk excavation was evaluated using the CIRIA C760 curve for *Excavation in front of a high stiffness wall in stiff clay*.

This option assumes that the underpinning imposes a ground movement field (resulting from installation and lateral deflection), leading to lateral and vertical components of movement and displacements at foundation level comparable to those measured in the instance of embedded retaining walls.

Whilst it is acknowledged that the empirical data set is not strictly applicable to the construction technologies adopted, the assessment and associated ground movement mechanisms are representative of the adopted underpinning scenario. This is considered a reasonable approximation in this instance and once again, bounds the solution between maximum potential heave, settlements and lateral deformations anticipated for the type of construction presented herein, which are inherently subject to satisfactory control of workmanship.

As for Method 1, short-term and long-term phases were considered. The proposed building loads were also incorporated.

16.4.12 *Impact Assessment*

i) Building Damage Assessment

16.4.13 The potential impact/damage induced on primary façade/wall elements of the buildings within the zone of influence of the proposed scheme has been evaluated on the basis of the calculated ground movement field. The walls of concern are shown in Figure 16.8, including the wall nomenclature/reference system adopted. The arrangement is based on the currently available survey information and presents a reasonable array of primary structures both perpendicular and parallel to the proposed basement (covering the key deformation mechanisms).

16.4.14 Each wall has been assumed to behave as an equivalent beam subject to a bending and extension/compression deformation mechanism, based on the evaluated greenfield ground movement, as outlined previously. The walls under investigation were conservatively considered to be of masonry structure.

16.4.15 Attention was also paid to potential ground movements both parallel and perpendicular to Templewood Avenue and West Heath Road.

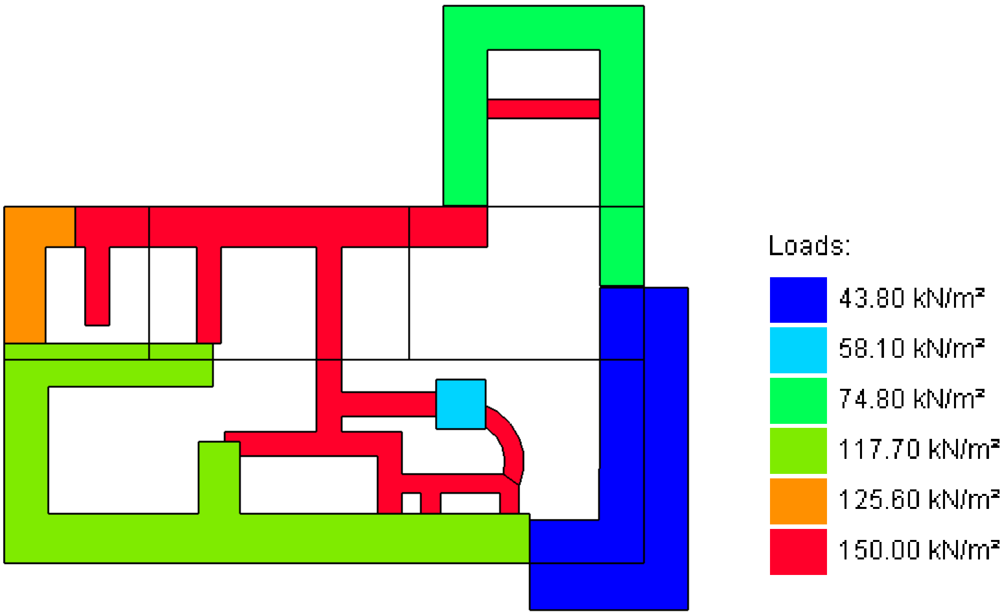


Figure 16.7: Long-term phase loading regime model with adjacent properties.

16.4.16 Tensile strains induced within the building masonry walls have been evaluated based on the deflection ratios Δ/L estimated from the analyses. The assessment considers the well-established Burland (1997) damage classification method, as presented and summarised in Figure 16.10 & Figure 16.11. This method involves a simple but robust means of assessment, which is widely adopted and is considered to comprise an industry standard/best practice basis for impact assessments of this typology.

16.4.17 Potential damage categories are directly related to the tensile strains induced by the assessed interim (short-term) and long-term phases of construction, arising from a combination of direct tension and bending induced tension mechanisms, as reported in Table 16.3.

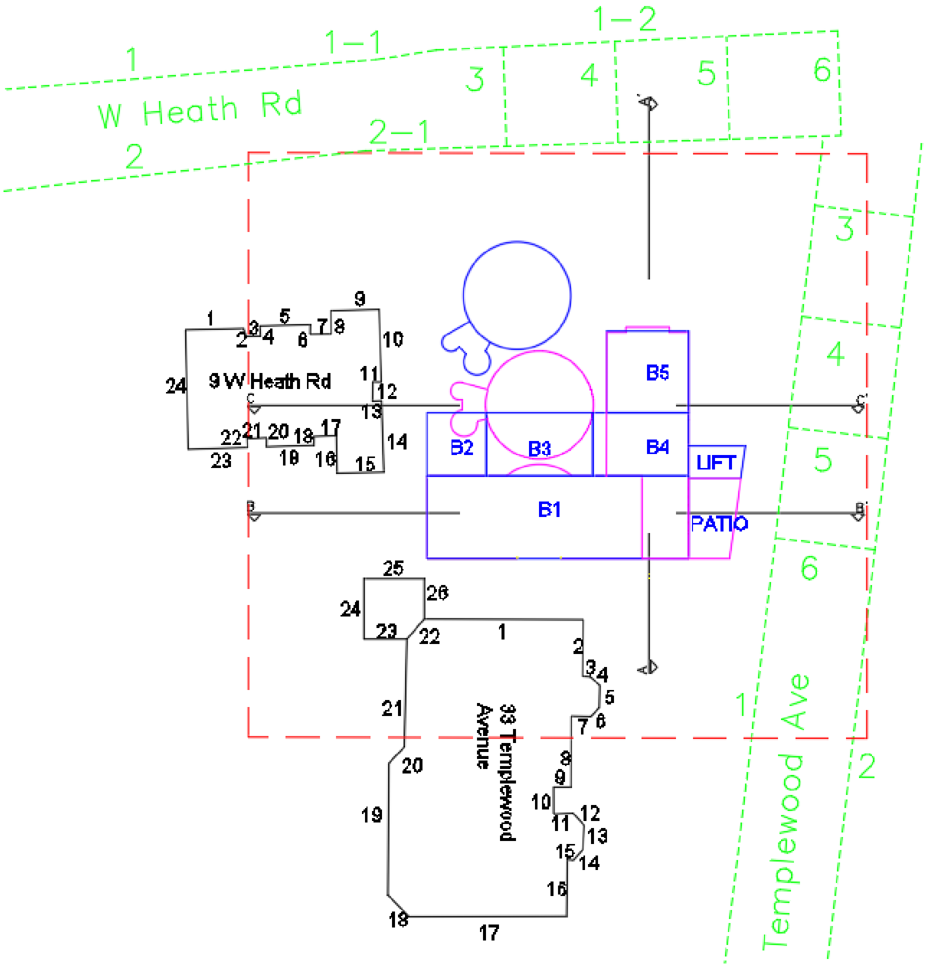


Figure 16.8: Simplified scheme and nomenclature for building façade/masonry wall elements (black), existing (magenta) and proposed (dashed blue) schemes, street movement monitoring areas (green) and excavation zone of influence (dashed red).

ii) Thames Water Utilities Impact Assessment

16.4.18 The potential impact induced on the adjacent Thames Water assets has been evaluated on the basis of the calculated ground movement field. The same methodology was followed for the Thames Water assets (Method 1 and Method 2), using XDISP to conduct the utility damage assessment. Figure 16.9 shows the geometry of the XDISP model, which considers a simplified excavation area as previously discussed in Figure 4.1. The movements were assessed at 1m intervals along each asset.

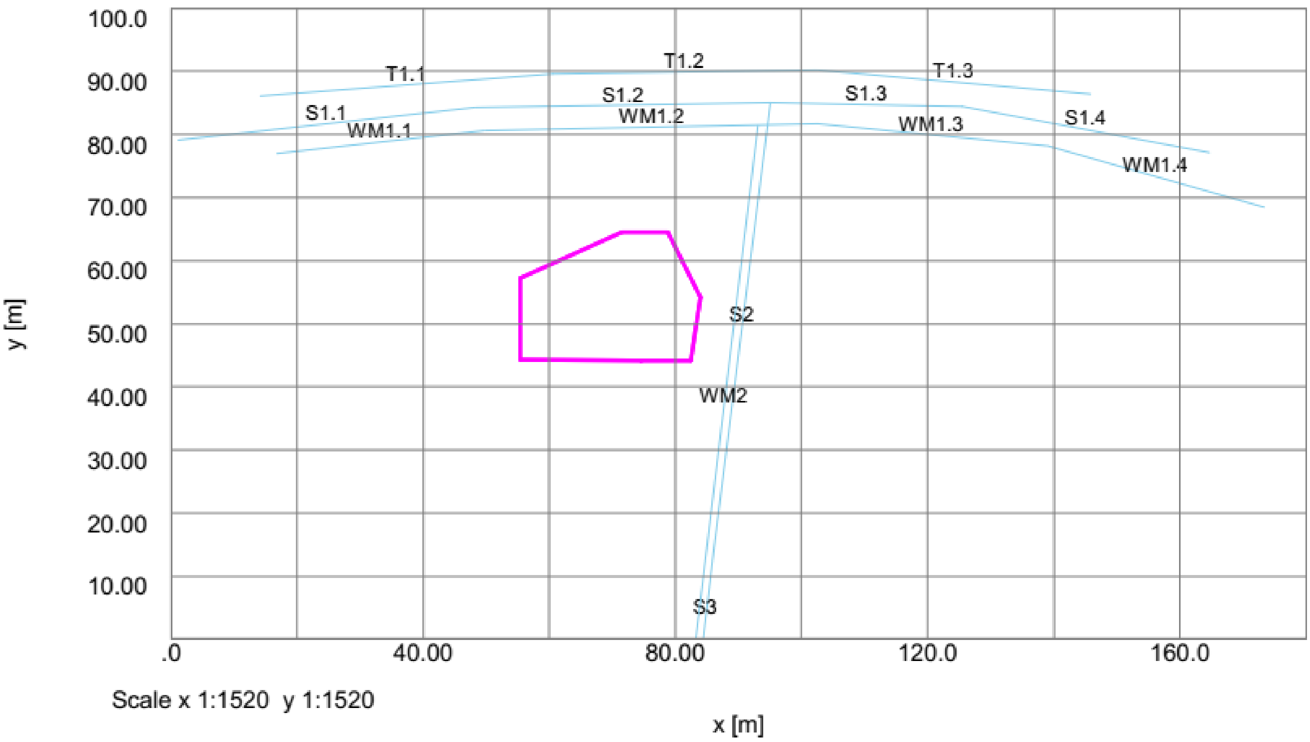


Figure 16.9: XDISP Models

16.4.19 The resultant movements of each asset were imported into XDISP to undertake the damage assessment in accordance with methodology approved by Thames Water. Details of material, internal diameter and lining thickness were input in accordance with Table 16.1 for XDISP to calculate curvature, compressive and tensile strains due to the assessed movements. All utilities were assumed to be *near surface assets* when using Method 2 – CIRIA curves (i.e. no sub-surface curves were adopted).

16.4.20 A maximum allowable tensile strain of 500με has been used for masonry sewer (S1). For the assumed concrete sewer (S2 & S3), an allowable limit of 3mm has been used for pull-out checks, 2° for rotation checks and 40με and 400με for tensile and compressive strain checks, respectively. The neutral axis of the masonry and concrete sewers was considered at one edge of the cross-section (i.e., the full external diameter was considered when calculating flexural strains). A reduction factor, RF, has been applied to the axial tensile strains when calculating the combined tensile strains. The reduction factor was taken as 0.2 for all assets except for the masonry sewer, where a factor of 1.0 was conservatively assumed. The beneficial contribution of axial strains was ignored in the strain calculation.

16.4.21 For the cast iron water and trunk mains, an allowable limit of 3mm has been used for pull-out checks, 0.1^{o} for rotation checks and 100με and 1200με for tensile and compressive strain checks, respectively.

16.5 Building Impact Assessment Outcomes

16.5.1 The results from the analysis are presented in Table 16.3 (denoting the evaluated damage categorisation in accordance with the Burland criteria presented herein).

16.5.2 The majority of the façades fall within Category 0, representative of a Negligible damage classification.

16.5.3 Three façades have been classified as Category 1, representative of Very Slight damage classification.

16.5.4 No façades have been classified as Category 2 (slight) or higher.

16.5.5 On the basis of the bounding analysis methods, it is assessed that the damage category for the properties adjacent to 35 Templewood Avenue will not exceed Category 1 – Very Slight.

16.5.6 West Heath Road and Templewood Avenue run adjacent to the site under consideration in the north and east, respectively. The impact of underpinning, excavation and piled wall installation works on these roads has also been assessed in terms of maximum vertical and horizontal deflections at a number of locations. Soil displacements were assessed along the green lines drawn on the streets (see Figure 16.8). Lines running both parallel (segments 1 & 2) and perpendicular (segments 3-6) to the streets were defined to capture the effects more accurately.

16.5.7 The assessment found that the majority of displacements at these locations were <1mm and as such are considered negligible. In the area immediately adjacent to the proposed car lift, the predicted movements are up to 8mm, decreasing to 0mm on the opposite side of the road.

16.5.8 On the basis of these results, it can be reasonably concluded that the risk of the proposed works resulting in loss of structural integrity to the pavement build-up of West Heath Road and Templewood Avenue is low. Where movements are expected to be slightly greater, such as the area adjacent to the proposed car lift, it may be prudent for the contractor to make an allowance for minor *making good* of pavement surfacing.

Table 16.3: Evaluated damage categories for strip/excavation and long-term condition stages (refer to Figure 16.8 for wall nomenclature)

Method 1

Building	Wall/façade reference	Damage Category Envelope	
		Excavation	Long-term
Schreiber House	1	0 (Negligible)	0 (Negligible)
	2	0 (Negligible)	0 (Negligible)
	3	0 (Negligible)	0 (Negligible)
	4	0 (Negligible)	0 (Negligible)
	5	0 (Negligible)	0 (Negligible)
	6	0 (Negligible)	0 (Negligible)
	7	0 (Negligible)	0 (Negligible)
	8	0 (Negligible)	0 (Negligible)
	9	0 (Negligible)	0 (Negligible)
	10	0 (Negligible)	0 (Negligible)
	11	0 (Negligible)	0 (Negligible)
	12	0 (Negligible)	0 (Negligible)
	13	0 (Negligible)	0 (Negligible)
	14	0 (Negligible)	0 (Negligible)
	15	0 (Negligible)	0 (Negligible)
	16	0 (Negligible)	0 (Negligible)
	17	0 (Negligible)	0 (Negligible)

	18	0 (Negligible)	0 (Negligible)
	19	0 (Negligible)	0 (Negligible)
	20	0 (Negligible)	0 (Negligible)
	21	0 (Negligible)	0 (Negligible)
	22	0 (Negligible)	0 (Negligible)
	23	0 (Negligible)	0 (Negligible)
	24	0 (Negligible)	0 (Negligible)
33 Templewood Avenue	1	0 (Negligible)	0 (Negligible)
	2	0 (Negligible)	0 (Negligible)
	3	0 (Negligible)	0 (Negligible)
	4	0 (Negligible)	0 (Negligible)
	5	0 (Negligible)	0 (Negligible)
	6	0 (Negligible)	0 (Negligible)
	7	0 (Negligible)	0 (Negligible)
	8	0 (Negligible)	0 (Negligible)
	9	0 (Negligible)	0 (Negligible)
	10	0 (Negligible)	0 (Negligible)
	11	0 (Negligible)	0 (Negligible)
	12	0 (Negligible)	0 (Negligible)
	13	0 (Negligible)	0 (Negligible)
	14	0 (Negligible)	0 (Negligible)
	15	0 (Negligible)	0 (Negligible)
	16	0 (Negligible)	0 (Negligible)
	17	0 (Negligible)	0 (Negligible)
	18	0 (Negligible)	0 (Negligible)
	19	0 (Negligible)	0 (Negligible)
	20	0 (Negligible)	0 (Negligible)

	21	0 (Negligible)	0 (Negligible)
	22	0 (Negligible)	0 (Negligible)
	23	0 (Negligible)	0 (Negligible)
	24	0 (Negligible)	0 (Negligible)
	25	0 (Negligible)	0 (Negligible)
	26	0 (Negligible)	0 (Negligible)

Method 2

Building	**Wall/façade reference**	**Damage Category Envelope**	
		CIRIA Excavation & Installation	**Long-term**
Schreiber House	1	0 (Negligible)	0 (Negligible)
	2	0 (Negligible)	0 (Negligible)
	3	0 (Negligible)	0 (Negligible)
	4	0 (Negligible)	0 (Negligible)
	5	0 (Negligible)	0 (Negligible)
	6	0 (Negligible)	0 (Negligible)
	7	0 (Negligible)	0 (Negligible)
	8	0 (Negligible)	0 (Negligible)
	9	0 (Negligible)	0 (Negligible)
	10	0 (Negligible)	0 (Negligible)
	11	0 (Negligible)	0 (Negligible)
	12	0 (Negligible)	0 (Negligible)
	13	0 (Negligible)	0 (Negligible)
	14	0 (Negligible)	0 (Negligible)
	15	**1 (Very Slight)**	**1 (Very Slight)**

	16	0 (Negligible)	0 (Negligible)
	17	0 (Negligible)	0 (Negligible)
	18	0 (Negligible)	0 (Negligible)
	19	0 (Negligible)	0 (Negligible)
	20	0 (Negligible)	0 (Negligible)
	21	0 (Negligible)	0 (Negligible)
	22	0 (Negligible)	0 (Negligible)
	23	0 (Negligible)	0 (Negligible)
	24	0 (Negligible)	0 (Negligible)
33 Templewood Avenue	1	0 (Negligible)	0 (Negligible)
	2	**1 (Very Slight)**	0 (Negligible)
	3	0 (Negligible)	0 (Negligible)
	4	0 (Negligible)	0 (Negligible)
	5	0 (Negligible)	0 (Negligible)
	6	0 (Negligible)	0 (Negligible)
	7	0 (Negligible)	0 (Negligible)
	8	0 (Negligible)	0 (Negligible)
	9	0 (Negligible)	0 (Negligible)
	10	0 (Negligible)	0 (Negligible)
	11	0 (Negligible)	0 (Negligible)
	12	0 (Negligible)	0 (Negligible)
	13	0 (Negligible)	0 (Negligible)
	14	0 (Negligible)	0 (Negligible)
	15	0 (Negligible)	0 (Negligible)
	16	0 (Negligible)	0 (Negligible)
	17	0 (Negligible)	0 (Negligible)
	18	0 (Negligible)	0 (Negligible)

	19	0 (Negligible)	0 (Negligible)
	20	0 (Negligible)	0 (Negligible)
	21	0 (Negligible)	0 (Negligible)
	22	0 (Negligible)	0 (Negligible)
	23	0 (Negligible)	0 (Negligible)
	24	0 (Negligible)	0 (Negligible)
	25	0 (Negligible)	0 (Negligible)
	26	**1 (Very Slight)**	**1 (Very Slight)**

Building damage classification, after Burland et al 1977 and Boscardin and Cording 1989				
Category of damage		Description of typical damage (ease of repair is underlined)	Approximate crack width (mm)	Limiting tensile strain %
0	Negligible	Hairline cracks of less than about 0.1mm are classes as negligible.	< 0.1	0.0-0.05
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	0.05-0.075
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	0.075-0.15
3	Moderate	The cracks require some opening up and can be patched by a mason. Recurrent cracks can be masked by suitable linings. Repointing of external brickwork and possibly a small amount of brickwork to be replaced. Doors and windows sticking. Service pipes may fracture. Weather-tightness often impaired.	5-15 or a number of cracks >3	0.15-0.3
4	Severe	Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Windows and frames distorted, floors sloping noticeably. Walls leaning or bulging noticeably, some loss of bearing in beams. Service pipes disrupted.	15-25 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 number of cracks	

Figure 16.10: Damage categorisation - relationship between category of damage and limiting strain ε_{lim}.

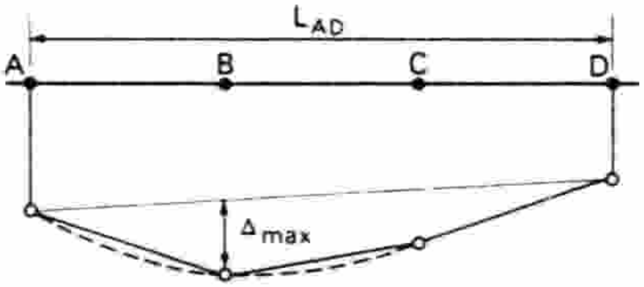


Figure 16.11: Definition of relative deflection Δ and deflection ratio Δ/L.

16.6 Thames Water Impact Assessment Outcomes

16.6.1 The results are summarized in the tables and figures in the present chapter. The full XDISP output is appended to this report.

Method 1

1. Excavation (short-term) – Table 16.4 and Figure 16.12
2. Excavation (short-term) + Loading (long-term) – Table 16.5 and Figure 16.13

Method 2

3. CIRIA Excavation & Installation - Table 16.6, Figure 16.14 and Figure 16.15
4. CIRIA Excavation & Installation + Loading (Long-term) – Table 16.7 and Figure 16.18

16.6.2 Note: In the contour plots, a positive (+) sign in vertical movement indicates settlement and a negative (-) sign indicates heave.

16.6.3 Sudden changes in the displacement curves are an inherent consequence of the XDISP modelling approach, which employs three parameters for the definition of the movement for each side of a corner of the excavation.

16.6.4 This results in the movement curves that cause the asset to bend and strain in a way which is less smooth than expected in reality. This typically occurs at certain locations (excavation corners, middle of excavation side, transition of no-movement to movement areas). These are not considered to be representative of the expected behaviour of the asset.

16.6.5 Therefore, these unrealistic spikes have been ignored when summarizing and the results and comparing to the screening criteria (values indicated with an asterisk (*) in Table 16.4 to Table 16.7).

METHOD 1 - Post-excavation

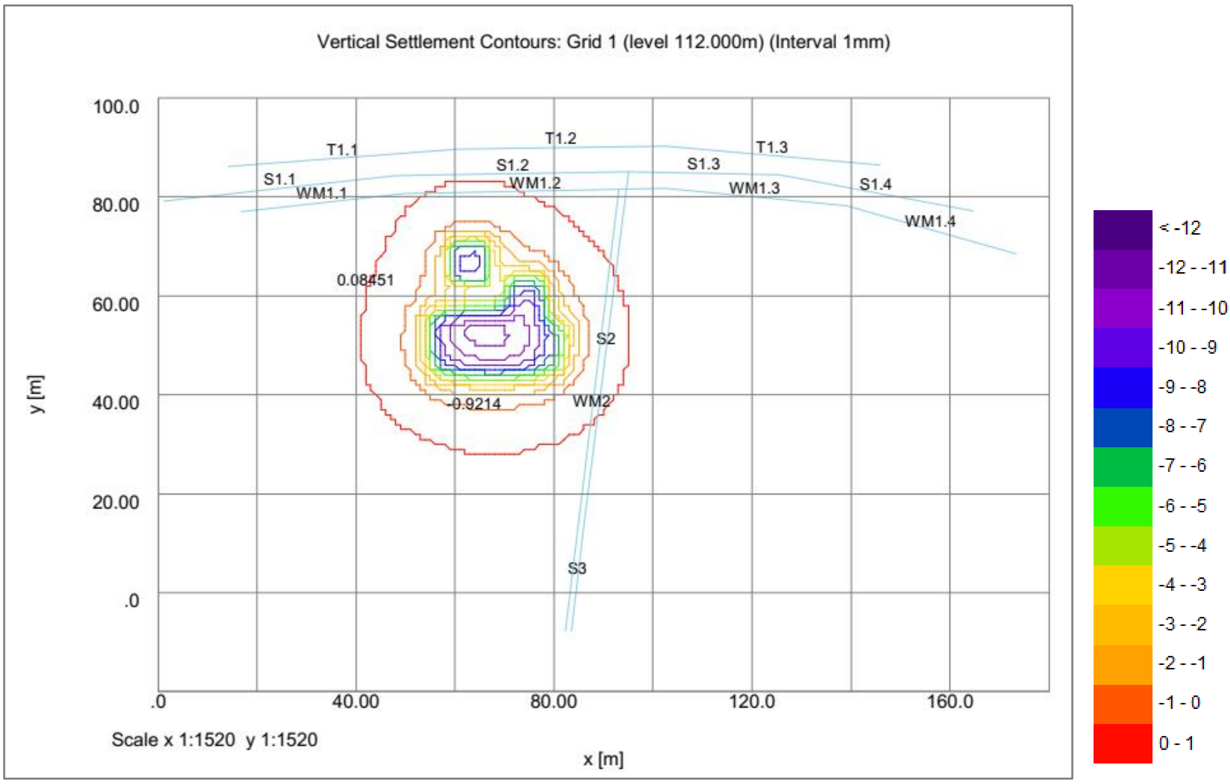


Figure 16.12: Vertical Movement – Method 1 after Excavation

Table 16.4: Utility impact assessment – Method 1 after Excavation

Assets	Tensile Strain [με]		Compressive Strain [με]		Pull-out [mm]		Rotation [degrees]	
	Maximum	Limit	Maximum	Limit	Maximum	Limit	Maximum	Limit
S1.1	1	500	-1	-625	-	-	-	-
S1.2	2	500	-2	-625	-	-	-	-
S1.3	0	500	0	-625	-	-	-	-
S1.4	0	500	0	-625	-	-	-	-
S2	5	40	-4	-400	0.01	3	0.00107	2.0
S3	0	40	0	-400	0.00	3	0.00001	2.0
WM1.1	0	100	0	-1200	0.00	3	0.0002	0.1
WM1.2	0	100	0	-1200	0.00	3	0.00073	0.1
WM1.3	0	100	0	-1200	0.00	3	0.00001	0.1
WM1.4	0	100	0	-1200	0.00	3	0.00001	0.1
WM2	1	100	-1	-1200	0.00	3	0.0017	0.1
T1.1	0	100	0	-1200	0.00	3	0.00004	0.1
T1.2	0	100	0	-1200	0.00	3	0.00005	0.1
T1.3	0	100	0	-1200	0.00	3	0.00001	0.1

All assets are within Thames Water screening criteria.

METHOD 1 – Long-term

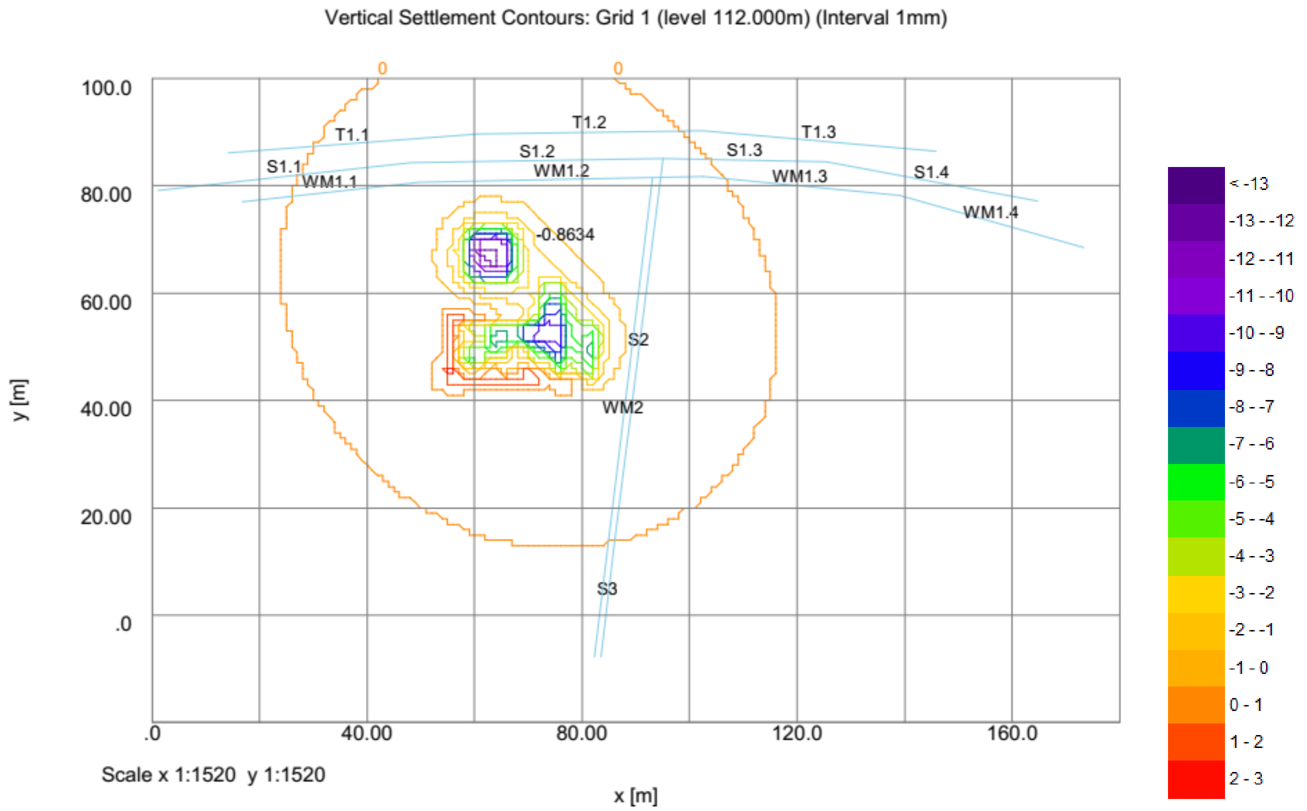


Figure 16.13: Vertical Movement – Method 1 Long-term

Table 16.5: Utility impact assessment – Method 1 Long-term

Assets	Tensile Strain [με]		Compressive Strain [με]		Pull-out [mm]		Rotation [degrees]	
	Maximum	Limit	Maximum	Limit	Maximum	Limit	Maximum	Limit
S1.1	1	500	-1	-625	-	-	-	-
S1.2	4	500	-4	-625	-	-	-	-
S1.3	0	500	0	-625	-	-	-	-
S1.4	0	500	0	-625	-	-	-	-
S2	3	40	-3	-400	0.01	3	0.00136	2.0
S3	0	40	0	-400	0.00	3	0.00002	2.0
WM1.1	0	100	0	-1200	0.00	3	0.00029	0.1
WM1.2	1	100	-1	-1200	0.00	3	0.00122	0.1
WM1.3	0	100	0	-1200	0.00	3	0.00002	0.1
WM1.4	0	100	0	-1200	0.00	3	0.0000	0.1
WM2	1	100	-1	-1200	0.00	3	0.00215	0.1
T1.1	0	100	0	-1200	0.00	3	0.00009	0.1
T1.2	0	100	0	-1200	0.00	3	0.00014	0.1
T1.3	0	100	0	-1200	0.00	3	0.00001	0.1

All assets are within Thames Water screening criteria.

METHOD 2 – CIRIA Excavation & Installation

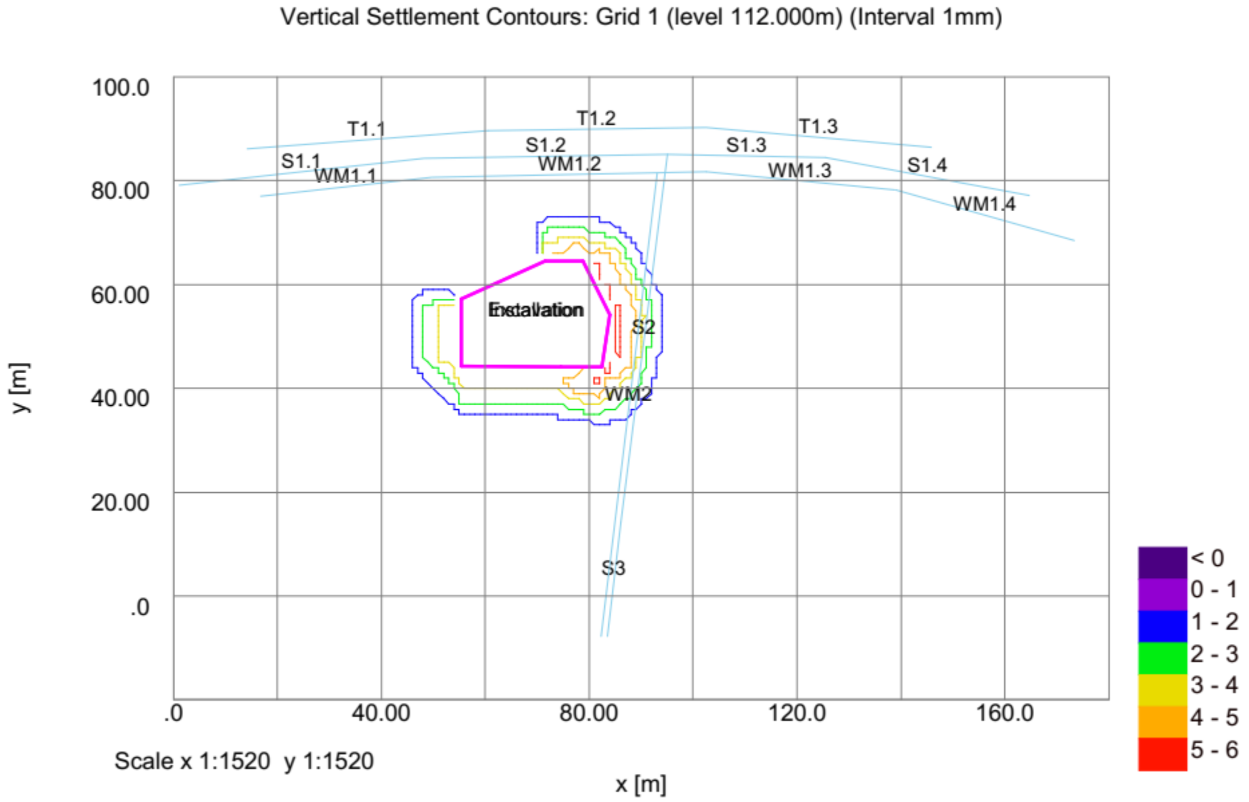


Figure 16.14: Vertical Movement – Method 2 CIRIA Excavation and Installation

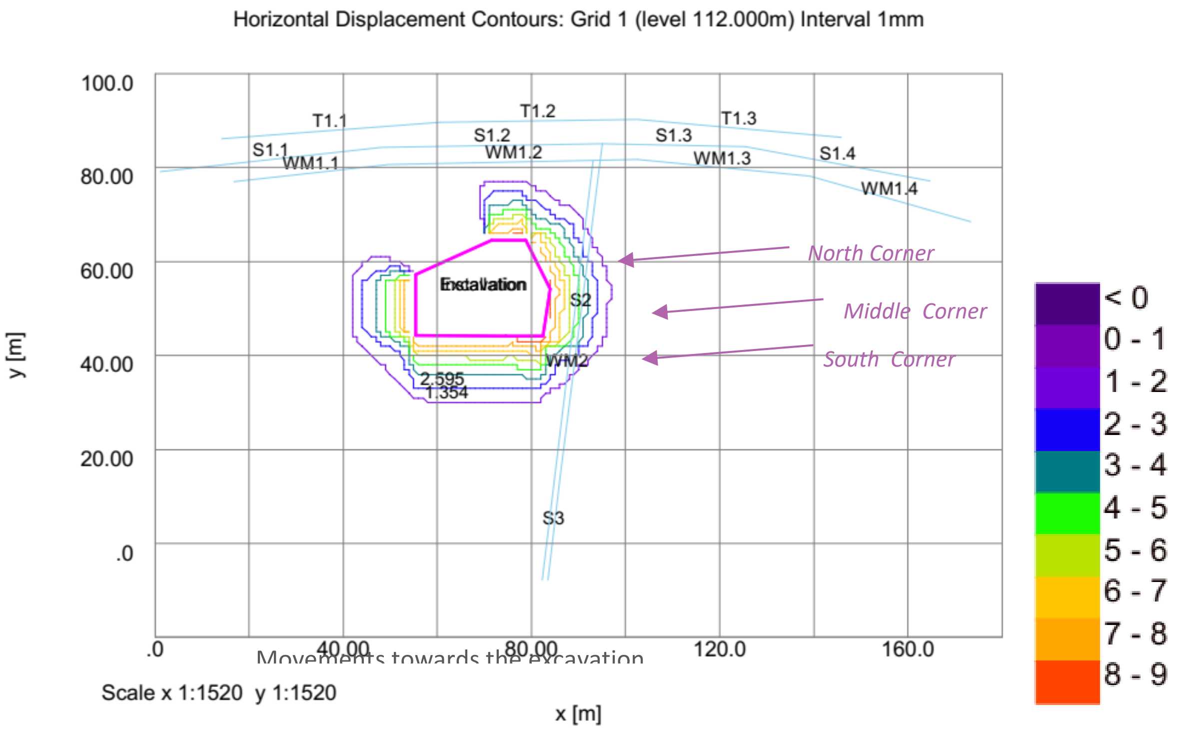


Figure 16.15: Horizontal Movement – Method 2 CIRIA Excavation and Installation

Table 16.6: Utility impact assessment – Method 2 CIRIA Excavation and Installation

Assets	Tensile Strain [με]		Compressive Strain [με]		Pull-out [mm]		Rotation [degrees]	
	Maximum	Limit	Maximum	Limit	Maximum	Limit	Maximum	Limit
S1.1	-	500	-	-625	-	-	-	-
S1.2	-	500	-	-625	-	-	-	-
S1.3	-	500	-	-625	-	-	-	-
S1.4	-	500	-	-625	-	-	-	-
S2	34*	40	-382	-400	0.40	3	0.03407	2.0
S3	-	40	-	-400	0.00	3	0	2.0
WM1.1	-	100	-	-1200	0.00	3	0	0.1
WM1.2	-	100	-	-1200	0.00	3	0	0.1
WM1.3	-	100	-	-1200	0.00	3	0	0.1
WM1.4	-	100	-	-1200	0.00	3	0	0.1
WM2	91	100	-683	-1200	0.44	3	0.04771	0.1
T1.1	-	100	-	-1200	0.00	3	0	0.1
T1.2	-	100	-	-1200	0.00	3	0	0.1
T1.3	-	100	-	-1200	0.00	3	0	0.1

** Excludes spikes in data*

All assets are within Thames Water screening criteria. Sewer 2 that runs below Templewood Avenue has recorded spikes in the data which exceed the Thames Water screening criteria for the tensile strain for unreinforced concrete pipes. These spikes also occur in the compression strain profile, indicating that they are due to flexural strain, related to bending of the pipe. These spikes have been ignored as they result from modelling simplifications described previously. The highlighted value quoted in the table above was considered to be the most representative value of the maximum tensile strain. Figure 16.16 and Figure 16.17 show the movement and combined strains profile of this asset.

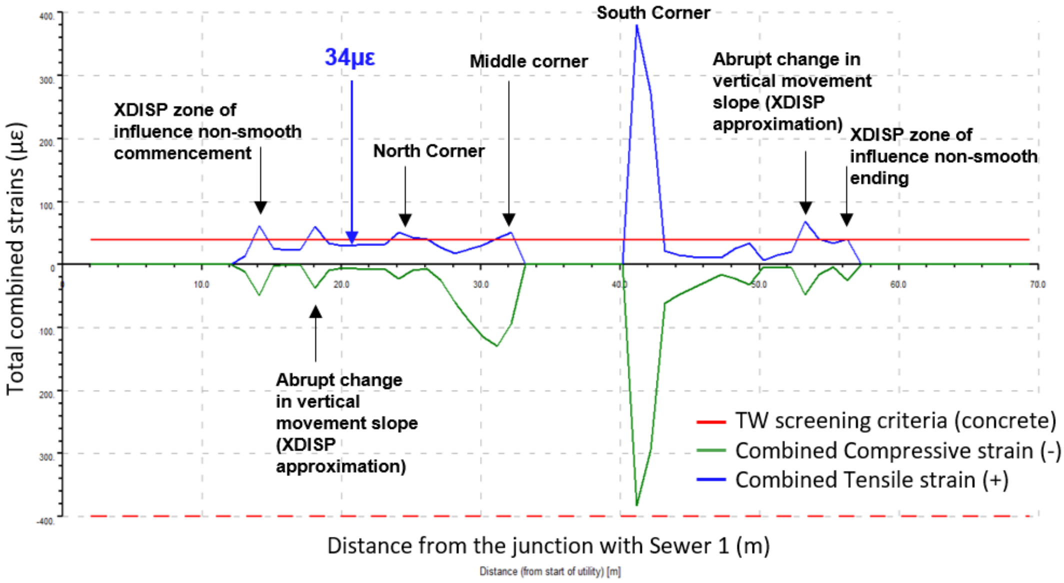


Figure 16.16: Movement profile of Sewer 2 – Method 2 CIRIA Excavation and Installation

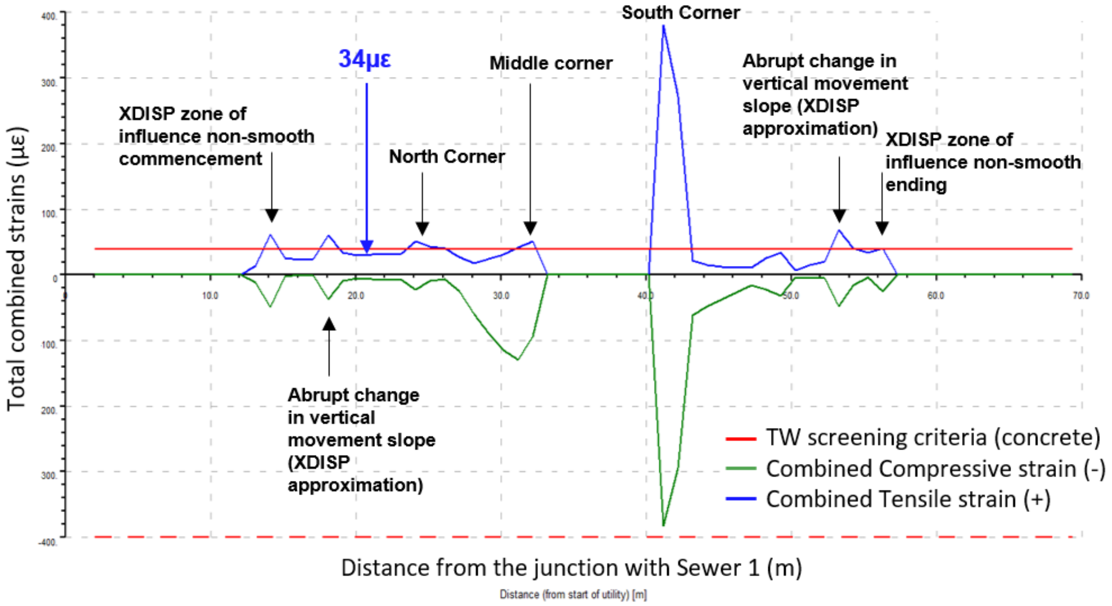


Figure 16.17: Combined Strain profile of Sewer 2 – Method 2 CIRIA Excavation and Installation

METHOD 2 – Long-term

The horizontal movements at this stage are the same as the previous stage (Figure 16.15) since the movements of the PDISP long-term movements are only vertical movements (settlement). The figure below shows the cumulative vertical movements of XDISP using CIRIA curves and the PDISP Long-term loading.

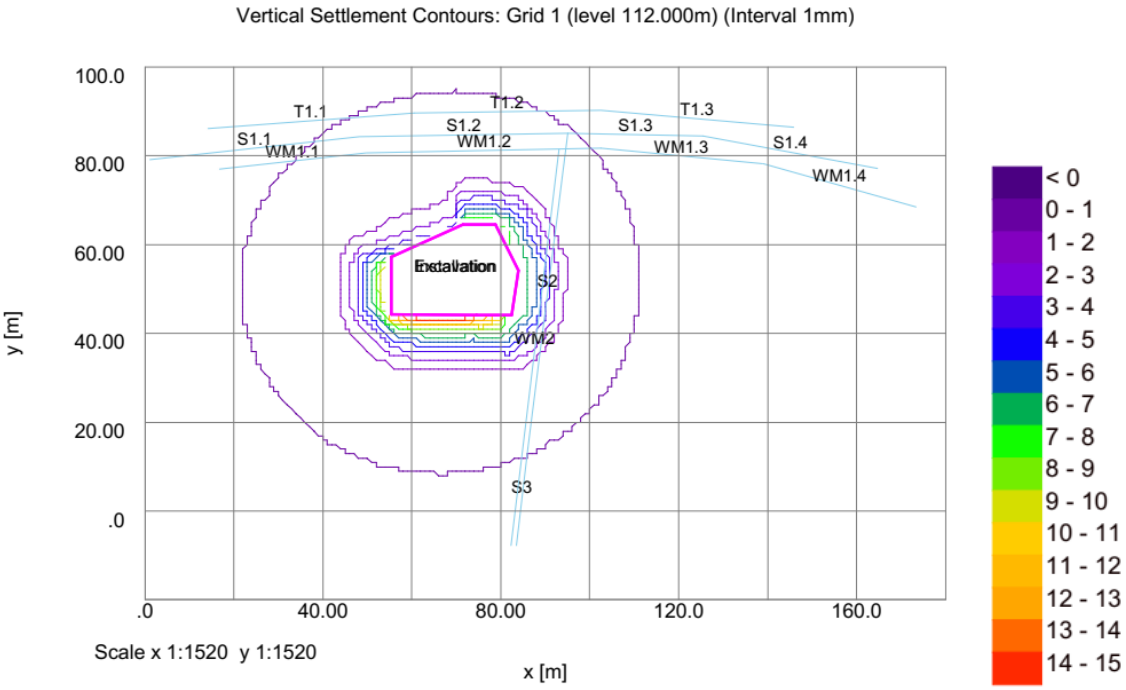


Figure 16.18: Vertical Movement – Method 2 – CIRIA curves + Long-term loading

Table 16.7: Utility impact assessment – Method 2 – CIRIA curves + Long-term loading

Assets	Tensile Strain [me]		Compressive Strain [me]		Pull-out [mm]		Rotation [degrees]	
	Maximum	Limit	Maximum	Limit	Maximum	Limit	Maximum	Limit
S1.1	0	500	0	-625	-	-	-	-
S1.2	1	500	-1	-625	-	-	-	-
S1.3	0	500	0	-625	-	-	-	-
S1.4	0	500	0	-625	-	-	-	-
S2	34*	40	-383	-400	0.40	3	0.03432	2.0
S3	0	40	0	-400	0.00	3	0.00005	2.0
WM1.1	0	100	0	-1200	0.00	3	0.00004	0.1
WM1.2	0	100	0	-1200	0.00	3	0.00015	0.1
WM1.3	0	100	0	-1200	0.00	3	0.00002	0.1
WM1.4	0	100	0	-1200	0.00	3	0	0.1
WM2	91	100	-684	-1200	0.44	3	0.04807	0.1
T1.1	0	100	0	-1200	0.00	3	0.00001	0.1
T1.2	0	100	0	-1200	0.00	3	0.00003	0.1
T1.3	0	100	0	-1200	0.00	3	0.00001	0.1

** Excludes spikes in data*

All assets are within Thames Water screening criteria. Sewer 2 that runs below Templewood Avenue has recorded spikes in the data which exceed the Thames Water screening criteria for the tensile strain for unreinforced concrete pipes. These spikes also occur in the compression strain profile, indicating that they are due to flexural strain, related with the bending of the pipe. These spikes have been ignored as they result of a non-smooth bending profile caused by the XDISP simplistic modelling approach typically near corners of excavation and the beginning of the zone of influence. The value quoted in the Table above was considered to be the most representative value of the maximum tensile strain.

Figure 16.19 and Figure 16.20 show the movement and combined strains profile of this asset.

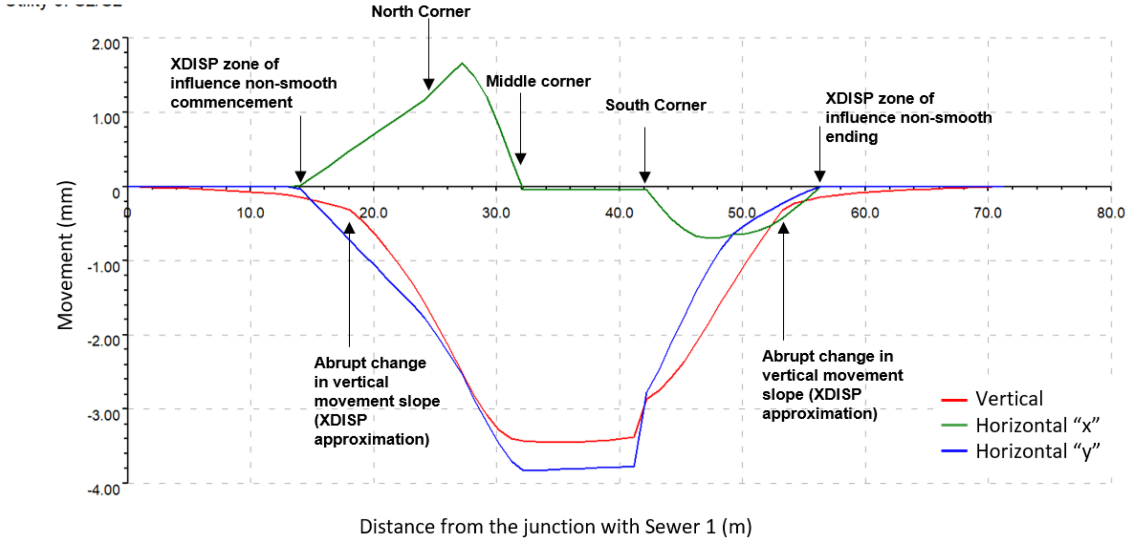


Figure 16.19: Movement profile of Sewer 2 – Method 2 – CIRIA curves + Long-term loading

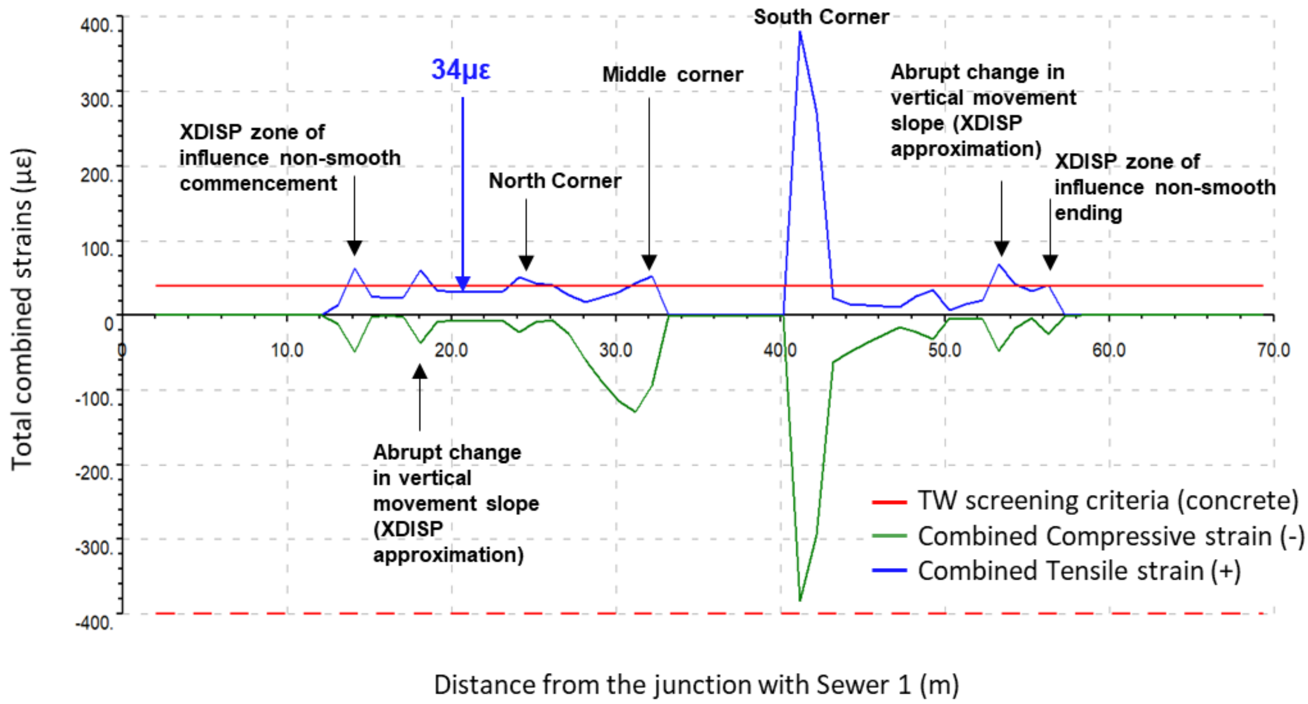


Figure 16.20: Combined strain profile of Sewer 2 – Method 2 – CIRIA curves + Long-term loading

16.6.6 It should be noted that Sewer 2 was assumed to be of concrete construction, which is the most conservative assumption in terms of performance criteria. If the asset is proven to be of vitrified clay construction, the tensile strain screening criterion increases to 80με.

16.7 Conclusions and Closing Remarks

16.7.1 The interaction between the proposed 35 Templewood Avenue development, the Schreiber House and 33 Templewood Avenue has been reviewed as part of the GMA study presented herein.

16.7.2 The proposed development construction operations comprise a series of stages, including strip of the existing ground floor structure/temporary propping of existing walls, basement deepening/excavation and construction of the proposed elements. The impact of construction works has been reviewed on the basis of two alternative methods (i.e. evaluating the effects of unloading/overburden removal using Pdisp (Method 1) and the excavation effect using empirical CIRIA ground movement curves in Xdisp (Method 2)). The two different scenarios have been considered in order to bind the potential ground movements arising from the proposed works (i.e. maximum potential heave and settlement respectively). This strategy ensures a robust evaluation of potential impact in light of the bespoke, intricate and workmanship dependent underpinning processes adopted.

16.7.3 The results from the analysis are presented in Table 16.3 (denoting the evaluated damage categorisation in accordance with the Burland criteria presented herein). The majority of the facades fall within Category 0, representative of a *Negligible* damage classification. Three structures / facades have been classified as Category 1, representative of *Very Slight* damage classification. No damage category higher than this has been assessed.

16.7.4 In addition to the above, assessments were carried out to quantify the potential impact of the proposed development on the adjacent roadway. It was found that the ground movements at both West Heath Road and Templewood Avenue are generally <1mm. In the area close to the proposed car lift, movements were up to 8mm, decreasing to 0mm on the opposite side of the road. The risk of damage to the adjacent roadways as a result of the proposed works is considered to be low. However, it may be prudent for the contractor to allow for localised *making good* of any minor surface defects – particularly in the area immediately adjacent to the proposed car lift.

16.7.5 The results of the impact assessment on the Thames Water assets carried out using XDISP have been presented in Chapter 16. All assets comply with the Thames Water screening criteria with the exception of certain isolated peak values of tensile strain of Sewer 2 under Templewood Avenue, which is the result modelling simplifications. These spikes in curvature/deformation have been ignored as they are not representative of a realistic behaviour of the asset. It is concluded that the impact on the Thames Water assets due to the redevelopment proposals is negligible.

16.7.6 It is noted that the predicted ground movements, the associated wall tensile strains and level of damage categorisation are considered to be moderately conservative in view of the relatively cautious ground model assumptions and *greenfield* nature of the assessment undertaken.

16.7.7 It is also noted that the GMA will be supplemented by a project specific monitoring regime and Action Plan, which will delineate lines of responsibility, monitor trigger levels and appropriate mitigation measures. The assessment presented herein is dependent and reliant on the works being undertaken by an experienced contractor, high quality workmanship and appropriate supervision of construction means and methods by experienced personnel.

17 REFERENCES

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APPENDICES

APPENDIX 1 – FIGURES

APPENDIX 2 – GROUNDSURE REPORTS

APPENDIX 3 – OS HISTORICAL MAPS

APPENDIX 4 – QUALITATIVE RISK ASSESSMENT METHODOLOGY

APPENDIX 5 – EXPLORATORY HOLE RECORDS

APPENDIX 6 – CHEMICAL LABORATORY TEST RESULTS

APPENDIX 7 – GEOTECHNICAL LABORATORY TEST RESULTS

APPENDIX 8 – SOIL GAS MONITORING TEST RESULTS

APPENDIX 9 – OASYS GMA CALCULATIONS