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For

Origin Housing

Project Number:

12047

July 2015

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Document History and Status

Revision	Date	Purpose/Status	Author	Check	Review
D1	June 2015	Draft	F Drammeh	E Brown	E Brown/G Acheson
F1	July 2015	Final	F Drammeh	E Brown	E Brown/G Acheson

Document Details

Last saved	08/07/2015 10:21
Path	FDemb-020715-12047-BIA-F1
Author	F Drammeh, MEng (Hons)
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Project Number	12047
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1.0 INTRODUCTION

1.1. Appointment and Scope

1.1.1. This report has been produced by Campbell Reith Hill LLP (CampbellReith) on behalf of Origin Housing (the Client). It provides a Basement Impact Assessment (BIA) relating to the proposed redevelopment of Ashton Court (hereafter referred to as the site), which includes the demolition of the buildings in the south of the property on Camden Mews, and the construction of a three storey building comprising flats with a single storey basement. An existing common room on Camden Park Road is also proposed to be demolished and replaced by a two storey building, however, this building does not include a basement. The focus of this report is therefore the proposed building on Camden Mews. The layout for the proposed basement is indicated on drawings contained in Appendix A. The references and limitations associated with this report follow the main text.

1.1.2. The report has been produced in general accordance with the policies and technical procedures for Basement Impact Assessments for the London Borough of Camden comprising:

- Guidance for Subterranean Development (GSD). Issue 01. November 2010. Ove Arup & Partners
- Camden Planning Guidance (CPG) 4: Basements and Lightwells, revised September 2013
- Camden Development Policy (CDP) 27: Basements and Lightwells.

1.1.3. A BIA is required for all planning applications with basements in Camden in accordance with DP 27 to demonstrate that schemes:

a) maintain the structural stability of the building and neighbouring properties;

b) avoid adversely affecting drainage and run off or causing other damage to the water environment; and,

c) avoid cumulative impacts upon structural stability or the water environment in the local area.

1.1.4. The purpose of this report is to evaluate the impacts of the proposed basement considering the issues of hydrology, hydrogeology and land stability via the process described by the GSD and to make recommendations for detailed design. The GSD presents a staged methodology and tool kit which is illustrated by flow charts and checklists. This report has been structured to follow that guidance through the incremental stages of:

d) Screening (Section 4.0)

e) Scoping (Section 5.0)

f) Ground Investigation and Study (Section 6.0)

g) Impact Assessment (Section 8.0)

h) Non-technical summary (Section 9.0)

1.1.5. This report considers the full screening, scoping, ground investigation and basement impact assessment stages. It relies upon readily available desk study information and a recent ground

investigation, sufficient to identify and appraise the nature and magnitude of potential impacts, together with appropriate mitigation measures. It is intended that this document supports the deliberations required to grant planning permission.

1.1.6. This report considers information about the proposed development (Appendix A) and a recent site specific ground investigation (Appendix B). Reference has also been made to CampbellReith's Geoenvironmental and Geotechnical Desktop Study and CampbellReith's Construction Methodology Report. Desk study data contained within CampbellReith's Geographical Information System (GIS) database, publicly available information, and information contained in the GSD and CPG4 have also been referred to.

TABLE 1.1: Existing Site Specific Information

Report Title	Author	Reference
Ashton Court, Geotechnical and Geoenvironmental Desktop Study, June 2015, FDli-020715-12047-DS-F1	CampbellReith	[1]
Envirocheck Report, ref: 67216162_1_1, May 2015	Envirocheck	[2]
Ashton Court, Camden Road, Ground Investigation Report, March 2015, Report Reference:C13480	Ground Engineering Limited	[3]
Ashton Court, Camden Road, Trial Pit Logs, May 2015, Reference:C13480a	Ground Engineering Limited	[4]
Ashton Court Topographic Survey	J. Brotherton & Partners	[5]

1.1.7. This assessment has been carried out or reviewed by persons with the relevant qualifications required by the guidance comprising:

Elizabeth Brown: BSc MSc C.Geol FGS

G Acheson: BSc (Hons) CEng MIStructE, AMICE

2.0 SITE DESCRIPTION

2.1. Site Location and Layout

2.1.1. The full site description is detailed in CampbellReith's Geotechnical and Geoenvironmental Desktop Study Report (FDli-020715-12047-DS-F1) [1] and this should be referred to. A summary is provided below.

2.1.2. The site is located on Camden Road, NW1 9HE, in the London Borough of Camden, and is centred on an approximate National Grid reference of 529740E, 184830N. A site walkover was completed by a representative of CampbellReith on 29th April 2015. The site location is presented in Figure 1 with existing layout plan showing the buildings to be demolished on Figure 2.

2.1.3. The site is a rectangular plot of approximately 0.45 hectares and currently comprises flats in a 4 storey building on Camden Road and a two storey building on Camden Mews with a single storey common room on Camden Park Road to the east linking the two buildings. The remaining area between the two buildings comprises a grassed garden area.

2.1.4. The two storey building on Camden Mews comprises partial undercroft parking and covers an approximate area of 26 x 7m. It is bound to the southeast by a cobblestone road into Camden Mews, to the east by Camden Park Road, and residential property to the west and southwest. The garden area slopes down from west to east (c45.40 to 44.65m AOD on the wooden deck of the common room patio) and from south to north (c45.70m AOD on the paved area between the rear of the flats on Camden Mews and the common room to 44.40m AOD at the back of the main building). The ground level of the common room is approximately 0.95m lower than the ground level of the Camden Mews flats.

2.1.5. An approximately 10m high Cherry tree and a 12m high Ash tree are located in the garden with an approximately 12m high Plane tree located in the paved area to the east of the common room. These are located at about 11m, 4.50m and 4m to the north of the Camden Mews flats respectively.

2.1.6. Two foundation inspection pits were undertaken against the party wall to the west to investigate the foundations to the adjacent property on Camden Mews. TP1 was undertaken in the garden against a brick boundary wall. Although the pit was probed beneath the wall, it did not reveal the foundations to the adjacent housing. The construction of the boundary wall comprised brickwork. The concrete foundations extended to about 0.45m bgl and projected between 170mm and 440mm into the site. A possible relic concrete foundation was encountered beneath the foundations of the masonry pier from 0.46m to 0.82m bgl.

2.1.7. TP2 was undertaken adjacent to the party wall with 103 Camden Mews in the southwest corner. The construction comprised brickwork over mass concrete. The concrete foundation projected 670mm into the site and extended to 0.75m bgl. The pit was extended northwards into the site and revealed mass concrete under the thin asphalt surface of the carpark. At both locations the founding stratum comprised Made Ground and it is considered that the concrete may represent ground beams. Further trial pitting is proposed.

2.2. Surrounding Land-Use

2.2.1. The site is bound to the west and southwest by a residential property (103 Camden Mews). Camden Road (A503) is present along the northwest boundary with Camden Park Road (A5200) to the northeast and east. A cobblestone road leading to Camden Mews is present on the southeast with housing beyond.

2.2.2. A search of previous planning applications on the London Borough of Camden Council planning website found no records of applications for the construction of basements beneath the adjoining property (252 Camden Road and 103 Camden Mews). Additionally, no evidence of basements was found for 99 and 101 Camden Mews, 82 – 90 Camden Mews across the access road; and Nos 51 – 59 Camden Park Road on previous planning applications or during the site walkover undertaken as part of the desktop study.

2.3. Proposed Development

2.3.1. The proposed development is shown on drawings presented as Figures 3a and 3b contained in Appendix A. It is proposed to demolish the flats on Camden Mews and construct a three storey block of flats with a single storey basement. The common room on Camden Park Road is also proposed to be demolished with a two storey building comprising a common room on the ground floor and two flats above constructed.

2.3.2. The proposed finished floor level (FFL) of the Camden Mews ground floor slab is 45.73m AOD and 43.08m AOD for the basement slab. Ground level on Camden Mews is approximately 45.60m AOD in the vicinity of the site. Due to the slight change in ground level within the development area, the maximum depth of excavation for the basement is anticipated to be c3m. The proposed FFL for the new common room ground floor slab is 44.70m AOD (approximately 1m lower than the Camden Mews ground floor slab).

3.0 ENVIRONMENTAL SETTING

3.1. Geology

3.1.1. The site geology and environmental setting is fully detailed in CampbellReith's desktop study report [1] and this should be referred to. A summary is provided below.

3.1.2. Based on the ground investigation data [3&4] and the geological sheet for the area (Sheet 256, North London 1:50000 Geological Survey of England and Wales) [6], the site geology comprises Made Ground over London Clay.

3.1.3. WS1 [3] was undertaken to 10m bgl and recorded Made Ground to 1.50m bgl over London Clay. TP1 and TP2 [4] were undertaken in the south western and north western corners on the boundary with 103 Camden Mews and Made Ground was recorded to the base of both pits at a maximum depth of 1.30m bgl. TP1 was probed beyond the base of the pit to 1.70m bgl and Made Ground was still encountered.

3.1.4. A British Geological Survey (BGS) historical borehole (TQ28SE4) within 500m of the site recorded London Clay to 45m bgl over the Lambeth Group and Thanet Sand, which were in turn underlain by Chalk to the base of the pit at 128m bgl.

TABLE 3.1: Summary of Geology

Strata	Depth to Base (m bgl)	Depth to base[a] (m AOD)	Thickness (m)	Description
Made Ground[a]	1.50 - >1.70	c43.90 - <43.70	1.50 - >1.70	Man-made cohesive and granular soils associated with the historic development of the site.
London Clay[b]	7	38.40	5.50	Firm to stiff closely fissured orange brown and grey mottled clay with partings of sand.
	45 (proven to 10 on site)	0.40	43.50	Stiff closely fissured grey clay.
Undifferentiated and Lambeth Group and Thanet Sand[c]	c70	c-25.00	c25	Sands and clays
Chalk[c]	>120	<-83.00	>60	White Chalk with flints

[a] Based on a ground level of 45.40m AOD in the southern area of the site
[b] These depths and descriptions for the MG and LC are from WS1, TP1 and TP2 contained in reference 3 and 4
[c] These depths are from a historic borehole record approximately 500m to the NW and may differ on site

3.1.1. The Envirocheck report indicates a moderate potential for shrinking or swelling clay ground stability hazards on site. This will be associated with the London Clay. The report indicates 'no hazard' for compressible ground stability hazards, ground dissolution stability hazards and

running sand ground stability hazards and a 'very low' risk for collapsible ground stability hazards and for landslide ground stability hazards.

3.1.2. Reference to Figure 17 of the GSD indicates that the site is not within an area of known significant landslide potential and this concurs with the known site topography.

3.2. Hydrogeology and Hydrology

3.2.1. The site is situated on an Unproductive Stratum (associated with the London Clay). Groundwater was not encountered during the site works in the GEL investigation [3], however, a water level of 5.23m bgl was recorded during the monitoring visit following the site works. The desk study information obtained from the Envirocheck Report [2] indicates there are no licensed abstractions within 250m of the site and with respect to the potential for rising groundwater in the basal Chalk aquifer, the site is not within a critical area for shallow foundations and basements.

3.2.2. Figure 12 of the GSD, the Ordnance Survey plans [2], and the site reconnaissance indicate that the site is more than 500m away from surface water features.

3.3. Flooding

3.3.1. Figure 15 of the GSD (extracted from Figure 5 of the Camden Core Strategy) indicates that the site did not flood in either the 1975 or 2002 flood events.

3.3.2. The London Borough of Camden Strategic Flood Risk Assessment report [7] indicates that the site is in a low risk area for internal and external sewer flooding as well as surface water flooding.

3.3.3. Reference to the Environment Agency's recent modelling of surface water flooding [8] indicates that the site is in an area of very low risk from surface water flooding. Despite this, properties in the immediate vicinity of the site have been allocated low to high risk of flooding from surface water. Of particular note are the properties c30m northwest of the site in the vicinity of Busby Mews, which have been assigned a medium risk of flooding from surface water and the properties approximately 200m to the west which have been assigned a high risk.

3.3.4. The site is not within a Zone 2 or Zone 3 flood risk area associated with rivers or the sea. The site is not within the areas associated with floods with a return period of up to 1000 years, nor is it an area of coincident with a BGS geological indicator of flooding.

3.4. Site History

3.4.1. The site's history and industrial setting are fully detailed in the CampbellReith desk study report and this should be referred to. A summary is provided below.

3.4.2. Historic maps contained in reference [2] indicate the site was originally developed in the early 1870s with two buildings believed to be of residential use in the northern half. The site remained the same with minor landscape alterations to the rear of the properties indicated until 1920 when three small structures were indicated in the southernmost area along Camden Mews. An alteration to the layout of the buildings on Camden Mews was undertaken in the early 1950s. One of the buildings in the northern half, No. 254 Camden Road, is marked as a day nursery in 1960. The site remained unchanged until the early 1970s when the buildings in the northern area were demolished. The current buildings are indicated to have been constructed in the early 1980s and have remained unaltered, although a previous planning application on the London

Borough of Camden Planning website indicates the common room was demolished and rebuilt in the mid-1980s due to damage to the foundations as a result of heave/subsidence.

3.4.3. The London County Council bomb damage maps 1939 – 1945 [9] indicate that both Nos 254 and 256 Camden Road suffered minor blast damage.

3.5. Liaison With Regulatory Authorities

3.5.1. The Environmental Health, Building Control and Planning Departments of the London Borough of Camden Council were consulted on 7th May 2015 as part of the desktop study.

3.5.2. The Building Control Officer indicated that the site and adjacent land use has been residential for possibly the last 40 years. The area is underlain by London Clay although gravels and sands are locally encountered above the London Clay. The top of the London Clay is typically encountered at c0.50m bgl, however fill is present on a number of sites in the area. Raft or piled foundations are used in the area. Piped networks are used for drainage.

3.5.3. The Environmental Health Officer confirmed the site has not been determined as Contaminated Land under Part IIA of the Environmental Protection Act 1990 as the Council considers it to be suitable for its current use and that the site has no former industrial land uses and therefore will not been identified as a priority for inspection under the Council's Part IIA Strategy. The site is not on the Council's contaminated land register and there is no evidence of contamination issues affecting the site, other than the soil profile in Camden tends to exhibit high levels of Lead. There are no historical landfills identified within 250 metres of the site. Finally, there are no Environment Agency or Local Authority industrial processes within 50 metres of the site.

3.5.4. The Planning Officer indicated that the site is in the Camden Square Conservation Area therefore permission is required from the council before any work is undertaken on trees and in addition there is a Tree Preservation Order on five trees located on site.

3.6. Tree Information

3.6.1. As discussed in Section 2, three trees (a Cherry, Plane and Ash tree) ranging from 10 to 12m high were noted close to the area of proposed development. The Plane and Ash trees have Tree Protection Orders.

3.7. Underground Services

3.7.1. The CampbellReith GIS database includes information on the approximate location of a number of tunnel networks, including those operated by London Underground Limited, redundant tunnels such as the Mail Rail, the larger diameter deep tunnels associated with government communications and electricity supply, and the proposed HS2 routes. The database suggests that the site is not located within 100m of London Underground, Network Rail assets, the Crossrail Safeguarding Zones, Royal Mail tunnels or government communication tunnels.

3.7.2. The CampbellReith database indicated a possible National Grid tunnel running very close to the site boundary along Camden Mews and which possibly encroached on the site. National Grid was contacted and the plans obtained did not indicate the presence of a tunnel; it is thought that this reflects the limits on the accuracy of the in house database. Responses from the other utilities companies showed low and medium pressure gas pipes running along Camden Mews and Camden Park Road.

3.7.3. An asset location search was undertaken prior to the site investigation and maps provided by the client indicate various Thames Water assets running close to the site boundary along Camden Mews and Camden Park Road. These include two combined sewers running along Camden Mews and Camden Park Road. A storm relief sewer tunnel is indicated running along Camden Road, however this is >30m away from the proposed basement location. Thames Water and National Grid should be consulted to determine whether they require an assessment of the impact of the development on their assets.

4.0 STAGE 1 - SCREENING

4.1. Screening

4.1.1. In accordance with the GSD, an initial screening exercise has been undertaken in relation to Subterranean Flow (Table 4.1), Slope Stability (Table 4.2) and Surface Flow and Flooding (Table 4.3). These tables follow the form of the BIA screening flowcharts which are presented in Appendix E of the GSD. The following appraisal is based on the proposed new basement construction, the extent of which is indicated on drawings contained in Appendix A.

4.1.2. The screening exercise considers the site walkover, desk study, recent ground investigation data and data contained in the GSD. In the context of this report, the desk study data have been discussed in Sections 2 and 3. The ground investigation data has been discussed in detail in Section 3 and 6. Based on such data, the scoping exercise assumes the following ground model:

- An existing ground level of around 45.50m AOD in the area of proposed development;
- A sequence of strata as outlined in Table 3.1;
- An equilibrium groundwater level at around 5.25m bgl in the London Clay (as established from the site investigation [3]); and
- A proposed basement FFL of 43.08m AOD.

TABLE 4.1: Subterranean groundwater flow screening flowchart

Question		Answer	Comments/Justification if answered 'no'
1a	Is the site located directly above an aquifer?	No.	The site is underlain by Made Ground over London Clay which is an Unproductive Stratum.
1b	If yes to 1a), will the proposed basement extend beneath the water table surface?	N/A.	Anticipated groundwater level is c5.25m bgl (see Section 3.2) vs proposed basement level (from ground level to underside of basement slab) of c3m bgl.
2	Is the site within 100m of a watercourse, well (used/disused) or potential spring line?	No.	No such features have been recorded within 100m of the site. Reference has been made to Figures 2, 11, 12 and 15 of the GSD, aerial photography (Google Earth), the Envirocheck Report [1], the Environment Agency website [8] and references 8 and 9.
3	Is the site within the catchment of the pond chains on Hampstead Heath?	No.	The site is not located within the area indicated on Figure 14 of the GSD.
4	Will the proposed basement development result in a change in the proportion of hard surfaced/paved areas?	Yes.	The proposed area of the Camden Mews flats is 26 x 7m at basement level which would cover approximately the same area as the current building. At ground floor level, an approximate 2.50m extension into the garden is proposed for decking. This means a reduction of the soft landscaped garden by circa $65m^2$.
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 Sustainable Urban Drainage?)	No.	The proposed development will result in a nominal increase in hard surfacing of approximately $65m^2$. The development is not amenable to soakaway drainage and the surface water will be drained via the piped network.
6	Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to, or lower than, the mean water level in any local pond (not just the pond chains on Hampstead Heath) or spring line.	No.	No such features are present within 100m of the site, as discussed in Question 2 above.

TABLE 4.2: Slope/ground stability screening flowchart

	Question	Answer	Justification
1	Does the existing site include slopes, natural or manmade, greater than 7°?	No.	Observations from the CampbellReith site reconnaissance and the topographic survey [5] confirm that the development area is gently undulating. Figure 16 of the GSD indicates that the site is not in an area where the slope angle exceeds 7°.
2	Will the proposed re-profiling of the landscape at the site change slopes at the property boundary to more than 7°?	No.	The current plans detailed in Appendix A do not indicate landscape reprofiling.
3	Does the development neighbour land, including railway cuttings and the like, which slopes greater than 7°?	No.	Site reconnaissance and Figure 16 of the GSD indicates that the site is not in an area where the slope angle exceeds 7°.
4	Is the site in a wider hillside setting with a slope of more than 7°?	No.	Site reconnaissance and Figure 16 of the GSD indicates that the site is not in an area where the slope angle exceeds 7°.
5	Is the London Clay the shallowest strata at this site?	Yes.	The site is directly underlain by London Clay (see Section 3.1).
6	Will any tree(s) be felled as part of the proposed development and/or any works proposed within any tree protection zones where trees are to be retained?	No.	The current plans do not indicate the felling of trees. Three trees located in the area of proposed development have Tree Protection Orders (see Section 2.1).
7	Is there a history of shrink-swell subsidence in the local area, and/or evidence of such effects at the site?	Yes.	The Envirocheck Report [2] indicates a moderate potential for shrinking or swelling clay ground stability hazards on site and a previous planning application on the London Borough of Camden Planning website indicates the common room was demolished and rebuilt in the mid-1980s due to damage to the foundations as a result of heave/subsidence (see Section 3.4). With reference to BRE Chapter 4.2 Building Near Trees [10], whilst the proposed basement falls within the zone of influence of all the trees identified in Section 2.1, the suggested foundation depths do not exceed 2.10m bgl. The finished floor level of the basement slab will be beyond this depth and therefore not anticipated to be affected by ground movements induced by trees.
8	Is the site within 100m of a watercourse or potential spring line?	No.	Refer to Question 2 in Table 4.1
9	Is the site in an area of previously worked ground?	No.	By reference to Figure 3, 5 and 16 of the GSD and the BGS Geological Map [6], the site is not in an area of recorded worked ground. However, as for any site in London, it is anticipated that the natural strata will be overlain by a thickness of Made Ground and given the site history discussed in Section 3 and the recent ground investigations [3&4], Made Ground is anticipated to a depth of between 1.50 and c1.70m bgl or more.

10	Is the site within an aquifer? If so, will the proposed basement extend beneath the water table such that dewater may be required during construction?	No.	As discussed in Table 4.1 Question 1a, the site is underlain by an Unproductive Stratum (London Clay). The proposed development is not anticipated to extend beneath the water table, however, the development may encounter limited volumes of perched groundwater in the London Clay and as a result temporary dewatering may be required.
11	Is the site within 50m of the Hampstead Ponds?	No.	Figure 14 of the GSD indicates that the site is considerably greater than 50m from the Hampstead Ponds.
12	Is the site within 5m of a highway or pedestrian right of way?	Yes.	The site walkover (Section 2) and ordnance survey maps indicate that the site is adjacent to Camden Road in the northwest and more specifically the proposed development area is adjacent to Camden Park Road to the east and Camden Mews Road to the southeast. Desk study research indicates the presence Thames Water and National Grid assets running along Camden Mews and Camden Park Road. Refer to Question 12, Table 5.3.
13	Will the proposed basement significantly increase the differential depth of the foundations relative to neighbouring properties?	Likely	Refer to Question 12, Table 5.3.
14	Is the site over (or within the exclusion zone of) any tunnels?	No.	The CampbellReith GIS database and plans provided by the client suggest that the site is not located within 100m of any tunnels (see Section 3.7).

TABLE 4.3: Surface flow and flooding screening flowchart

	Question	Answer	Comments/Justification if answered 'no'
1	Is the site within the catchment of the ponds on Hampstead Heath?	No.	Refer to Table 4.1, Question 3.
2	As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route?	No.	Refer to Question 5, Table 4.1.
3	Will the proposed basement development result in a change in the proportion of hard surface/paved external areas?	Yes.	Refer to Question 4, Table 4.1.
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 water courses?	No.	See Question 2. The site is relatively remote from any watercourses.
5	Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream water courses?	No.	The site is relatively remote from any watercourses.
6	Is the site in an area known to be at risk from surface water flooding, such as South Hampstead, West Hampstead, Gospel Oak and King's Cross, or is it at risk from flooding, for example because the proposed basement is below the static water level of a nearby surface water level of a nearby surface water features?	No.	The site is not in an area of known surface water flood risk (see Section 3). The site is remote from water features. Refer to Question 2, Table 4.1.

4.2. Non-technical Summary – Stage 1:

4.2.1. Four issues were identified during the screening process. Three relate to stability and one relates to surface flow and flooding, as follows:

- Table 4.1- Q4 and Table 4.3 - Q3, potential increase in hard surfaced/paved area;
- Table 4.2 - Q7, presence of shrink-swell soils;
- Table 4.2 - Q12, proximity of highway/pedestrian right of way; and
- Table 4.2 - Q13, potential increased differential in foundation depths.

4.2.2. These issues will be carried forward to Stage 2 – Scoping.

5.0 STAGE 2 - SCOPING

5.1. Scoping

5.1.1. The scoping stage considers the steps necessary to assess the impact of the issues identified during the screening stage. Tables 5.2 and 5.3 review those issues and address the potential impacts and necessary actions to mitigate these issues. The potential impacts requiring further consideration are defined in terms of significance based on Environmental Impact Assessment (EIA) terminology reproduced in Table 5.1 below.

TABLE 5.1: Significance Matrix

Magnitude of Effect	Sensitivity of Receptor				
	Very high	High	Medium	Low	Negligible
Very Large	Substantial Significance	Substantial Significance	Moderate Significance	Moderate Significance	[1]
Large	Substantial Significance	Moderate Significance	Moderate Significance	Minor Significance	[2]
Medium	Moderate Significance	Moderate Significance	Minor Significance	[2]	Neutral Significance
Small	Moderate Significance	Minor Significance	[2]	Neutral Significance	Neutral Significance
Negligible	[1]	[2]	Neutral Significance	Neutral Significance	Neutral Significance
[1] The choice between 'Moderate Significance', 'Minor Significance' and 'Neutral Significance' will depend on the specifics of the impact and will be down to professional judgement and reasoning.					
[2] The choice between 'Minor Significance' and 'Neutral Significance' will depend on the specifics of the impact and will be down to professional judgement and reasoning.					

Table 5.2: Slope/ground stability scoping flowchart

Question		Potential impact and actions
7	Is there a history of shrink-swell subsidence in the local area, and/or evidence of such effects at the site?	**Potential Impact:** The site is underlain by London Clay which has a high volume change potential and there are trees within the zone of influence of the proposed building (see Sections 2.1.5 and 3.4.2). **Actions:** None, because the proposed basement level is beyond the recommended founding depth derived from NHBC Standards Part 4: Chapter 4.2, Building near trees [10]. This is therefore of neutral significance.
12	Is the site within 5m of a highway or pedestrian right of way?	**Potential Impacts:** The construction of a basement can result in ground movements detrimental to roads and any infrastructure contained therein. The plans provided by the client indicate that there are Thames Water and National Grid assets running beneath the road pavements adjoining the site. **Actions:** The owners of these assets, along with the owner of the highway and the access road, should be consulted to determine any constraints to design, for example, easements, surcharge loadings on the basement walls and limiting values on ground movement. Such matters will need to be considered in the design of the basement and an estimate of likely ground movements made. There will be a need for support to the excavation (see CampbellReith Construction Sequence Report). This is considered to be of moderate significance.
13	Will the proposed basement significantly increase the differential depth of the foundations relative to neighbouring properties?	**Potential Impact:** The proposed basement slab level is 43.08m AOD. Whilst not conclusive, TP2 [4] indicates the foundations to 103 Camden Mews could be in the region of 0.75m bgl whereas the proposed basement will extend to c3.00m bgl (see Section 2). The adjoining property does not contain a basement. **Actions:** It is considered unlikely that the foundations to the adjacent property are founded in the Made Ground and the depth of the foundations to the neighbouring property should be determined. An additional inspection pit is proposed in the neighbouring property to further investigate the party wall foundations. A Ground Movement Assessment and Construction Sequence are reported separately. For the purposes of this assessment it has been assumed that the neighbouring building is on shallow strip foundations at depths of 0.75m bgl (as indicated by TP2) which is a conservative assumption. This is considered to be of moderate significance.

Table 5.3: Surface flow and flooding scoping flowchart

Question		Answer	Potential impact and actions
3	Will the proposed basement development result in a change in the proportion of hard surface/paved external areas?		**Potential Impact:** The increase is minimal (approximately 65m²). There is considered to be no adverse impact (see answers to Questions 4 and 5, Table 4.1). This issue is considered to be of minor significance.

5.2. Non-technical Summary – Stage 2

5.2.1. The scoping stage has highlighted that there are two issues that must be considered in design. These are associated with ground movements and their potential impact on surrounding infrastructure and the neighbouring property to the west. A Ground Movement Assessment has been undertaken to determine the impact of the demolition and construction activities on the neighbouring property and this is reported separately.

5.2.2. With respect to cumulative effects associated with groundwater flow and surface flow and flooding, the screening and scoping stages have established that this is of neutral significance as the proposed development is not anticipated to intersect the groundwater table and the site is relatively remote from watercourses.

5.2.3. Detailed design of the basement with careful consideration to sequencing and workmanship is necessary to ensure ground movements do not exceed acceptable limits. An indicative Construction Sequence Report is provided separately.

6.0 STAGE 3 – GROUND INVESTIGATION

Summary of Investigation

6.1. Scope of Works

6.1.1. A geotechnical ground investigation comprising a single window sample hole (WS1) to 10m bgl, a single gas and groundwater monitoring visit and geotechnical laboratory testing was procured by the Robert Lombardelli Partnership and carried out by Ground Engineering Limited (GEL) in January 2015 [3]. The purpose of the investigation was to provide geotechnical data for the proposed development and hence a contamination assessment was not undertaken. The results of the investigation are discussed below.

6.1.2. Two foundation inspection pits (TP1 and TP2) were undertaken in April and May 2015 by GEL to investigate the party wall foundations. No in-situ or laboratory testing was undertaken in this investigation.

6.1.3. The ground conditions encountered over the depth of the monitoring well installed in WS1 are summarised in Table 6.1. A visit was made to site on one occasion to monitor gas and water levels within the installation and to obtain samples.

TABLE 6.1: Standpipe Summary

Exploratory Hole	Response Zone (m bgl)	Strata Encountered	
WS1	1.00 – 7.00	1.00 – 1.50	Made Ground
		1.50 – 7.00	London Clay

6.2. Groundwater Observations

6.2.1. Groundwater was not encountered during the site works. A single monitoring visit was undertaken on 3rd February 2015 and the recorded water level was 5.23m bgl.

6.3. Geotechnical Testing

6.3.1. In-situ testing was undertaken for geotechnical purposes and samples were obtained for appropriate laboratory analysis.

6.3.2. Sixteen hand shear vane tests (UK Specification for Ground Investigation) were undertaken and whilst the hand vane results cannot be used for design, they can be used as an aid to the assessment of desiccation as desiccated soils tend to exhibit increased undrained shear strength.

6.3.3. Geotechnical laboratory testing is summarised in Table 6.2.

TABLE 6.2: Laboratory Tests (Geotechnical)

Test type and reference (BS 1377: 1990 unless stated)	Number
Natural moisture content (Part 2:3.2)	18 (including 8 undertaken as part of the undrained triaxial tests)
Liquid and plastic limits and plasticity index (Part 2:4.3, 5.3 and 5.4)	1
One dimensional consolidation properties (Part 5:3)	2
Single stage 100mm UU triaxial compression test (Part 7:8)	8
Water soluble sulphate content 2:1 aqueous extract (BRE SD1 2005)	4

Test type and reference (BS 1377: 1990 unless stated)	Number
Soil pH (BRE SD1 2005)	4

6.3.4. Moisture content determinations on disturbed samples, including those obtained by dynamic continuous sampling apparatus (such as window or windowless sampling), may not be wholly representative due to disturbance arising from the sampling process.

6.3.5. The undrained shear strength determinations and the oedometer tests were undertaken on samples from a windowless sampler hole. Due to the sampling process, it is difficult to obtain the quality of samples required for strength and compressibility testing and results from both tests must be evaluated carefully. Sample disturbance can lead to an underestimate of strength in the triaxial tests and an overestimate compressibility in the oedometer tests.

6.4. Made Ground

6.4.1. Made Ground was encountered to 1.50m bgl in WS1. The base of the Made Ground was not proven in TP1 and TP2 which terminated in the Made Ground at a maximum depth of 1.30m bgl. TP1 was probed beyond the base of the pit with a metal bar which indicated Made Ground was present to at least 1.70m bgl in places. The Made Ground was heterogeneous and was described as yellow brown, dark brown and grey gravelly sand, slightly gravelly to gravelly clay or sandy gravelly clayey silt. The gravel was described as angular to subrounded flint, limestone, wood, brick, concrete, asphalt, chalk, shell fragments and ash. Inclusions of metal fragments, plastic, ceramic tile fragments, mortar fragments, nails and metal bolts were recorded in TP1 and TP2. Live roots were encountered to 0.65m bgl in TP1 and beyond the base of the Made Ground in WS1 located in the garden. Live roots were also encountered to the base of TP2 at 1.30m, however, these were smaller and as there were no trees close to the inspection pit, these are believed to be the roots of the potted plant against the party wall.

6.4.2. Two moisture content determinations were undertaken on the cohesive Made Ground and the results were 27 and 30%.

6.5. London Clay

6.5.1. London Clay was encountered beneath the Made Ground in WS1 and was described as firm to stiff brown, orange brown and grey mottled clay up to 7.00m bgl. It was noted to be closely fissured with partings of sand. This represents the weathered zone of the London Clay. From 7.00m bgl the London Clay was described as stiff grey clay and noted to be closely fissured. Live roots were reported to be observed to 4.00m bgl. Selenite crystals were observed from 3.90m bgl to the base of the hole at 10.00m bgl.

6.5.2. Eight undrained shear strength (Cu) determinations were undertaken from laboratory triaxial testing and the values ranged from to 64 to 167kN/m². As described previously, there are limitations associated with undrained shear strength determinations on samples from windowless sample holes. Based on this and from our experience of the London Clay, the following moderately conservative relationship with respect to the characteristic value of Cu is suggested:

- Cu (kN/m²) = 70 + 6z (where z = depth below the top of the London Clay which was encountered at 1.50m bgl)

6.5.3. One dimensional consolidation properties were obtained from an oedometer test so as to determine the coefficient of compressibility, mv, of the soil due to changes in vertical stress. An applied pressure of 101kN/m^2 on a sample from 2.90m bgl gave a coefficient of compressibility of 0.44m^2 /MN, with 0.24m^2/MN determined on a sample from 3.60m bgl. However, it is considered that these tests have significantly overestimated the compressibility of the London Clay due to disturbance during sampling and specimen preparation. The coefficient of compressibility is broadly equivalent to 1/E where E = the drained modulus. Reference to Padfield and Sharrock [11] indicates that the undrained vertical modulus (E_u) may be taken to be 400Cu and the drained modulus (E′) 0.75E_u.

6.5.4. One Atterberg Limit determination was undertaken and the Plasticity Index value was 57%, Liquid Limit value 81% and Plastic Limit value 24%. The Modified Plasticity Index value was 56% and with reference to Chapter 4.2 of the NHBC Standards [10], the London Clay has a high volume change potential.

6.5.5. Sixteen moisture content determinations were undertaken and the results ranged from 24 to 32%.

6.6. Buried Concrete

6.6.1. Four soil samples from the London Clay were subjected to pH and water soluble sulphate determinations. With reference to BRE Digest SD1 (2005 Ed) [12], the results indicate a DS-4 classification, however, none of the samples were subjected to total sulphur and acid soluble sulphate content testing to allow an assessment to be made in relation to the potential thaumasite form of concrete attack.

6.7. Non-technical Summary – Stage 3

6.7.1. The ground investigation has indicated that the Made Ground is likely to be at least 1.70m deep in the western corner of the proposed development area. London Clay is present below for considerable depth.

6.7.2. A single monitoring visit indicates a standing groundwater level of around 5.25m bgl.

6.7.3. The pH and sulphate test results indicate that an ACEC AC-4 class should be adopted for buried concrete, although this should be confirmed by further testing which should also include an assessment of the risk of the thaumasite form of attack.

7.0 CONCEPTUAL GROUND MODEL

7.1.1. The ground conditions encountered during the ground investigation are presented in Table 3.1. London Clay is assumed to be present from around 1.50m bgl.

7.1.2. An equilibrium groundwater level of around 5.25m bgl is anticipated. The basement formation level is proposed to be at c3.00m bgl. An inspection pit against the adjacent property to the southwest (103 Camden Mews) indicates the wall could be founded at a depth of around 0.75m bgl. An additional inspection pit on the neighbouring property is recommended to further investigate the nature and depth of the foundations.

7.1.3. No tunnels are known to pass below or in close proximity to the site. Thames Water and National Grid assets run beneath Camden Park Road and Camden Mews.

8.0 BASEMENT IMPACT ASSESSMENT

8.1. Basement Impact Assessment

8.1.1. Consideration has been given to each of the three aspects of the Basement Impact Assessment process: groundwater flow, land stability and surface water flows. Residual risks were shown to exist for stability only and design implications associated with this are discussed below.

8.2. Slope and Ground Stability

8.2.1. As discussed during the screening and scoping stages, the proposed basement extension is not expected to cause any slope instability given the topography of the site and its surroundings. However, ground movements around the excavation could affect surrounding infrastructure and the adjacent property.

8.2.2. An indicative basement Construction Sequence Report has been prepared by CampbellReith (SKsk-12047-020715-CS-F1) and is contained within the ground movement assessment report. The proposed method of construction comprises the installation of a sheet piled wall around the perimeter of the basement following demolition of the existing building. Excavation would be carried out in two stages; approximately 500mm of the excavation undertaken then propping installed, followed by excavation down to 50mm below the underside of the basement slab level.

8.2.3. The ground movement assessment referred to is reported separately (FDemb-12047-020715-GMA-F1).

8.2.4. Reference to CIRIA C580 [13] indicates that ground surface movements associated with the construction of retaining walls and subsequent excavation can extend to approximately 4 x basement depth. Therefore with a depth of excavation of 3m, ground movements could theoretically extend to 101 and 103 Camden Mews, 84 – 90 Camden Mews and 59 Camden Park Road.

8.2.5. Assuming moderate support stiffness, CIRIA C580 indicates that horizontal and vertical ground movements at the top of the sheet pile wall are likely to be in the order of 9mm, reducing to 6mm at a distance of 4.5m and 3mm at a distance of 9m. It is assumed that the new link block will be constructed after the basement and that the basement wall will be designed for any surcharge from the foundations.

8.2.6. In addition, analysis of the vertical ground movements (heave/settlement) associated with the demolition of the existing building and the construction of the new building together with the basement has been undertaken using the Oasys programme Pdisp Version 19.3. This suggests a maximum heave of 10mm on the party wall, reducing to 3mm at a distance of 4.5m and 1mm at a distance of 9m.

8.2.7. The analyses indicate that for the demolition of the existing building and basement excavation, the maximum vertical ground surface movement will be 3mm (settlement of 6mm minus heave of 3mm) and the horizontal ground surface movement will be no more than 9mm.

8.2.8. The length of the neighbouring property (103 Camden Mews) has been assumed to be 9m with an approximate height (H) of 6m. Building strain has been assessed over the full length of the property (L =9m) and between the party wall and a foundation 4.50m beyond it (L= 4.5m). Following the procedure given in CIRIA C580 Box 2.5, L/H=0.75 (i.e. at the intermediate foundation) and 1.50 at L=9m (i.e. at the far side of the property).

8.2.9. The maximum horizontal movement, δh = 3mm, and vertical movement, Δ = 4mm between the foundations of 103 Camden Mews. The maximum horizontal strain, ε_h ($\delta h/L$)= 0.06% and the maximum deflection ratio Δ/L = 0.08% beneath the adjoining property (103 Camden Mews). This represents a maximum damage category of 'slight' (Burland Category 2).

8.2.10. Ground movements and building strains on the remaining properties within the theoretical zone of influence are negligible.

8.3. Geotechnical Design

8.3.1. There are a number of issues that must be considered in the detailed geotechnical design of the basement. These are listed below and some general advice on the design and construction of basements is presented in the following sections. Issues to be considered:

- The requirement for further intrusive investigation including borehole(s) to greater depth and high quality samples for strength testing;
- Earth pressures from the surrounding ground;
- Ground movements around the excavation;
- Nearby infrastructure such as gas pipes and sewers beneath Camden Mews and Camden Park Road; and
- Necessary precautions against concrete attack.

8.4. Basement Wall Design

8.4.1. Whilst the final design and construction sequence of the basement wall is the responsibility of the Contractor, an indicative sequence of works has been prepared and this assumes an embedded retaining wall in the form of sheet piles. Suggested soil parameters for the design of embedded retaining walls are provided in Table 8.1, however additional ground investigation is recommended to confirm these parameters.

TABLE 8.1: Basement Wall Design Parameters

Stratum	Bulk Unit Weight (kN/m^3)	Effective Cohesion, c', kPa	Angle of Shearing resistance, ϕ'	Undrained Shear Strength (kN/m^2)	Young's Modulus (kN/m^2)
Made Ground	18	0	28°	N/A	E'_h= 5000
London Clay	20	1.5	20°	Cu = 70+6z[1]	E'_h= 60270 + 5166z[1]

[1] z is the depth below 1.50m bgl

8.4.1. The effective angle of internal friction (critical), ϕ' crit, and effective cohesion, c' for the London Clay, in Table 8.1 have been estimated by reference to CIRIA Report C580 [13]. The horizontal Young's Modulus in the London Clay has been derived from E'_h=1.23E_{vu}, where a relationship of E_{vu}=700Cu may be used for retaining wall design due to the low strain when compared to foundation design.

8.4.2. Design should be carried out in accordance with BS EN 1997:1 and the appropriate partial factors depending upon the selected design method should be applied to the parameters given above.

8.4.3. Obstructions associated with the history of the site could hamper the insertion of the piled walls and foundations and should be removed as part of the demolition contract.

8.5. Drainage

8.5.1. The impact of the development on surface water flooding is considered to be negligible. Foul water is anticipated to be disposed into the piped network. Consideration should be given to the installation of non-return valves to prevent backflow into the basement.

8.6. Further Investigations and Monitoring

8.6.1. The following actions are recommended:

- An additional inspection pit to further investigate the foundations to the neighbouring property is recommended;
- Further intrusive ground investigation, undertaken in accordance with BS5930+A2 and BS EN 1997, to provide geotechnical information as outlined in CampbellReith's Desk Study Report (FDli-12047-020715-DS-F1) is recommended. The investigation should also include a contamination assessment to target the identified potential pollutant linkages in the desk study and in addition, it could consider elements such as soils reuse and waste classification.
- Consideration should be given to groundwater monitoring to capture seasonal variations in the groundwater table;
- A pre and post works condition survey should be undertaken in relation to potentially affected surrounding properties;
- Consideration should be given to the potential need for monitoring of ground and building movements;
- The owner of the adjacent highways (likely to be the London Borough of Camden) should be consulted to establish associated constraints;
- Statutory undertakers, including utility operators, should be consulted to establish if any such assets could be affected by the works and associated constraints;
- Given the setting of the site it is recommended that consideration should be given to the potential risks to any below ground works posed by UXOs in accordance with CIRIA Report C681; and
- The excavation of the basement will result in a volume of waste soil arising which should be classified and disposed of in accordance with good practice and legislation.

9.0 NON-TECHNICAL SUMMARY

9.1. The following is a summary of the key issues identified with the proposed development of Ashton Court, 254 – 256 Camden Road, London NW1 9HE.

9.2. The site specific ground investigation has found that the site is underlain by 1.50 to 1.70m of Made Ground, over London Clay. Groundwater was monitored in the London Clay at c5.25m bgl. The proposed basement is not expected to intercept the groundwater table although temporary groundwater control could be required for managing perched groundwater in the London Clay.

9.3. A services survey undertaken for the site and its surrounding area prior to the ground investigation has shown that there are a number of services that run beneath Camden Park Road and the access road associated with Camden Mews. Whilst there will be a modest increase in the hardstanding, there are no concerns relating to the change in the quantity or quality of surface water run-off as this is anticipated to be discharged into the piped network.

9.4. There are no concerns relating to subterranean groundwater flow, surface flow and flooding, and slope stability.

9.5. Post construction, there may be some further settlement. Vertical ground movements (total settlement from the construction minus long term heave from the demolition of the existing building and basement excavation) on 103 Camden Mews are not expected to exceed 5mm. This occurs midway along the party wall.

9.6. It is recommended that condition surveys of properties within the zone of influence of the basement are carried out and a foundation inspection pit undertaken on the neighbouring property prior to works commencing. It is also recommended that construction methods are developed to ensure that ground movements are within tolerable limits. A ground movement assessment (reported separately) confirms that any damage to neighbouring structures can be limited to 'slight' (Burland Category 2) using normal construction techniques. Ground movements which could affect the surrounding infrastructure are anticipated to be negligible.

TECHNICAL REFERENCES

Reference*	Reference Title	Type
6	British Geological Survey. North London. England and Wales Sheet 256. Solid and Drift Edition.	Geological Map
7	London Borough of Camden Strategic Flood Risk Assessment	Report
8	Environment Agency Website – 'What's in your backyard' – http://apps.environment-agency.gov.uk/wiyby/default.aspx	Website
9	London City Council Bomb Damage Maps 1939 - 1945	Maps
10	NHBC Standards Part 4:Chapter 4.2, Building near trees	NHBC Standard
11	C J Padfield and M J Sharrock, Settlement of Structures on Clay Soils	CIRIA Publication
12	BRE Special Digest 1:Concrete in Aggressive Ground	BRE Publication
13	Embedded retaining walls - guidance for economic design. CIRIA Report C580	CIRIA Publication

*Continues from Table 1.1

LIMITATIONS

1. Where any data or information supplied by the client or other external source, including that from previous studies, has been used, it has been assumed that the information is correct. No responsibility can be accepted by CampbellReith for inaccuracies within this data or information.
2. This report is limited to those aspects described in the introduction and no liability is accepted for any other aspects.
3. The generalised soil conditions described in the text are intended to convey trends in subsurface conditions. The boundaries between strata are approximate and have been developed on interpretations of the exploration locations and samples collected.
4. Water level and gas readings have been taken at times and under conditions stated on the exploration logs. It must be noted that fluctuations in the level of groundwater or gas may occur due to a variety of factors which may differ from those prevailing at the time the measurements were taken.
5. The findings and opinions expressed are relevant to those dates of the reported site work and should not be relied upon to represent conditions at substantially later dates.
6. This report is produced solely for the benefit of the client, and no liability is accepted for any reliance placed upon it by any other party unless specifically agreed in writing.

Appendix A: Figures

Ashton Court

Client: Origin Housing

Figure 1:
Site Location and Neighbouring Properties Within Zone of Influence of Proposed Basement

Scale: 1:2500@A4

Job Number: 12047
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Drg No - Status/Revision: GIS005 - A
File location: N:\12000 - 12249\12047 L - Ashton Court\Project_Workspaces (pdf in Outputs)
Date (Revision History): 16/06/2015 (A, First Issue,15/06/15, LB)

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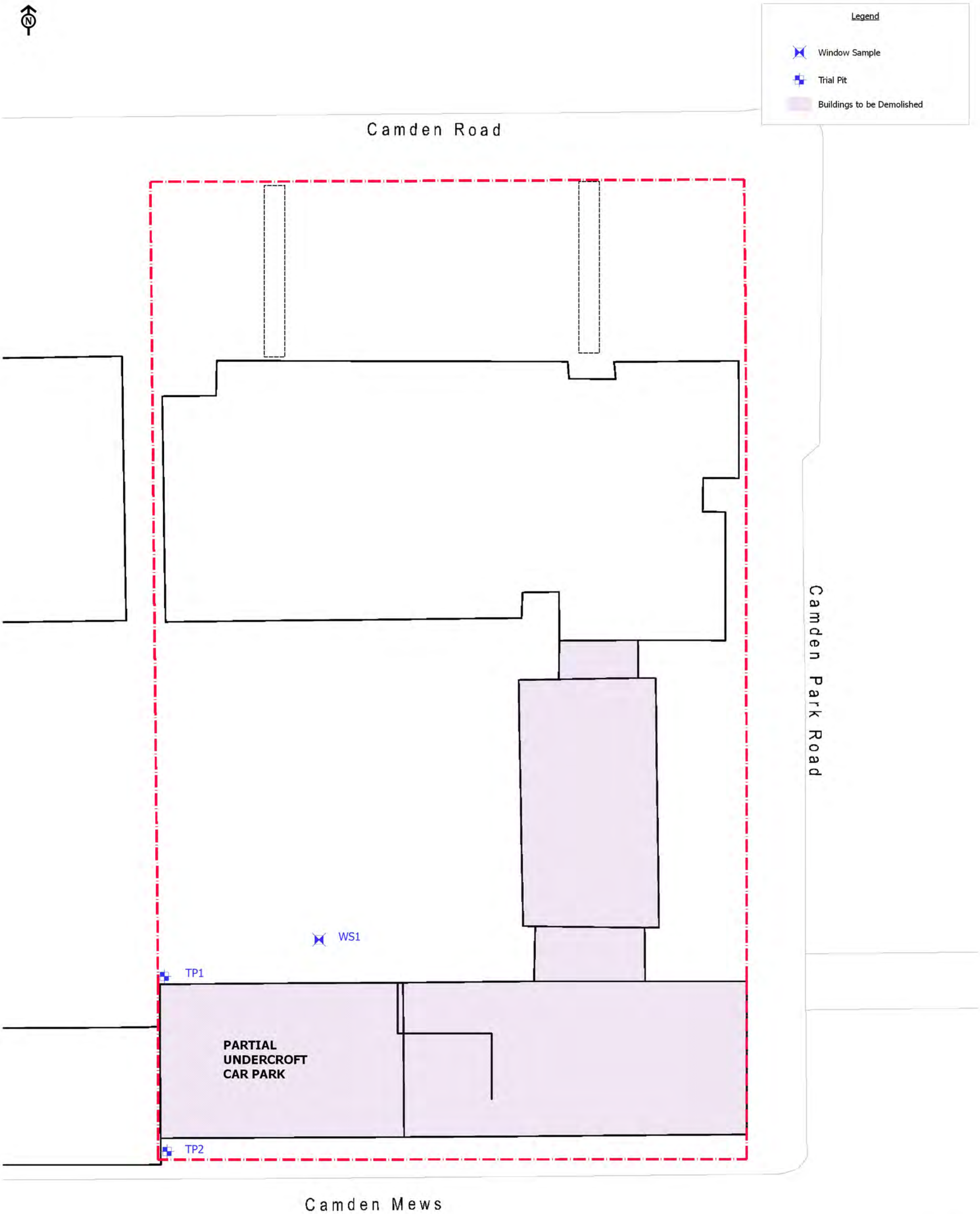

NTS

Ashton Court

Client: Origin Housing

Figure 2:
Existing Site Layout

Scale: NTS
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Based on Archadia Charted Architects drawing no. OH233-0-21 (Feb 2014)
Job Number: 12047
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Drg No - Status/Revision: GIS012 - A
File location: N:\12000 - 12249\12047 L - Ashton Court\Project_Workspaces (pdf in Outputs)
Date (Revision History): 27/05/2015(A, First Issue, 27/05/15, LB)

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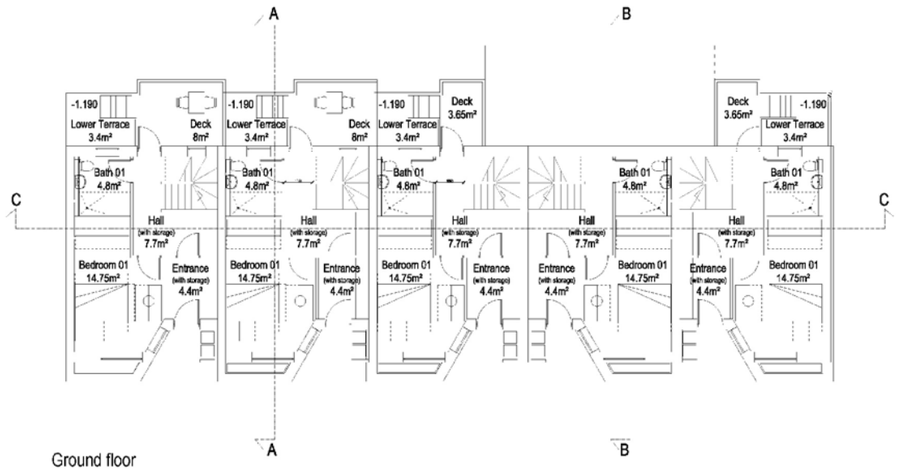
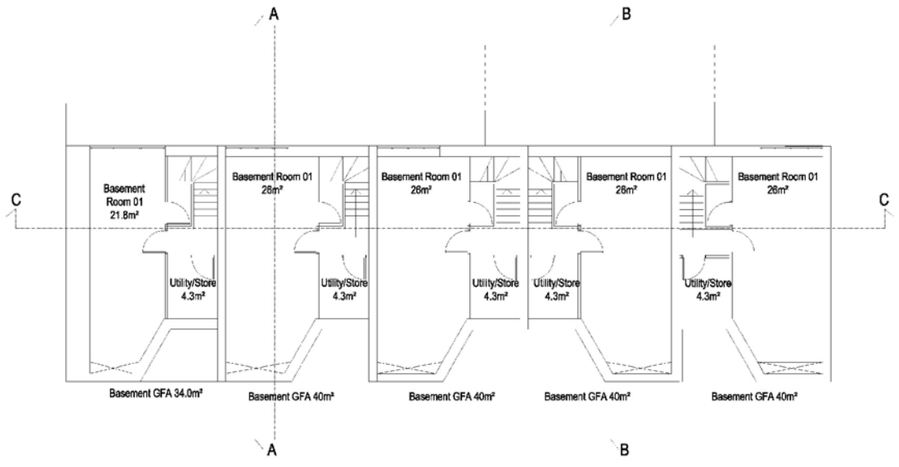
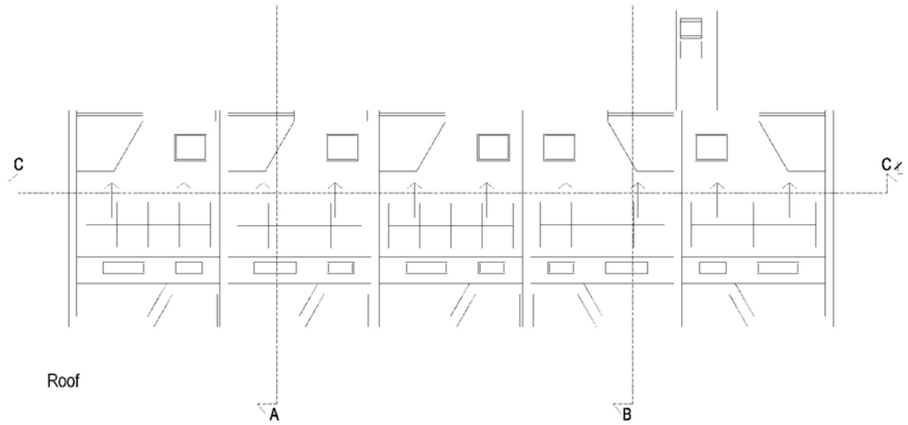


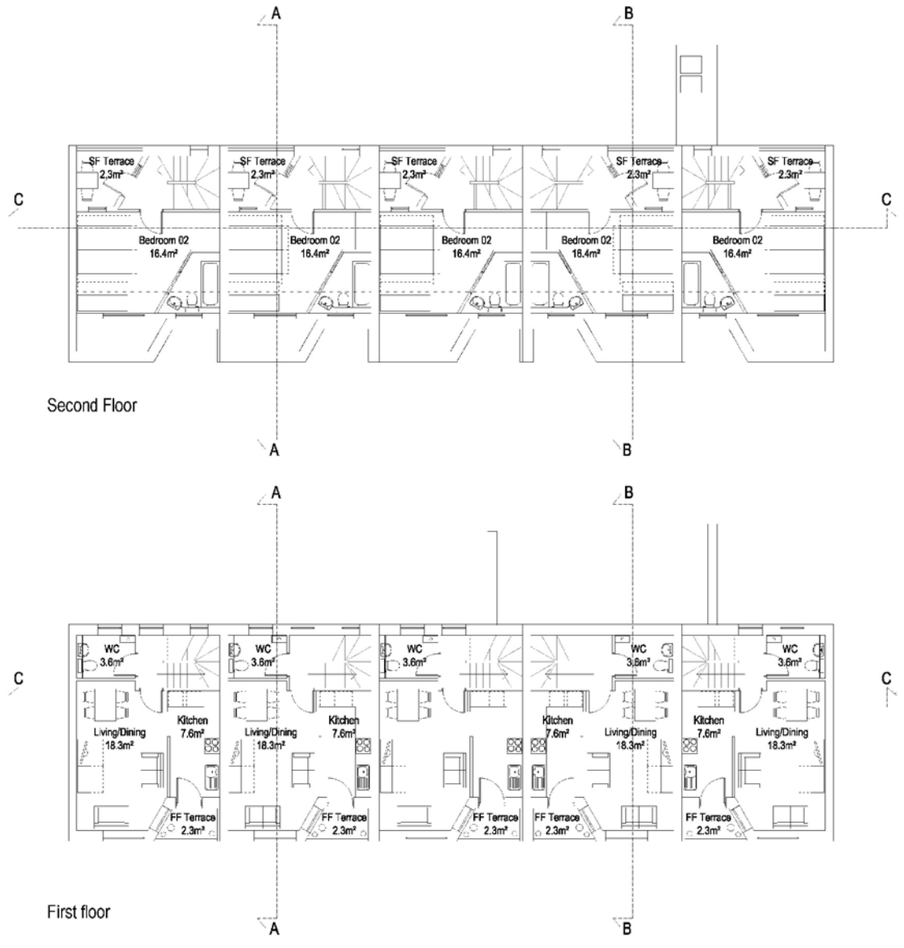
Ground floor



Basement floor



Roof



Second Floor

First floor

NTS

Ashton Court

Client: Origin Housing

Figure 3a:
Camden Mews Proposed Development (All Floors)

Scale: NTS
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Based on Archadia Charted Architects drawing no. OH233-1-05, Rev C (Jul 2015)
Job Number: 12047
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Drg No - Status/Revision: GIS006 - B
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Date (Revision History): 08/07/2015(A, First Issue, 16/06/15, LB; B, Updated Layer, 07/08/2015, LB)

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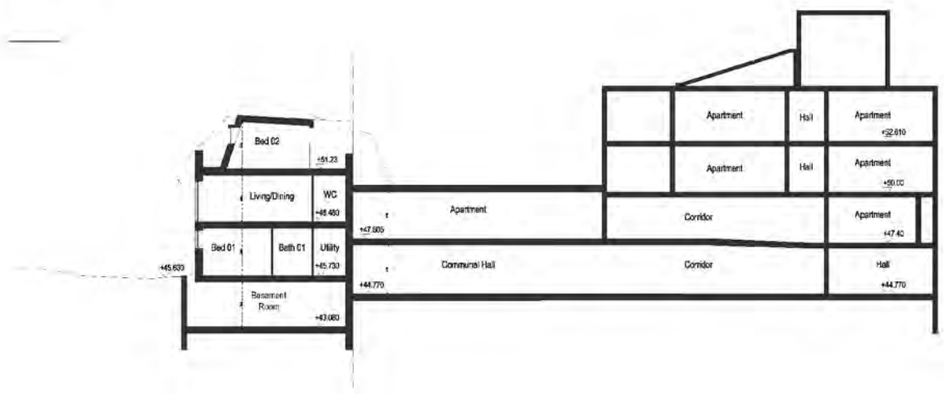
Section AA



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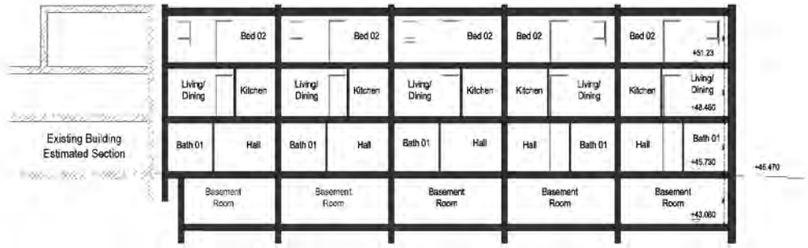

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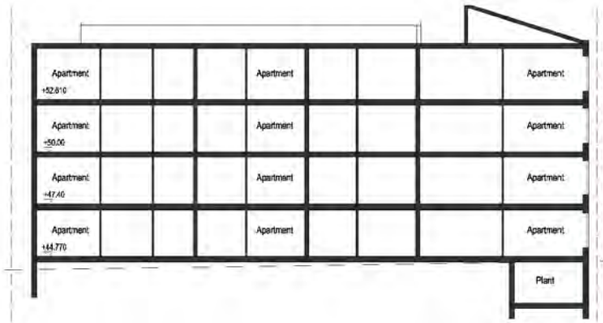

Section DD

Ground Floor

Ashton Court

Client: Origin Housing

Figure 3b:
Camden Mews Proposed Development (Sections)

NTS

Scale: NTS
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Drg No - Status/Revision: GIS004 - B
File location: N:\12000 - 12249\12047 L - Ashton Court\Project_Workspaces\BIA (pdf in Outputs)
Date (Revision History): 08/07/2015(A, First Issue, 27/05/15, LB; B, Updated Layers, 08/07/15, LB)

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Appendix B: Ground Investigation

GROUND ENGINEERING LIMITED

Tel: 01733-566566
www.groundengineering.co.uk

Site: **ASHTON COURT, CAMDEN ROAD, LONDON NW1**

TRIAL PIT TP1

Date: 29/04/15 to 01/05/15

Pit Size: 1.80m L x 0.80m W x 1.20m D.

Ground Level:

Samples and in-situ Tests			(Date) Water	Description of Strata	Legend	Depth m	O.D. Level m
Depth m	Type	Result					
0.20	D1			MADE GROUND - Soft, locally firm, dark brown, slightly sandy, slightly gravelly, silty CLAY with occasional cobbles of brick and concrete. Gravel is brick, concrete, flint, plastic, wood, clay pipe and mortar fragments.			
0.20	ES1					0.50	
0.55	D2			MADE GROUND - Light brown and brown, gravelly, silty SAND with occasional cobbles of brick, mortar and concrete. Gravel is flint, brick and ceramic tile fragments.			
0.55	ES2						
0.80	ES3A						
	ES3B						
0.80	D3A						
	D3B					1.20	
1.20	ES4						
1.20	D4			Pit completed at 1.20m depth			

KEY

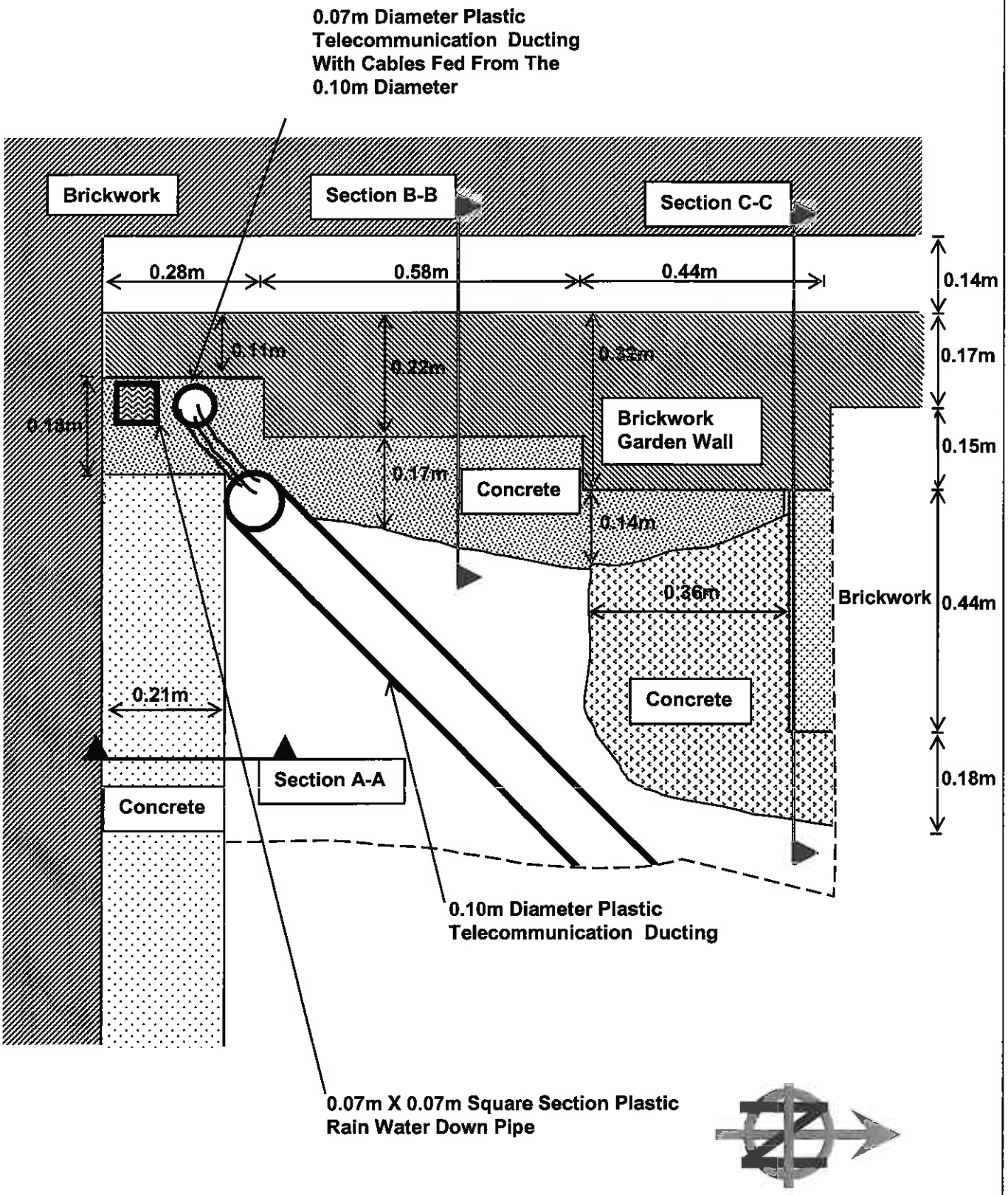
- D - Disturbed Sample
- B - Bulk Sample
- U - Undisturbed Sample
- R - Root Sample
- W - Water Sample
- J - Jar Sample
- ▽ Water Strike
- ▼ Water Rise
- ▼c Level on completion
- MP - Mackintosh Probe
- P( ) - Hand Penetrometer Cohesion ( ) kPa
- V - Vane Shear Test Cohesion ( ) kPa

REMARKS

1. Live roots observed to 0.65m depth
2. Pit sides stable
3. Pit dry
4. Pit probed down to 1.70m depth with bar in made ground
5. Probing beneath boundary wall found head deposit clay below 0.60m depth
6. ES = Environmental Sample

Project No	
13480A	
Scale	Page
1:25	1/1

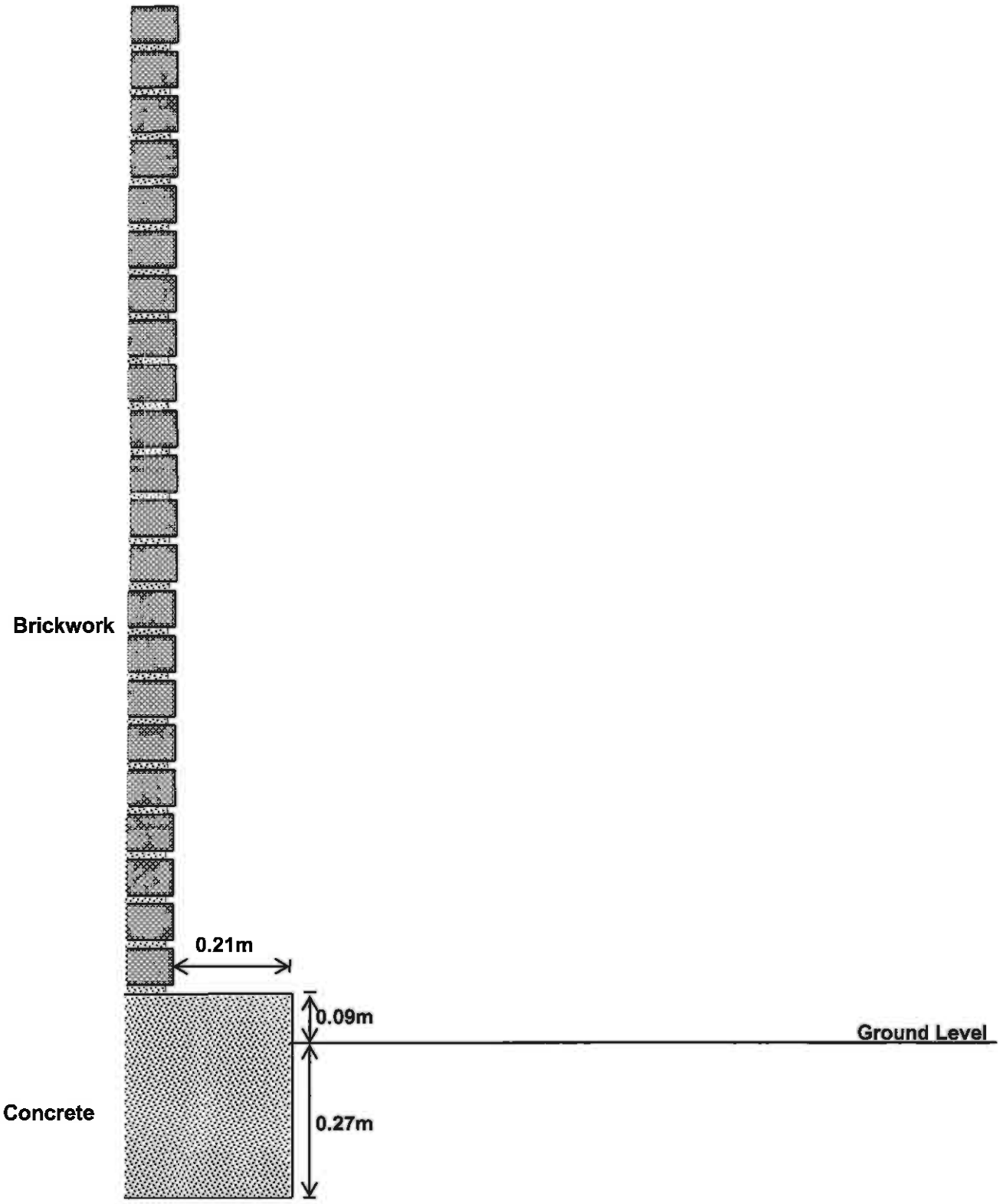
Trial Pit TP1
Plan



Not To Scale

Project : Ashton Court, Camden Road, London NW1 Client : Origin Housing Development Ltd.	GROUND ENGINEERING LIMITED Peterborough Tel : 01733 566566	Project No. C13480A

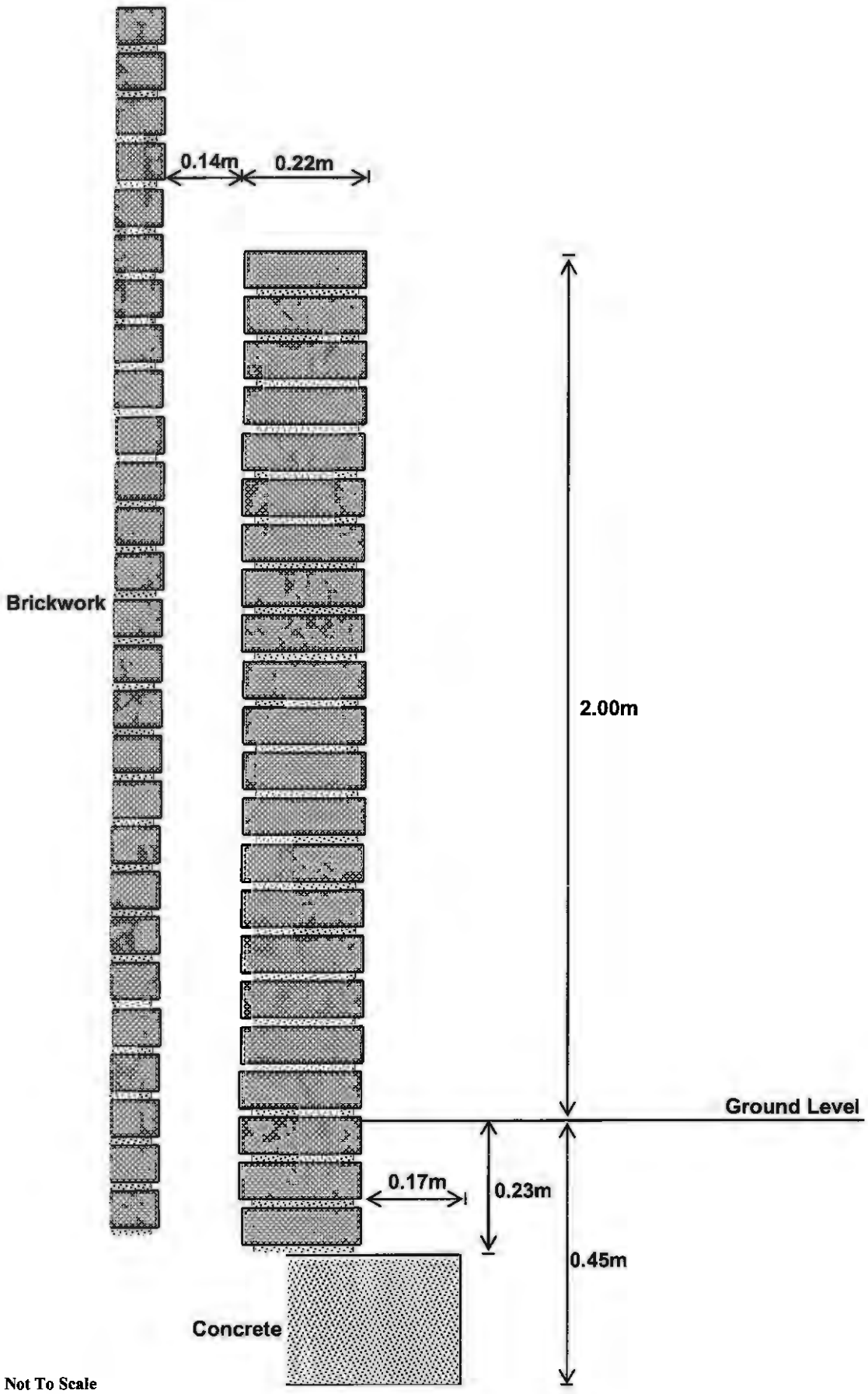
Trial Pit TP1
Cross Section A-A



Not To Scale

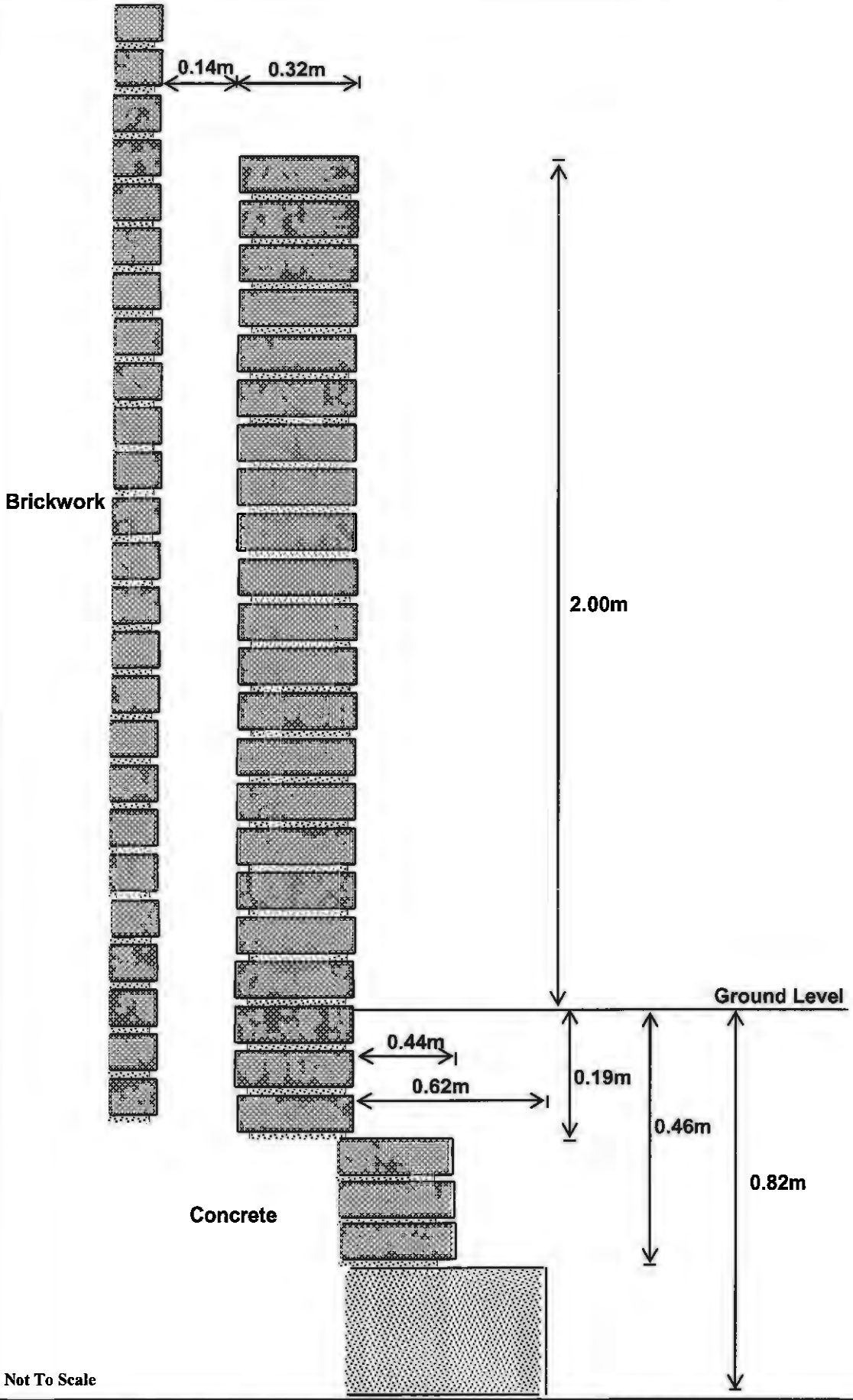
Project : Ashton Court, Camden Road, London NW1 Client : Origin Housing Development Ltd.	GROUND ENGINEERING LIMITED Peterborough Tel : 01733 566566	Project No. C13480A

Trial Pit TP1
Cross Section B-B



Project : Ashton Court, Camden Road, London NW1 Client : Origin Housing Development Ltd.	GROUND ENGINEERING LIMITED Peterborough Tel : 01733 566566	Project No. C13480A

Trial Pit TP1
Cross Section C-C



Project : Ashton Court, Camden Road, London NW1

Client : Origin Housing Development Ltd.

GROUND ENGINEERING LIMITED
Peterborough Tel : 01733 566566

Project No. C13480A

GROUND ENGINEERING LIMITED

Tel: 01733-566566
www.groundengineering.co.uk

Site: ASHTON COURT, CAMDEN ROAD, LONDON NW1

TRIAL PIT
TP2

Date: 29/04/15

Pit Size: 1.20m L x 1.00m W x 1.30m D.

Ground Level:

Samples and in-situ Tests			(Date) Water	Description of Strata	Legend	Depth m	O.D. Level m
Depth m	Type	Result					
				MADE GROUND - ASPHALT.		0.05	
				MADE GROUND - CONCRETE.		0.20	
0.30	D1			MADE GROUND - Dark brown, sandy, gravelly, clayey SILT with occasional cobbles of brick and concrete. Gravel is brick, concrete, asphalt, metal bolts, nails, flint, mortar and plastic fragments.			
0.30	ES1						
0.60	D2						
0.60	ES2						
0.90	D3						
0.90	ES3						
1.20	D4						
1.20	ES4					1.30	
				Pit completed at 1.30m depth			

KEY

- D - Disturbed Sample
- B - Bulk Sample
- U - Undisturbed Sample
- R - Root Sample
- W - Water Sample
- J - Jar Sample
- ▽ Water Strike
- ▼ Water Rise
- ▼c Level on completion
- MP - Mackintosh Probe
- P( ) - Hand Penetrometer Cohesion ( ) kPa
- V - Vane Shear Test Cohesion ( ) kPa

REMARKS

1. Live roots observed to 1.30m depth
2. Pit sides stable
3. Pit dry
4. ES = Environmental Sample

Project No	
13480A	
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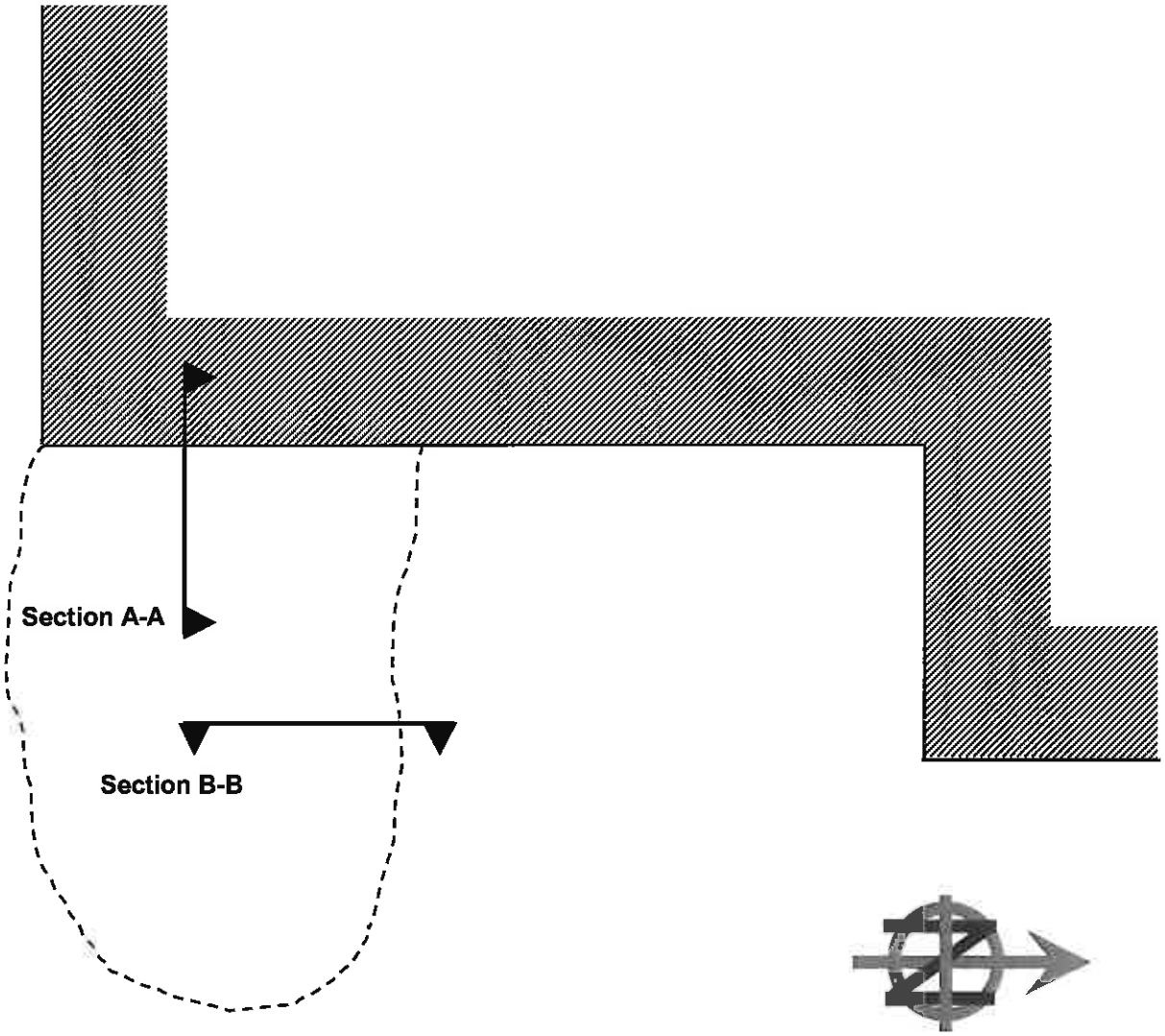
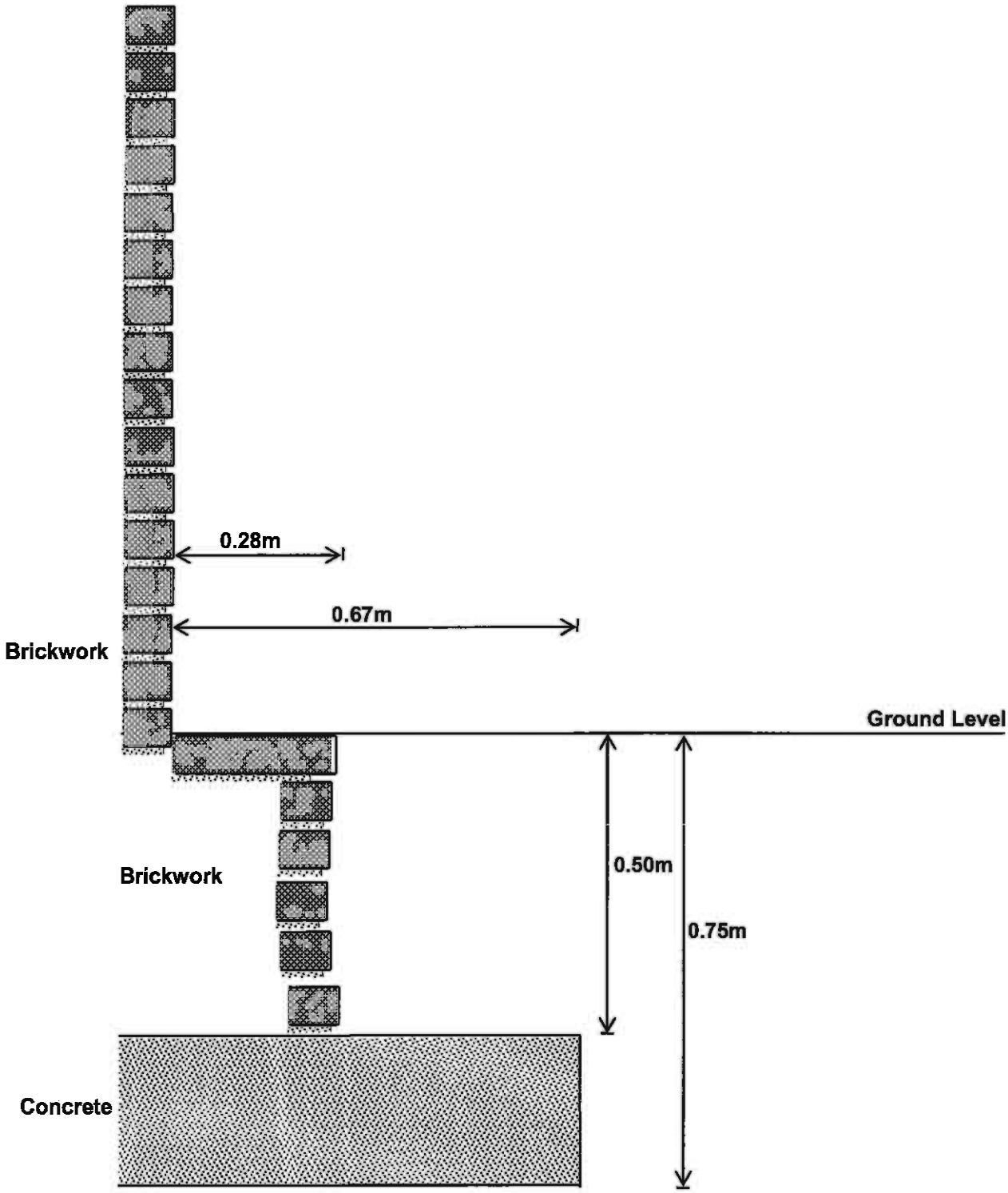
Trial Pit TP2
Plan



Not To Scale

Project : Ashton Court, Camden Road, London NW1 Client : Origin Housing Development Ltd.	GROUND ENGINEERING LIMITED Peterborough Tel : 01733 566566	Project No. C13480A

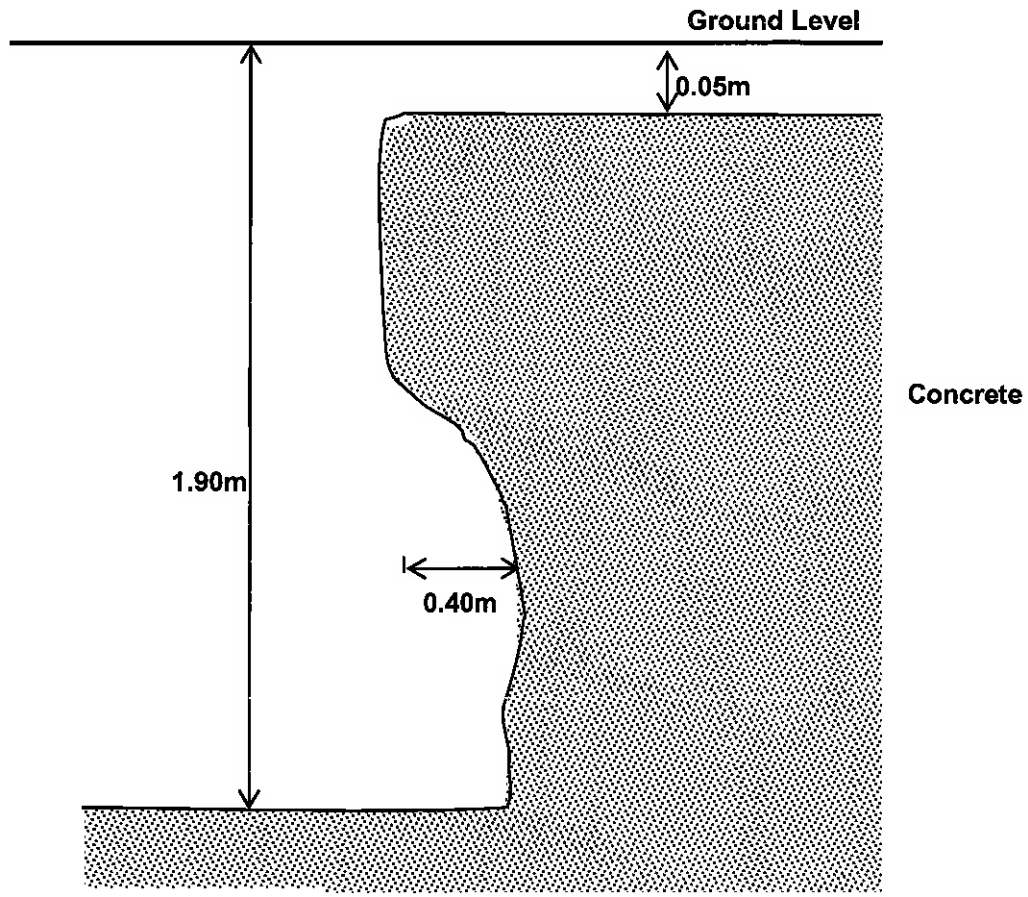
Trial Pit TP2
Cross Section A-A



Not To Scale

Project : Ashton Court, Camden Road, London NW1 Client : Origin Housing Development Ltd.	GROUND ENGINEERING LIMITED Peterborough Tel : 01733 566566	Project No. C13480A

Trial Pit TP2
Cross Section B-B



Not To Scale

Project : Ashton Court, Camden Road, London NW1 Client : Origin Housing Development Ltd.	GROUND ENGINEERING LIMITED Peterborough Tel : 01733 566566	Project No. C13480A

GROUND ENGINEERING LIMITED

Tel: 01733-566566
www.groundengineering.co.uk

Site: **ASHTON COURT, CAMDEN ROAD, LONDON NW1**

WINDOW SAMPLE WS1

Date: 14/01/15

Hole Size: 87mm dia to 2.00m
77mm dia to 5.00m
57mm dia to 10.00m

Ground Level:

Samples and in-situ Tests			(Date) Water	Inst.	Description of Strata	Legend	Depth m	O.D. Level m
Depth m	Type	Result						
0.30	D1				MADE GROUND - Yellow brown and brown, gravelly SAND. Gravel is angular and sub-angular flint, limestone and wood.			
0.60	D2				MADE GROUND - Very stiff, dark brown and grey, sandy, gravelly CLAY. Gravel is very angular to sub-rounded flint, brick, concrete, asphalt, chalk and shell fragments.		0.50	
0.90	D3							
0.90	V1	(110)					1.10	
1.20	D4				MADE GROUND - Firm, brown and dark brown, slightly sandy, slightly gravelly CLAY. Gravel is angular to sub-rounded flint, ash and brick fragments.			
1.50	D5						1.50	
1.80	V2	(130+)			Stiff, closely fissured to firm, brown, orange brown and grey mottled CLAY with partings of sand.			
1.80-2.00	U1A							
2.20	D6							
2.50	D7		▼s					
2.50	V3	(117)						
2.60-2.90	U2A							
2.90	V4	(108)						
3.10	D8							
3.10	V5	(116)						
3.40	D9							
3.40	V6	(110)						
3.60-3.90	U3A							
3.90	V7	(108)			...Selenite crystals below 3.90m depth.			
4.20	D10							
4.20	V8	(104)						
4.50	D11							
4.50	V9	(117)						
4.70-5.00	U4A							
					(LONDON CLAY)			
5.20	D12		▼s					
5.20	V10	(130+)						
5.50	D13							
5.50	V11	(130+)						
5.80-6.00	U5A							
5.80	V12	(125)						
6.00-7.00	U6							
6.20	V13	(126)						
6.40	V14	(120)						
6.70	V15	(130+)						
					Stiff, closely fissured, grey CLAY with selenite crystals.		7.00	
7.50	V16	(130+)						
7.80-8.00	U7A							
					(LONDON CLAY)			
8.80-9.00	U8A							
9.80-10.00	U9A						10.00	

REMARKS

Borehole completed at 10.00m depth

1. Starter pit excavated from GL to 1.20m depth
2. Live roots observed to 4.00m depth
3. Gas monitoring standpipe installed to 7.00m depth

Project No 13480

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KEY

D - Disturbed Sample
B - Bulk Sample
U - Undisturbed Sample
W - Water Sample
▽ Water Strike
▼ Depth to Water on completion
J - Jar Sample
M - Mackintosh Probe
V - Vane Shear Test Cohesion ( ) kPa
P( ) - Hand Penetrometer Cohesion ( ) kPa
▼s Standpipe Level

Groundwater Strikes

No	Depth m Struck	Rose to	Rate	Cased	Sealed

Groundwater Observations

Date	Depth m Hole	Casing	Water
14/01/15	10.00		dry
03/02/15	7.00	1.00	5.23
29/04/15	7.00	1.00	2.37

GROUND ENGINEERING

Newark Road
Peterborough PE1 5UA
Tel: 01733 566566
Fax: 01733 315280

GROUND INVESTIGATION REPORT

ASHTON COURT
CAMDEN ROAD
LONDON NW1

Report Reference C13480

On behalf of:-

Origin Housing Developments Limited
St. Richard's House
110 Eversholt Street
London
NW1 1BS

March 2015

ORIGIN HOUSING DEVELOPMENTS LIMITED

ROBERT LOMBARDELLI PARTNERSHIP LIMITED

GROUND INVESTIGATION REPORT

FOR

PROPOSED DEVELOPMENT

AT

ASHTON COURT

CAMDEN ROAD

LONDON NW1

Report Reference No. C13480 **March 2015**

INTRODUCTION

The client, Origin Housing Developments Limited, proposes to replace a 2-storey building at Ashton Court, between Camden Road and Camden Mews in London NW1, with four mews houses which may have at least a partial basement. The proposed building loads were not known at the time of report writing.

Ground Engineering Limited was commissioned by the client, under the direction of Robert Lombardelli Partnership Limited, to carry out a ground investigation to determine the nature and geotechnical properties of the underlying soils, in relation to the design and construction of the foundations. A desk study and contamination assessment were not required within the scope of this report.

LOCATION, TOPOGRAPHY AND GEOLOGY OF THE SITE

The site is located at Ashton Court, Camden Road (A503), London NW1. Ashton Court is bounded by Camden Road to the north-west, Camden Park Road (A5200) to the north-east, and Camden Mews to the south-east. The area of the proposed redevelopment is the southern part of the site fronting Camden Mews. The National Grid Reference for the centre of the site is TQ 2974 8482 and its location is shown on a plan following this report text.

At the time of the investigation in January 2015 the southern part of the site fronting Camden Mews contained a two-storey building, with partial under-croft parking. A single-storey Common Room with paved area fronted Camden Park Road to the north-east, and a three-storey block fronted Camden Road to the north-west. The site of the proposed redevelopment was approximately 29m wide fronting Camden Mews at its junction with Camden Park Road to the east, and extended north-west by approximately 8m. An under-croft car park was present fronting Camden Mews south-east of the site, which had a security gate to the rear, leading to an enclosed garden which contained a lawn, decked area, trees and shrubs.

An approximately 12m high Ash tree and a 10m high Cherry tree were present in the garden, approximately 4m and 11m to the north of the proposed mews houses. An approximately 12m high London Plane tree was present in the paved area fronting Camden Park Road pavement, which was approximately 4m north of the proposed mews houses.

This part of Camden stands at about 45mOD, on ground sloping down gently to the south-west.

The geological map, London sheet V NW (1935) at 1:10,560 scale, shows the site to be underlain by solid geology London Clay. Approximately 10m east of the site superficial Boyn Hill Gravel is shown covering the London Clay. The more recent geological map, sheet 256 (2006) at 1:50,000 scale, shows the site directly underlain by the solid geology of the London Clay Formation.

SITE WORK

The site work conducted on 14th January 2015 comprised one window sampled borehole (WS1). The borehole position is shown on the exploratory hole location plan following this report text.

Public utility service drawings were sourced and consulted prior to determining the exploratory hole positions. These drawings are available from Ground Engineering Limited on request. Prior to excavation, a service scan was made at each position using a CAT (Cable Avoidance Tool) to check for the absence of detectable buried services that may otherwise have been damaged by the investigation.

The exploratory hole record, presented following the plans, gives the descriptions and depths of the various strata encountered, details of all samples taken, installation details and the groundwater conditions observed during and on completion of boring and excavation, and during subsequent monitoring of the installation.

Window Sample Borehole

A window sample borehole (WS1) was sunk to a depth of 10.00m below ground level. A hand excavated inspection pit was undertaken to 1.20m depth at the borehole position in order to confirm the absence of any buried services prior to boring.

Representative small disturbed samples of soil were taken at regular intervals throughout the depth of the inspection pit.

The borehole was formed by a small track mounted window sampling and super heavy dynamic probing rig. The window sampling equipment consisted of drive-in sample tubes of specially constructed and strengthened steel, lined with a plastic core-liner. The barrels were initially of 87mm internal diameter and were reduced in diameter with successive barrels with increasing depth. Upon extraction, a continuous 'undisturbed' profile of the soil was obtained within the plastic liners. The plastic liners were subsequently split by a geotechnical engineer who sub-sampled them, with the remaining samples re-sealed within the plastic liners.

An immediate assessment of the apparent shear strength of clay was made within the liners using a hand shear vane, the average of three readings for each test depth have been recorded and presented on the borehole record in kilopascals (kPa), up to a maximum 130kPa. The apparent cohesion results have been plotted against depth in Figure 2.

On completion of borehole WS1, a gas and groundwater monitoring standpipe was installed to a depth of 7.00m. The pipes was perforated to within 1.00m of ground level and the annulus backfilled with pea gravel. A bentonite seal was placed from ground surface to 1.00m depth and a gas tap fitted. A protective stopcock cover was concreted in place at ground level above the installation.

Gas and Groundwater Monitoring Visits

As part of this investigation one return visit was made to site on 3rd February 2015, when the standpipe installed within borehole WS1 was monitored for a standing groundwater level and for landfill type gases using a Gasdata GFM430 analyser. The results of the monitoring visit are presented following the exploratory hole record.

LABORATORY WORK

The samples were inspected in the laboratory and assessments of the soil characteristics have been taken into account during preparation of the borehole record. The soil descriptions have been made in accordance with BS5930:1999. The geotechnical test results, undertaken in accordance with BS1377:1990, are presented following the exploratory hole records.

The moisture content of selected samples were determined. The moisture content results have been plotted against depth in Figure 1.

The index properties of a selected soil sample was determined as a guide to soil classification and behaviour. The liquid limit was determined by a cone penetrometer.

Test specimens were prepared at full diameter from selected undisturbed samples. Immediate undrained triaxial compression tests were performed under single-stage confining cell pressures. The moisture content and bulk density of each specimen was also determined. The apparent cohesion results have been plotted against depth with the hand vane results in Figure 2.

An indication of the swelling characteristics of selected undisturbed samples were obtained from tests in the consolidation apparatus or oedometer. These tests were performed on 75mm diameter and 50mm diameter samples, approximately 19mm thick, contained in steel rings. The specimens were saturated and both the swelling pressure and amount of swell measured.

Selected samples of soil were analysed to determine the concentration of soluble sulphate. The pH values was also determined.

GROUND CONDITIONS

The ground conditions encountered comprised made ground to a depth of 1.50m, which rested on the expected solid geology London Clay. The London Clay was found to at least the base of the borehole at 10.00m depth.

Made Ground

Made ground was encountered to a depth of 1.50m

From surface, yellow brown and brown, gravelly sand fill, was encountered to a depth of 0.50m. The gravel fraction comprised angular and sub-angular flint, limestone and wood fragments.

Beneath the gravelly sand fill, very stiff, dark brown and grey, sandy, gravelly clay fill, was encountered to a depths of 1.10m. From 1.10m to 1.50m depth, firm, brown and dark brown, slightly sandy, slightly gravelly clay fill was encountered. The gravel fraction comprised very angular to sub-rounded flint, chalk, shells, ash, brick, concrete and asphalt fragments.

London Clay Formation

Underlying the made ground at 1.50m depth, the anticipated London Clay Formation was encountered.

The London Clay initially comprised stiff, closely fissured, brown, orange brown and grey, clay with partings of sand to 7.00m below which the fissured clay was grey. The London Clay Formation was encountered to at least the base of the boreholes at 10.00m depth.

Roots

Live roots were observed to a depth of 4.00m, which was bored close to the Ash tree in the southern part of the site.

Groundwater

Borehole WS1 was dry during boring and on completion. During monitoring of the standpipe installed in WS1 on 3rd February 2015, water was recorded at 5.23m below ground level.

COMMENTS ON THE GROUND CONDITIONS IN RELATION TO FOUNDATION DESIGN AND CONSTRUCTION

The investigation confirmed the site to be underlain by made ground resting on solid geology London Clay. The made ground soils had variable bearing properties and were found to a maximum depth of 1.50m. The made ground should be avoided as a bearing stratum and would be penetrated by any proposed basement structure. The proposed building loads and foundation levels were not known at the time of report writing. The underlying London Clay Formation could offer adequate support for the proposed new foundations. Excavations to around 5.00m depth would be anticipated to be dry based on the findings of this investigation. The basement floor slab could be ground bearing.

Traditional Foundations

Large scale processes of natural sedimentation allow a certain degree of confidence to be placed in the absence of important variation of the engineering properties of natural soils across sites. By contrast, made ground whose history is not completely known, must, despite any amount of investigation, present the possibility of conditions existing which could not be accepted when considering the material as a bearing stratum.

The made ground initially comprised sand and gravel fill, covering layers of very stiff becoming firm, sandy, gravelly clay fill. The potential for variability within the made ground means that it should be avoided as a bearing stratum. In any case foundations for a basement would be extended through any made ground, which was found to extend locally to 1.50m depth.

A sample of the London Clay Formation had a modified plasticity index of 56%, and the result indicates the clay has a high volume change potential based on NHBC Standards Chapter 4.2 'Building near trees' (2014). If no basement is constructed, on an open site, away from the influence of trees, a minimum foundation depth of 1.00m below current or proposed ground level, whichever is deeper, would be required within the naturally deposited clays, if

present at such a depth, in order to be below the zone of seasonal volume change in accordance with the NHBC Standards.

The proposed buildings are within influencing distances of deciduous trees where clay soils are present, with an Ash tree in the garden, and London Plane tree noted in a paved area, approximately 4m north of the location of the proposed building. There is also a Cherry tree in the garden onsite 11m north of the proposed building. Based on moderate water demand mature Ash and London Plane trees, at a distance of 4m from proposed foundations, minimum foundation depths would locally need to be 2.15m in these clay soils based on NHBC Standards, however excavations for any proposed basement structure will penetrate and remove any desiccated clays. If no basement is proposed, for the adoption of the minimum foundation depth of 1.00m on this site in clay soils, foundations would need to be at least 18m from fully mature Ash trees and at least 20m from the fully mature London Plane. Within these distances, foundation depths will depend on the proximity of trees to new foundations and depths should be determined using the NHBC Standards.

Tree species within the site and along the site boundaries, and distances to the proposed buildings should be verified, before determining foundation depths based on NHBC Standards.

Some desiccation of the clay soils was noted in WS1, to approximately 2.60m depth (Figure 1), which was close to the existing Ash tree in the south of the site. Foundations should be taken at least 0.50m below the last vestiges of live roots in clay soils. Live roots were encountered to a maximum depth of 4.00m within WS1. Strip footings could be 'stepped' up along the length of wall runs where foundation depths vary due to the influence of trees, although stepped foundations are likely to suffer differential settlements. Steps should not exceed 0.50m and further guidance is provided in the aforementioned NHBC document.

Swelling pressures of 101kN/m^2 at 2.90m depth and 107kN/m^2 at 3.90m depth also indicated the presence of desiccated clay, which gives an estimated heave of 25mm per 1.00m of desiccated clay. Potentially damaging swelling pressures could be generated following removal of nearby trees as any desiccated clay is allowed to become saturated. Incorporation of

some void forming or compressible material against the sides of the foundations or basement walls, may also be required within the zones of influence of the existing trees in the shallow clay soils, especially where trees have been or are to be removed, in order to accommodate any vertical and horizontal movements caused by future heave of the clay.

Recommendations for foundation depths related to proposed tree planting are also provided in the NHBC Standards and the volume change potential should be considered for any proposed landscaping within a residential scheme on the site.

Bearing Capacity

The stiff clays of the London Clay Formation, where encountered at a depth of 1.00m have a net safe bearing capacity of 170kN/m^2 beneath a strip footing up to 0.60m wide, and 185kN/m^2 for a square pad foundation 1.20m by 1.20m in size. At 2.50m depth, the clays have a net safe bearing capacity of 185kN/m^2 based on strip foundations up to 0.60m wide, and 200kN/m^2 for a square pad foundation 1.20m by 1.20m in size. These bearing capacities incorporate a factor of safety of 3.0 against shear failure and should be sufficient to support the proposed buildings.

Basement Foundations

Foundations at estimated basement floor level (around 3.00m below ground level) would be within the London Clay and a basement raft foundation could be considered to support the column loads with a bearing pressure of 100kN/m^2 beneath a basement slab up to 8m wide. This does not consider any net effect of base heave. This bearing pressure incorporates a factor of safety of 3.0 against shear failure within the underlying clays.

A reinforced basement floor or basement raft could be cast on the excavated surface following proof rolling and careful inspection.

Piled Foundations

Alternatively piled foundations may be used to support the proposed mews houses, and may be incorporated into any basement construction. The underlying London Clay would provide a suitable pile bearing stratum. The advice of a specialist piling contractor should be sought with regard to suitable methods of pile installation. Installation of either single bored, CFA or interlocking sheet piles or contiguous bored piles are likely to be best suited to these ground conditions. Vibrations from driven piles could be potentially damaging to neighbouring structures, particularly where they are supported by shallow footings.

Preliminary working loads for a single bored pile may be estimated for preliminary cost and design purposes using the pile bearing coefficients given below, which are based on the following assumptions;

1. The ultimate load on a pile would be the sum of the adhesion in clay, acting on the shaft of the pile together with the end bearing load.
2. The adhesion acting on the shaft of a pile is a function of the values of apparent cohesion within the clay, presented on the laboratory summary sheets and in Figure 2.
3. The end bearing load would be a function (9.0) of the average cohesion of the clay at the level of the pile base (Figure 2).
4. A factor of safety of at least 2.0 would be used to assess the working load and if test loading of selected piles were not practical, the factor of safety (F) would be increased to at least 2.5.

Item	**Ultimate Pile Bearing Value (kN/m^2)**
Friction/adhesion in made ground	Ignored
Adhesion in London Clay, 3.00m to 6.00m	50
Adhesion in London Clay, below 6.00m	60
End bearing in London Clay, 6.00m to 10.00m	1,100

Based on these coefficients it is estimated that a single 300mm diameter bored pile installed to 6m depth within the London Clay, would have a working load of 85kN (F=2.5). Similarly, the same size pile extended to a depth of 10m within the London Clay would have a working load of 175kN (F=2.5).

Larger diameter piles would have increased working loads. For example, the same 6m and 10m length piles at 450mm diameter would have working loads of 155kN (F=2.5) and 290kN (F=2.5) respectively.

The final design of piles should be undertaken by a piling specialist.

Retaining Structures

The walls of the proposed basement will act as retaining walls and will need to be designed accordingly, together with allowance for potential swelling pressures in the upper clay soils. For a permanent retaining wall analysis effective stress parameters would be appropriate, however, in the absence of effective stress testing on samples from this site, published parameters and in-situ test results could be used as a conservative approach. The design of retaining walls may be based on the parameters in Table 1 below.

Table 1: Basement Retaining Walls

Soil Type	Bulk Density (Mg/m^3) γ_B	Angle of Shearing Resistance (degrees) ϕ'	Shear Strength (kPa) c_u	Effective Shear Strength (kPa) c'
Made Ground (Clay fill)	1.80	23	35	0
London Clay to 4.00m depth	2.00	23-26	80	0-2

Excavations

The made ground together with the underlying soils should be easily removed within foundation excavations for the proposed development, although former foundations are

likely to be more difficult to remove and require a breaker. The sides of excavations within the made ground soils are likely to be unstable and excavations should not be relied upon to stand unsupported.

If basements are proposed, following the installation of either interlocking sheet piles or contiguous bored piles, excavations for the basements should be fairly easily achieved within them in both made ground and stiff fissured clay alike, by means of modern mechanical plant.

Calculations based on the oedometer test results suggest that some theoretical heave is possible. The basement excavation will result in the relief of approximately 60kPa of overburden pressure, and the resulting heave within the London Clay is calculated to be in the order of 45mm in the centre of the 8m wide and 3.00m deep unconfined excavation, reducing towards the edges of the excavation. Heave within the London Clay would begin to take place soon after excavation but would be confined by the basement floor once it had been constructed and further by any load carried by it.

Excavations could be expected to remain dry to 5.00m depth based on the findings of this investigation, however it is recommended that the water level in the standpipe is rechecked nearer the proposed construction date. Care should be taken not to excavate below the water table in the absence of suitable groundwater control and side support, such as dewatering via screened sumps. Care should be taken to keep the excavations dry.

Attention should be given where personnel are to enter deep excavations, when sides should either be safely battered back, or close side support provided, in order to comply with statutory safety requirements and prevent sidewall collapse.

The basement structure should be completed with a water-proof membrane around its outer surface to ensure future water tightness with regard to percolating water, perched groundwater and any future water table fluctuations.

The neighbouring structures should be protected from ground movements particularly if excavations are to be undertaken prior to installation of side support and care should be taken to avoid the undermining of existing footings.

Floor Slabs

A ground bearing floor slab should not be adopted in areas underlain by a significant thickness of made ground. Consolidation within the made ground beneath a ground bearing floor slab would be differential to the main building structure. It is therefore recommended that the floor slab is suspended, are supported on its own foundations, or the made ground is reengineered. If basements are to be constructed, a reinforced basement floor or basement raft could be cast on the excavated surface following proof rolling and careful inspection.

Similarly, where the floor slabs are in clay soils within the zones of influence of trees, either extant or recently removed, the root affected clay should be removed and replaced with well compacted non-shrinkable material or the slabs suspended using the sub-floor gaps recommended in Tables 9 and 10 of the NHBC Standards Chapter 4.2 (2010), however excavations for any proposed basement structure will penetrate and remove any desiccated clays.

Soil Gas Monitoring

The monitoring of soil gasses (methane, carbon dioxide and oxygen) within the standpipe installed within borehole WS1, was undertaken on 3rd February 2015. The results of the monitoring are summarised in Table 2 below.

Table 2: Summary of Gas Monitoring Data

Hole Location	No. Visits	Methane (% v/v)	Carbon Dioxide (% v/v)	Oxygen (% v/v)	Flow (l/hr)	Water Level (mbgl)	Atmospheric Pressure (mb)
WS1	1	<0.1	0.4	17.3	<0.1	5.23	1004

The results of the soil gas monitoring of the installation indicated less than 0.1% by volume methane and a maximum 0.4% by volume carbon dioxide, recorded during the monitoring visit. The in-situ measurements recorded a gas emission rate of less than 0.1l/hr.

Using a flow rate of 0.1l/hr, the detection limit of the equipment used, these in-situ measurements indicate a gas screening value (GSV) of 0.0004l/h. This GSV falls within the modified Wilson and Card Characteristic Situation 1 or 'Green' classification of the NHBC traffic light system, as defined by the Construction Industry Research and Information Association, CIRIA Report C665, 'Assessing risks posed by hazardous ground gasses to buildings'. These results indicate no gas precautions measures are necessary.

Sulphate Conditions

Sulphate analysis of selected samples of soil yielded soluble sulphate concentrations within Design Sulphate Classes DS-1, DS-2, DS-3 and DS-4, of the BRE Special Digest 1, Table C2 (2005), presented in Appendix 1. The pH results of samples ranged between 7.5 and 7.7, indicating alkaline conditions.

The London Clay Formation commonly contains sulphides, such as pyrite, and so following oxidation, after disturbance during excavation for the basement or foundations, there may be an increased total potential sulphate content. There was no visual evidence of pyrite in the London Clay.

These results indicate an Aggressive Chemical Environment for Concrete (ACEC) Class of AC-4 for buried concrete in shallow foundations. These ACEC Classes should be considered when specifying a Design Chemical Class (DC Class) for buried concrete on this site, as detailed in the above cited BRE document.

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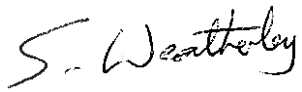

S. WEATHERLEY	**C. M. J. EBELING**
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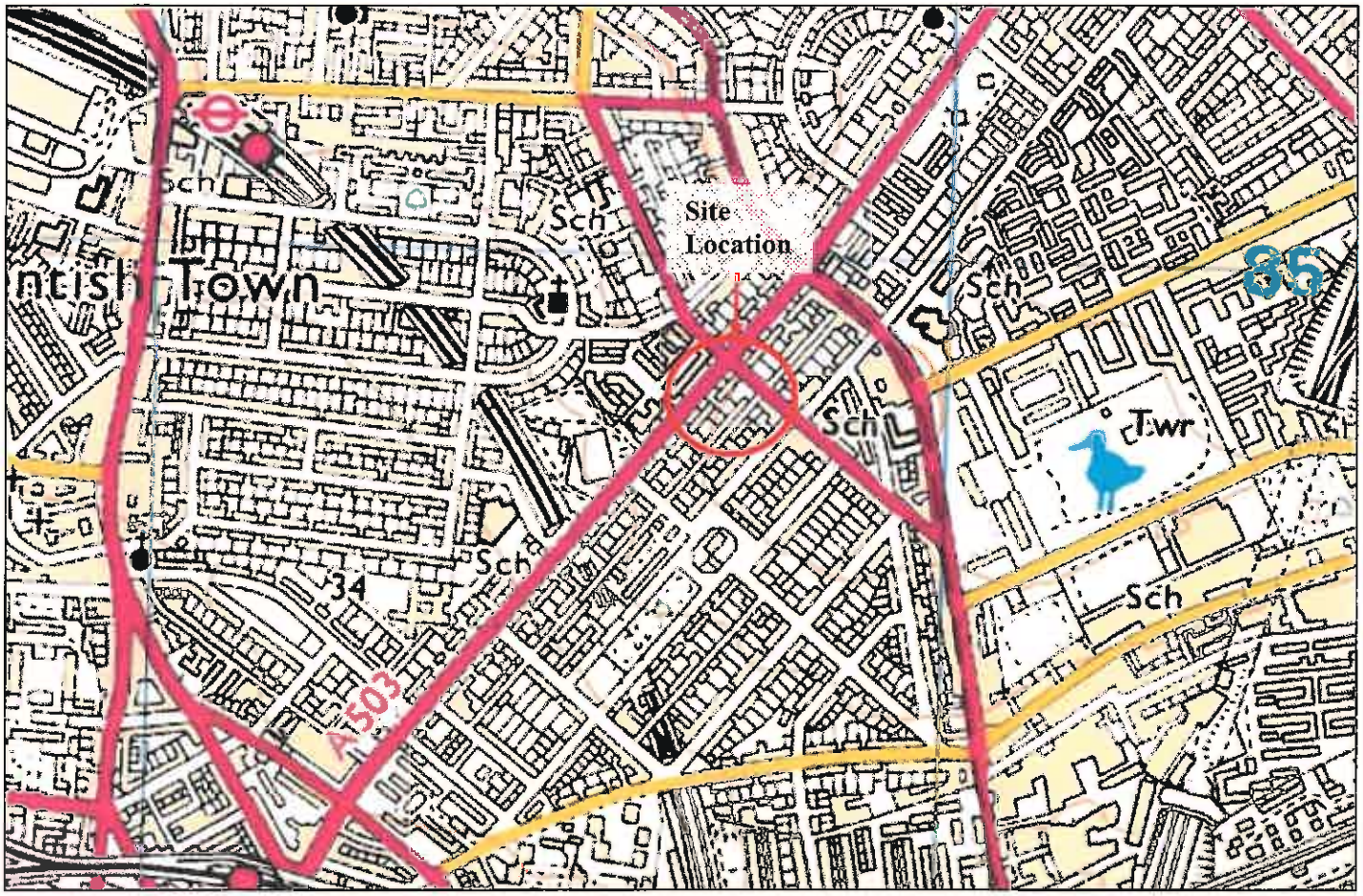
C.Geol., F.G.S.,	**C.Geol., F.G.S.,**
Senior Geo-Environmental Engineer	**Director**

Site Location Plan

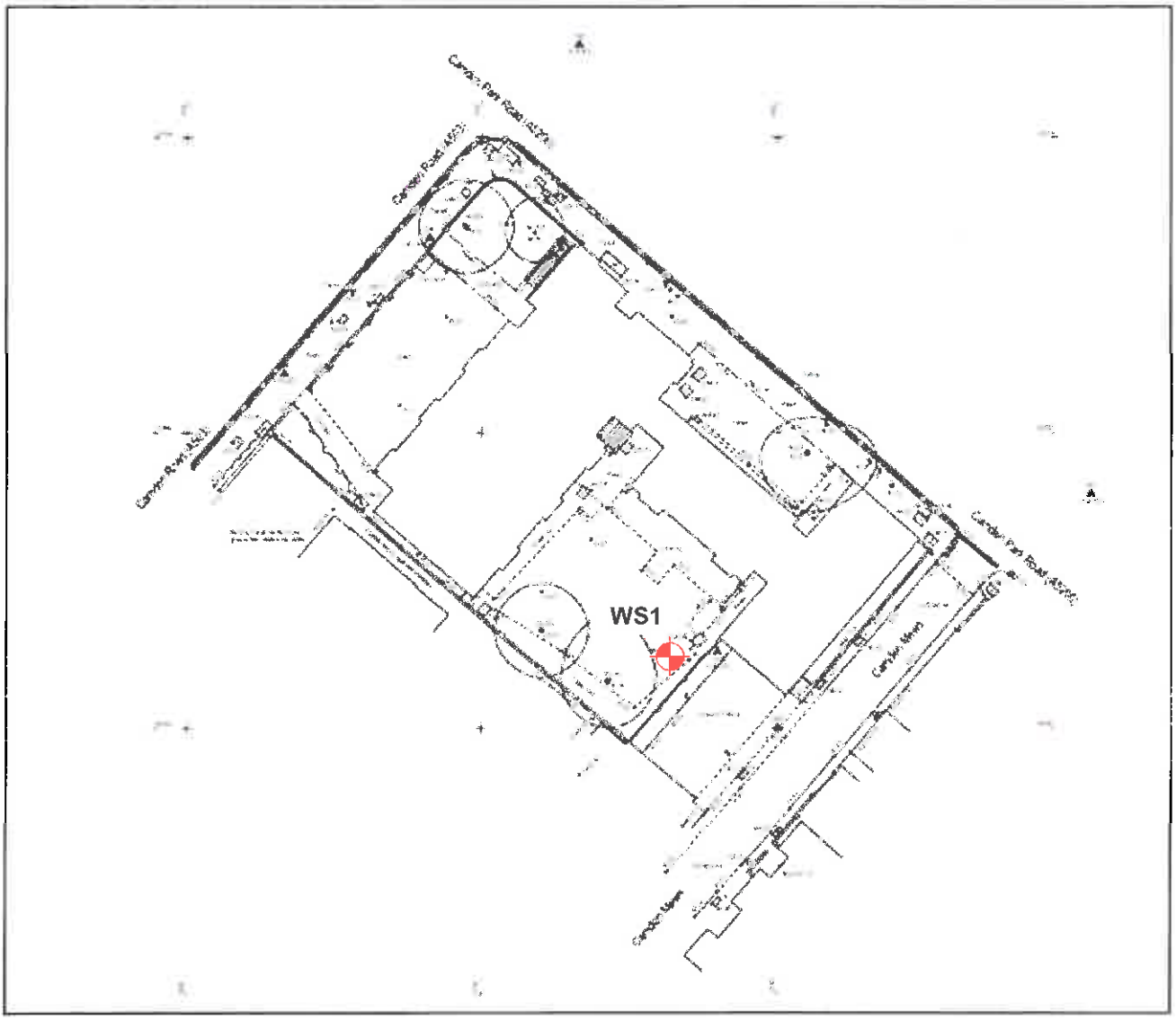


Not To Scale

Project : Ashton Court, Camden Road, London NW1 **Client : Origin Housing Developments Limited**	**GROUND ENGINEERING LIMITED** Peterborough Tel : 01733 566566	**Project No.** **C13480**

Exploratory Hole Location Plan

Plan provided by Robert Lombardelli Partnership Limited



Project : Ashton Court, Camden Road, London NW1 **Client : Origin Housing Developments Limited**	**GROUND ENGINEERING LIMITED** Peterborough Tel : 01733 566566	**Project No. C13480**

GROUND ENGINEERING LIMITED

Tel: 01733-566566
www.groundengineering.co.uk

Site: **ASHTON COURT, CAMDEN ROAD, LONDON NW1**

WINDOW SAMPLE WS1

Date: 14/01/15

Hole Size: 87mm dia to 2.00m
77mm dia to 5.00m
57mm dia to 10.00m

Ground Level:

Samples and in-situ Tests			(Date) Water	Inst.	Description of Strata	Legend	Depth m	O.D. Level m
Depth m	Type	Result						
0.30	D1				MADE GROUND - Yellow brown and brown, gravelly SAND. Gravel is angular and sub-angular flint, limestone and wood.		0.50	
0.60	D2				MADE GROUND - Very stiff, dark brown and grey, sandy, gravelly CLAY. Gravel is very angular to sub-rounded flint, brick, concrete, asphalt, chaik and shell fragments.		1.10	
0.90	D3							
0.90	V1	(110)						
1.20	D4				MADE GROUND - Firm, brown and dark brown, slightly sandy, slightly gravelly CLAY. Gravel is angular to sub-rounded flint, ash and brick fragments.		1.50	
1.50	D5							
1.80	V2	(130+)			Stiff, closely fissured to firm, brown, orange brown and grey mottled CLAY with partings of sand.			
1.80-2.00	U1A							
2.20	D6							
2.50	D7							
2.50	V3	(117)						
2.60-2.90	U2A							
2.90	V4	(108)						
3.10	D8							
3.10	V5	(116)						
3.40	D9							
3.40	V6	(110)						
3.60-3.90	U3A				...Selenite crystals below 3.90m depth.			
3.90	V7	(108)						
4.20	D10							
4.20	V8	(104)						
4.50	D11							
4.50	V9	(117)						
4.70-5.00	U4A							
					(LONDON CLAY)			
5.20	D12		▼s					
5.20	V10	(130+)						
5.50	D13							
5.50	V11	(130+)						
5.80-6.00	U5A							
5.80	V12	(125)						
6.00-7.00	U6							
6.20	V13	(126)						
6.40	V14	(120)						
6.70	V15	(130+)					7.00	
				BENEATH INSTALLATION	Stiff, closely fissured, grey CLAY with selenite crystals.			
7.50	V16	(130+)		BENEATH INSTALLATION				
7.80-8.00	U7A			BENEATH INSTALLATION				
				BENEATH INSTALLATION	(LONDON CLAY)			
8.80-9.00	U8A			BENEATH INSTALLATION				
				BENEATH INSTALLATION				
9.80-10.00	U9A			BENEATH INSTALLATION			10.00	

REMARKS

Borehole completed at 10.00m depth

1. Starter pit excavated from GL to 1.20m depth
2. Live roots observed to 4.00m depth
3. Gas monitoring standpipe installed to 7.00m depth

Project No 13480

Scale 1:50 | Page 1/1

KEY

D - Disturbed Sample
B - Bulk Sample
U - Undisturbed Sample
W - Water Sample
▽ Water Strike
▼ Depth to Water on completion
J - Jar Sample
M - Mackintosh Probe
V - Vane Shear Test Cohesion ( ) kPa
P( ) - Hand Penetrometer Cohesion ( ) kPa
▼s Standpipe Level

Groundwater Strikes

No	Depth m Struck	Rose to	Rate	Cased	Sealed

Groundwater Observations

Date	Depth m Hole	Casing	Water
14/01/15	10.00	1.00	dry
03/02/15	7.00		5.23

Gas Monitoring Record

Site: **Ashton Court, Camden Road, London NW1**

Report Ref: **C13480**

Date	Borehole No.	Methane (% v/v)		Methane LEL %	Carbon Dioxide (% v/v)		Oxygen (% v/v)		Flow Rate (l/hr)	Atmospheric Pressure (mb)	Depth of Well (mbgl)	Depth to Groundwater (mbgl)
		Peak	Steady		Peak	Steady	Min.	Max.				
03/02/15	WS1	<0.1	<0.1	<0.1	0.4	0.4	17.3	17.3	<0.1	1004	7.00	5.23

LEL – Lower Explosive Limit

LABORATORY TEST RESULTS

CONTRACT ASHTON COURT, CAMDEN ROAD, LONDON NW1

Bore-hole	Sample	Depth m	Classification				Density		Triaxial Compression					Sulphates (SO_4)				Remarks
			Liquid Limit %	Plastic Limit %	Plasticity Index %	Moisture Content %	Bulk Mg/m^3	Dry Mg/m^3	Type	Principal Stress Difference kPa	Cell Pressure kPa	Shear Strength kPa	Angle of Shear Resistance degrees	Soil: Total % Dry Wt.	Soil: Aqueous Extract mg/l	Water mg/l	pH	
WS1	D4	1.20				30												
	D5	1.50				27									424		7.7	
	U1A	1.80 - 2.00	81	24	57	25	2.04	1.64	Q	334	50	167	0					SOIL CLASSIFICATION = CV 2% retained on 425μm sieve
	D6	2.20				24												
	D7	2.50				26												
	U2A	2.60 - 2.90				30	1.97	1.51	Q	159	50	80	0		1285		7.7	
	D8	3.10				28												
	D9	3.40				29												
	U3A	3.60 - 3.90				32	1.99	1.51	Q	128	60	64	0		2508		7.5	
	D10	4.20				31												
	D11	4.50				29												
	U4A	4.70 - 5.00				32	1.88	1.42	Q	156	80	78	0					
	D12	5.20				29												

U - UNDISTURBED SAMPLE
D - DISTURBED SAMPLE
B - BULK SAMPLE
W - WATER SAMPLE

C.U. - CONSOLIDATED UNDRAINED
C.D. - CONSOLIDATED DRAINED
Q. - IMMEDIATE UNDRAINED
Q.M. - IMMEDIATE UNDRAINED MULTISTAGE

Aqueous Extract 2:1 Water:Soil

13480

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LABORATORY TEST RESULTS

CONTRACT ASHTON COURT, CAMDEN ROAD, LONDON NW1

Bore-hole	Sample	Depth m	Classification				Density		Triaxial Compression					Sulphates (SO_4)				Remarks
			Liquid Limit %	Plastic Limit %	Plasticity Index %	Moisture Content %	Bulk Mg/m^3	Dry Mg/m^3	Type	Principal Stress Difference kPa	Cell Pressure kPa	Shear Strength kPa	Angle of Shear Resistance degrees	Soil: Total % Dry Wt.	Soil: Aqueous Extract mg/l	Water mg/l	pH	
WS1	D13	5.50				28									3014		7.5	
	U5A	5.80 - 6.00				30	1.91	1.47	Q	180	100	90	0					
	U7A	7.80 - 8.00				28	1.92	1.50	Q	243	130	122	0					
	U8A	8.80 - 9.00				29	2.01	1.56	Q	256	150	126	0					
	U9A	9.80 - 10.00				30	1.97	1.52	Q	260	170	130	0					

U - UNDISTURBED SAMPLE
D - DISTURBED SAMPLE
B - BULK SAMPLE
W - WATER SAMPLE

C.U. - CONSOLIDATED UNDRAINED
C.D. - CONSOLIDATED DRAINED
Q. - IMMEDIATE UNDRAINED
Q.M. - IMMEDIATE UNDRAINED MULTISTAGE

Aqueous Extract 2:1 Water:Soil

13480

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GROUND ENGINEERING

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e: admin@groundengineering.co.uk

TEST CERTIFICATE

One-Dimensional Consolidation Properties

(Tested in accordance with BS1377 : Part 5 1990)

Client:	Ground Engineering Ltd	Certificate Number:	PL4884-1-6/731
Client Address:	Newark Road	Client Reference Number:	C13480
	Peterborough	Date Sampled:	Unknown
	Cambridgeshire	Date Received:	21.01.2015
Postcode:	PE1 5UA	Date Tested:	22.01.2015
Contact:	Simon Weatherley	Sampling Certificate No:	N/A
Site Name:	Ashton Court	Certificate of Sampling:	N/A
Site Address:	London NW1	Sampled By:	Client

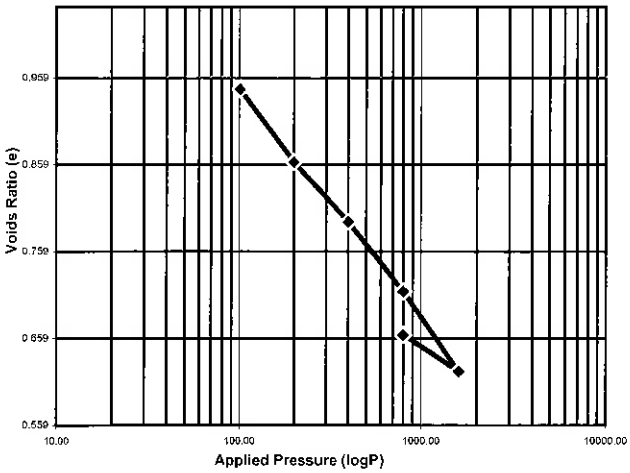
Test Details

Location:	WS1	
Sample Ref:	U2A	
Sample Description:	Stiff brown orange brown grey slightly silty CLAY	
Particle Density (Mg/m^3):	2.74	Assumed
Mean Lab Temp. (^{o}C):	22	
Variations from Standard:	None	
Lab Reference:	PL4884-1-6	
Depth (m):	2.90 m	

Specimen Details

	INITIAL	FINAL
Height (mm):	18.95	16.19
Bulk Density (Mg/m^3):	1.85	2.11
Moisture Content (%):	31	28
Dry Density (Mg/m^3):	1.41	1.65
Voids Ratio:	0.946	0.663
Degree of Saturation (%):	91.2	116.0
Diameter (mm):	75.03	N/A
Swelling Pressure (kPa):	101	N/A
Method of time fitting used:	Log Time	N/A

Voids Ratio against logarithm of Applied Pressure



Applied Pressure (kPa)	Coefficient of Compressibility m_v (m^2/MN)	Coefficient of Consolidation c_v (m^2/year)
101		
200	0.44	0.19
400	0.19	0.17
800	0.11	0.15
1600	0.07	0.22
800	0.03	---

Comments:

Approved Signatory: [x] M.Hartnup - Laboratory Manager
[ ] L.Petch - Team Leader

Signed:

for and on behalf of Ground Engineering Ltd

Date Reported: 02/02/2015

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TEST CERTIFICATE

One-Dimensional Consolidation Properties

(Tested in accordance with BS1377 : Part 5 1990)

Client:	Ground Engineering Ltd	Certificate Number:	PL4884-1-9/731
Client Address:	Newark Road	Client Reference Number:	C13480
	Peterborough	Date Sampled:	Unknown
	Cambridgeshire	Date Received:	21.01.2015
Postcode:	PE1 5UA	Date Tested:	21.01.2015
Contact:	Simon Weatherley	Sampling Certificate No:	N/A
Site Name:	Ashton Court	Certificate of Sampling:	N/A
Site Address:	London NW1	Sampled By:	Client

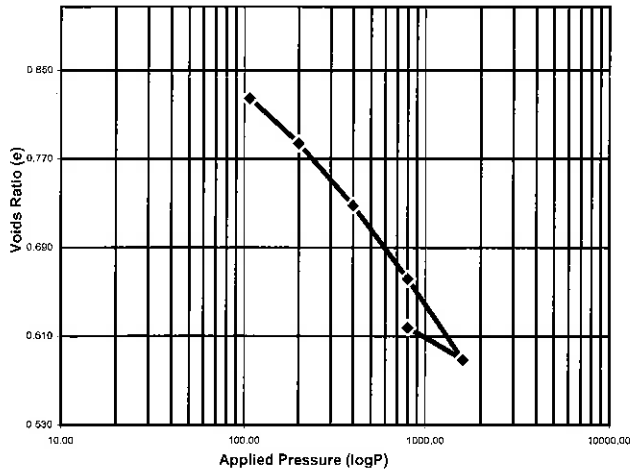
Test Details

Location:	WS1	
Sample Ref:	U3A	
Sample Description:	Stiff brown orange brown grey slightly silty CLAY	
Particle Density (Mg/m^3):	2.74	Assumed
Mean Lab Temp. (^{o}C):	22	
Variations from Standard:	None	
Lab Reference:	PL4884-1-9	
Depth (m):	3.90 m	

Specimen Details

	INITIAL	FINAL
Height (mm):	18.52	16.42
Bulk Density (Mg/m^3):	2.00	2.17
Moisture Content (%):	33	28
Dry Density (Mg/m^3):	1.50	1.69
Voids Ratio:	0.825	0.618
Degree of Saturation (%):	111.0	124.7
Diameter (mm):	50.00	N/A
Swelling Pressure (kPa):	107	N/A
Method of time fitting used:	Log Time	N/A

Voids Ratio against logarithm of Applied Pressure



Applied Pressure (kPa)	Coefficient of Compressibility m_v (m^2/MN)	Coefficient of Consolidation c_v (m^2/year)
107		
200	0.24	0.25
400	0.16	0.25
800	0.10	0.23
1600	0.06	0.22
800	0.02	---

Comments:

Approved Signatory: [x] M.Hartnup - Laboratory Manager
[ ] L.Petch - Team Leader

Signed:

for and on behalf of Ground Engineering Ltd

Date Reported: 02/02/2015

Registered in England Wales
Reg Number 6929574
Reg Office: Ground Engineering Ltd
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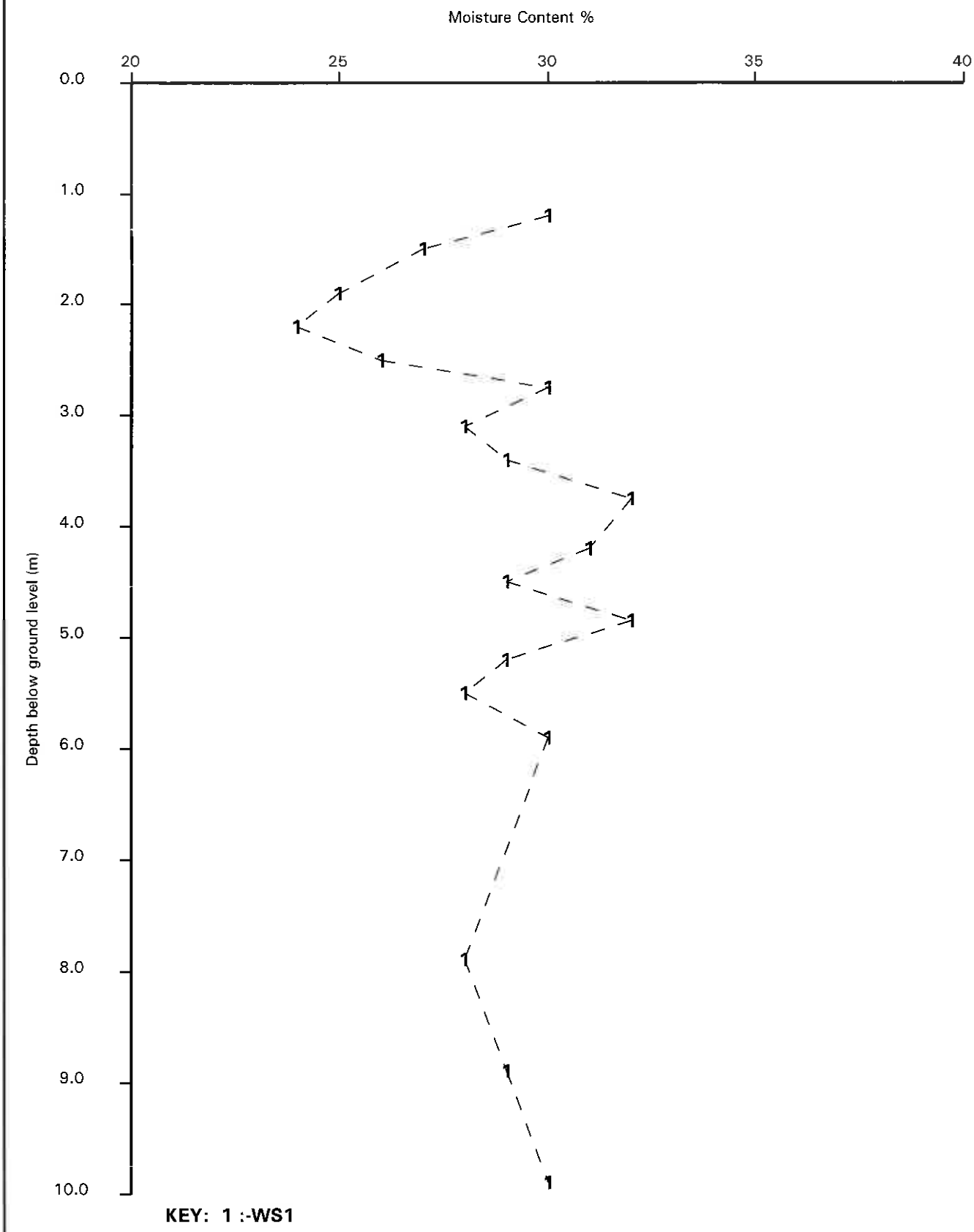
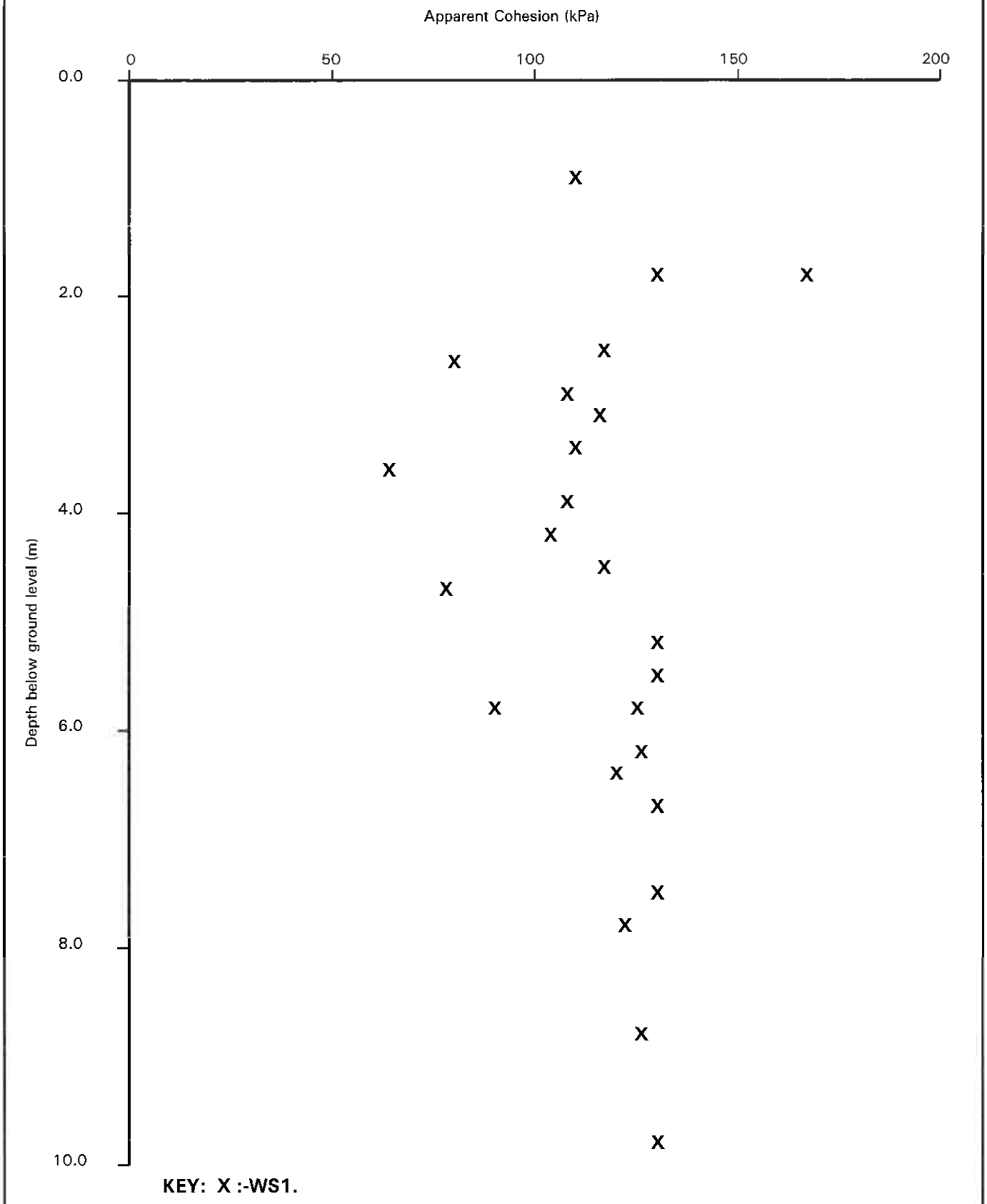


Moisture Content % vs Depth below ground level (m).

SITE	ASHTON COURT, CAMDEN ROAD, LONDON NW1	
CLIENT	ORIGIN HOUSING DEVELOPMENT LIMITED	Contract Number 13480
GROUND ENGINEERING LIMITED Tel: 01733-566566 www.groundengineering.co.uk	Date 12/03/15	Figure 1



Apparent Cohesion (kPa) vs Depth below ground level (m).

SITE	ASHTON COURT, CAMDEN ROAD, LONDON NW1	
CLIENT	ORIGIN HOUSING DEVELOPMENTS LIMITED	Contract Number 13480
GROUND ENGINEERING LIMITED Tel: 01733-566566 www.groundengineering.co.uk	Date 12/03/15	Figure 2

APPENDIX 1

CLASSIFICATION OF AGGRESSIVE CHEMICAL ENVIRONMENT FOR BURIED CONCRETE

TABLE C2 – AGGRESSIVE CHEMICAL ENVIRONMENT FOR CONCRETE (ACEC) CLASSIFICATION FOR BROWNFIELD LOCATIONS[a]

Table C2 Aggressive Chemical Environment for Concrete (ACEC) classification for brownfield locations

Sulfate and magnesium						Groundwater		ACEC
Design Sulfate Class for location	2:1 water/soil extract[b]		Groundwater		Total potential sulfate[c]	Static water	Mobile water	Class for location
1	2 (SO_4 mg/l)	3 (Mg mg/l)	4 (SO_4 mg/l)	5 (Mg mg/l)	6 (SO_4 %)	7 (pH)[d]	8 (pH)[d]	9
DS-1	< 500		< 400		< 0.24	≥ 2.5		AC-1s
							> 6.5[d]	AC-1
							5.5–6.5	AC-2z
							4.5–5.5	AC-3z
							2.5–4.5	AC-4z
DS-2	500–1500		400–1400		0.24–0.6	> 5.5		AC-1s
							> 6.5	AC-2
						2.5–5.5		AC-2s
							5.5–6.5	AC-3z
							4.5–5.5	AC-4z
							2.5–5.5	AC-5z
DS-3	1600–3000		1500–3000		0.7–1.2	> 5.5		AC-2s
							> 6.5	AC-3
						2.5–5.5		AC-3s
							5.5–6.5	AC-4
							2.5–5.5	AC-5
DS-4	3100–6000	≤ 1200	3100–6000	≤ 1000	1.3–2.4	> 5.5		AC-3s
							> 6.5	AC-4
						2.5–5.5		AC-4s
							2.5–6.5	AC-5
DS-4m	3100–6000	> 1200[e]	3100–6000	> 1000[e]	1.3–2.4	> 5.5		AC-3s
							> 6.5	AC-4m
						2.5–5.5		AC-4ms
							2.5–6.5	AC-5m
DS-5	> 6000	≤ 1200	> 6000	≤ 1000	> 2.4	> 5.5		AC-4s
						2.5–5.5	≥ 2.5	AC-5
DS-5m	> 6000	> 1200[e]	> 6000	> 1000[e]	> 2.4	> 5.5		AC-4ms
						2.5–5.5	≥ 2.5	AC-5m

Notes

a Brownfield locations are those sites, or parts of sites, that might contain chemical residues produced by or associated with industrial production (Section C5.1.3).

b The limits of Design Sulfate Classes based on 2:1 water/soil extracts have been lowered from previous Digests (Box C7).

c Applies only to locations where concrete will be exposed to sulfate ions (SO_4), which may result from the oxidation of sulfides such as pyrite, following ground disturbance (Appendix A1 and Box C8).

d An additional account is taken of hydrochloric and nitric acids by adjustment to sulfate content (Section C5.1.3).

e The limit on water-soluble magnesium does not apply to brackish groundwater (chloride content between 12 000 mg/l and 17 000 mg/l). This allows 'm' to be omitted from the relevant ACEC classification. Seawater (chloride content about 18 000 mg/l) and stronger brines are not covered by this table.

Explanation of suffix symbols to ACEC Class

- Suffix 's' indicates that the water has been classified as static.
- Concrete placed in ACEC Classes that include the suffix 'z' have primarily to resist acid conditions and may be made with any of the cements in Table D2 on page 42.
- Suffix 'm' relates to the higher levels of magnesium in Design Sulfate Classes 4 and 5.

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