Providing Ground Solutions

Walsh Group

Camden Lock, London

Geotechnical and Geoenvironmental Interpretative Report - Draft

December, 2014

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Reference	CG/18067A	DRAFT	0	Issue Date	December 2014

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EXECUTIVE SUMMARY

Card Geotechnics has been commissioned by Walsh Group to undertake a Geotechnical and Geoenvironmental Interpretative Report for a site at Camden Lock Village, London. The site currently comprises a car park, office buildings, retail units and market stalls. It is proposed to demolish the existing buildings and construct a number of mixed use multi-storey residential buildings with associated hardstanding and communal garden areas.

The historical development of the site was previously investigated by RPS in their October 2009 and November 2009. In summary, the site comprised open fields until the *Regent's Canal* was constructed in the early 1800s, with associated wharf buildings and residential properties constructed across the site. These buildings were subsequently redeveloped or were demolished during construction of the North London Overground Railway viaducts in the mid-1800s. No further significant changes were noted at the site.

The area experienced intensive bombing during the Second World War, with a number of properties along Torbay Street suffering serious blast damage. A detailed unexploded ordnance (UXO) risk assessment was undertaken by 6 Alpha Associates Limited in September 2014 which noted that there is a low to medium risk due to UXO across the northern and eastern part of the site and a medium to high risk across the southwestern part.

Local geotechnical mapping indicates that the site is directly underlain by the London Clay Formation. This is supported by historical BGS records from the surrounding area. An intrusive investigation, comprising six cable percussion boreholes to a maximum depth of -12.14mOD (39.5mbgl), six window sampler boreholes to a maximum depth of 20.79mOD (5mbgl) was undertaken from 28th October to 18th November 2014. An additional investigation, comprising three rotary boreholes to a maximum depth of some -4mOD (30mbgl), was undertaken from 24th November to 17th December 2014. Ground gas and groundwater monitoring wells were installed in the boreholes.

The investigation encountered limited Made Ground (0.5m to 1.5m) underlain by the London Clay Formation, which extended to the base of the boreholes. No groundwater strikes were encountered during the investigation, however groundwater was encountered during monitoring at 26.53mOD to 18.34mOD.

Negligible concentrations and flow of ground gas were recorded during the subsequent monitoring visits and a gas screening value of 0.0611l/hr has been calculated for the site. The site therefore conforms to Characteristic Situation 1 (NHBC 'Green') and no ground gas protection measures are therefore required in the development.

In order to mitigate the potential risk to Human Health due to contaminant exceedances encountered in samples from the Made Ground, a capping layer is recommended across the site. For communal landscaped areas, the capping layer may comprise hardstanding or a minimum of 150mm topsoil over 300mm subsoil and a geotextile membrane.

A preliminary assessment of the Topsoil/Made Ground for waste classification purposes indicates that the majority of this material may be classified as 'not hazardous' with respect to waste disposal. However, two samples were found to be 'hazardous' due to elevated pH and PAHs. Waste acceptance criteria (WAC) testing demonstrates that the 'not hazardous' samples may be disposed of in an inert landfill and that the 'hazardous' samples may be disposed of as 'stable non-reactive waste in non-hazardous landfill'.

Piled foundations are considered suitable for the proposed development of the site. A preliminary assessment of pile working loads demonstrates that a range of capacities from 240kN to 6,320kN is achievable using piles 0.45m to 1.5m in diameter and 10m to 25m in length, respectively, with the piles being driven from ground level, 21.7mOD or 11.7mOD, depending on the depth of the proposed on site. The final pile design should be undertaken by the specialist piling contractor engaged to undertake the works.

The London Clay Formation has a high volume change potential and floor slabs should therefore be designed as suspended in order to mitigate potential damage due to heave. It is anticipated that shallow excavations will remain stable in the short term.

Buried concrete within the London Clay Formation should be designed to DS-4 and AC-3s if disturbed during construction (i.e. during basement excavation), or DS-3 and AC-2s if undisturbed during construction, for example where piled foundations are employed.

1. INTRODUCTION

CGL has been commissioned by Walsh Group to undertake a geotechnical and geoenvironmental intrusive investigation to assess the ground conditions at a site proposed for development at Camden Lock Village, London.

The proposed development of the site is divided into two sections; the 'School Site', which comprises the northeastern part of the wider site, and the remainder of the site. A separate report[1] has been produced for the School Site area.

The objectives of this report are to:

- provide a summary of the site history and environmental setting;
- provide information on the ground conditions;
- provide an assessment and recommendations relating to the potential for soil and groundwater contamination and ground gas; and
- provide geotechnical recommendations to assist with foundation, floor slab and pavement design.

The site has been the subject of a number of previous reports, including;

- Phase 1 Environmental Risk Assessment (RPS 2009)[2]
- Archaeological Desk Based Assessment (RPS 2009)[3]

Pertinent information within these reports is summarised in Section 2, but the reports should be referred to for further details.

[1] CGL (2014) Camden Lock, London – Proposed School Site. *Geotechnical and Geoenvironmental Interpretative Report.* Ref: CG/18067. December 2014
[2] RPS (2009) Camden Lock Village London Borough of Camden. *Phase 1 – Environmental Risk Assessment*. Ref: HLEI4880/001R. October 2009
[3] RPS (2009) Camden Lock Village London Borough of Camden. *An Archaeological Desk Based Assessment*. Ref: JLK0617 RO1. November 2009

2. SITE LOCATION AND DESCRIPTION

2.1 Site location

The site is situated off Torbay Street in Camden, northwest London. The Ordnance Survey grid reference for the approximate centre of the site is 528813N, 184210E.

A site location plan is presented as Figure 1.

2.2 Site description and proposed development

The wider site is bordered by Hawley Road to the north, residential properties and Kentish Town Road to the east, the *Grand Union Towpath* and *Regent's Canal* to the south and Camden High Street and Castlehaven Road to the west.

The site is naturally split into four sections by the National Rail viaducts which cross the site. The sections of the site are shown on Figure 2 and are detailed below, along with the proposed development in each area;

2.2.1 Building A

Building A is situated in the southwest of the site and was subject to Phase 3 of the ground investigation. At the time of the investigation, the area was occupied by Camden Lock Village Market, which comprised a large number of single storey wooden market stalls with additional retail premises situated in the arches beneath the railway viaducts.

The development in Building A is proposed to comprise the demolition of the existing structures and construction of three multi storey buildings, comprising market and retail areas, office space and restaurant areas.

2.2.2 Building C

Building C occupies the western and central parts of the site, between the two National Rail viaducts. This area was investigated as part of the Phase 2 ground investigation. At the time of the ground investigation, this area comprised an office building with associated car parking, a waste transfer depot and vehicle maintenance and repair workshops, situated in the arches beneath the railway viaduct.

The proposed development in Building C comprises two multi storey buildings with basement levels and communal landscaped areas. The upper floors of the buildings will comprise residential properties and the lower floors and basement levels will predominantly comprise retail units, office space and leisure facilities.

2.2.3 Building D

Building D is situated in the southeast of the site and was also investigated during the Phase 2 ground investigation. At the time of the ground displacement, the area comprised office buildings with associated car parking.

The proposed development in Building D comprises a multi storey building with a basement and communal landscaping. The upper floors of the building will comprise residential properties, with office space and a restaurant on the ground and basement levels.

2.2.4 Buildings X and W

Buildings X and W are situated in the northern part of the site and was investigation as part of the Phase 1 ground investigation. During the investigation, the site was noted to comprise a car park with associated temporary office buildings, a number of mid-19th century residential properties and vehicle maintenance and repair businesses, predominantly situated in the arches beneath the railway viaducts.

The proposed development at Buildings X and W will comprise the demolition of the existing structures and construction of two multi storey residential buildings, with communal landscaped areas.

2.3 Historical Development

The historical development of the site was established by RPS in their October 2009[1] and November 2009[2] reports and is summarised below.

The site consisted of open fields until the *Regent's Canal* was constructed in the early 1800s, with associated wharf buildings and residential properties constructed across the site. A number of these buildings were subsequently demolished during construction of the North London Overground Railway viaducts in the mid-1800s. No further significant changes were noted at the site.

2.4 Bomb damage and unexploded ordnance

The area experienced intensive bombing during the Second World War, with a number of properties along being destroyed or damaged beyond repair.

A detailed unexploded ordnance (UXO) risk assessment[4] was undertaken by 6 Alpha Associates Limited in September 2014. The report notes that the risk posed by UXO at the site is 'low to medium' for basements and excavations within Buildings C, D, X and W and 'medium to high' in Building C.

2.5 Anticipated ground conditions

2.5.1 Published and unpublished geology

The British Geological Survey map sheet 256 indicates that the site is directly underlain by the London Clay Formation, which consists of stiff blue grey silty clay, weathering to brown silty clay..

The BGS holds records of a number of historical ground investigations within 300m of the site. Selected logs are summarised in Table 1 and are included in Appendix A.

[4] 6 Alpha Associates Limited (2014) *Detailed Unexploded Ordnance (UXO) Risk Assessment*. Ref: P4063. September 2014

Table 1 - Summary of BGS historical borehole records

BH record reference	Distance (m)	Direction	Base of BH (mbgl)	Ground water level (mbgl)	Depth to top of stratum (mbgl)				
					MG	London Clay Formation	Lambeth Group	Thanet Sand	Chalk
TQ28SE5	90	S	91.4	NR	-	0.0	42	NR	64
TQ28SE1203	300	SE	18.7	1.1	0.0	1.5	-	-	-
TQ28SE1204	300	SE	18.4	NR	0.0	0.9	-	-	-
TQ28SE1206	300	SE	9.6	1.1	0.0	2.1	-	-	-
TQ28SE1208	300	SE	9.4	NR	0.0	1.37	-	-	-
TQ28SE1239	180	NW	3.0	-	0.0	0.63	-	-	-
TQ28SE1240	180	NW	3.0	-	0.0	0.5	-	-	-
TQ28SE1241	180	NW	3.0	-	0.0	0.8	-	-	-
TQ28SE1242	180	NW	3.0	-	0.0	0.6	-	-	-
TQ28SE1491	190	SE	198.7	91.7	0.0	6.7	44.8	53.9	125.0
TQ28SE2272	257	SW	1.1	-	0.0	1.08	-	-	-

2.5.2 Hydrogeology and hydrology

The Environment Agency[5] has produced an aquifer designation system consistent with the requirements of the Water Framework Directive. The designations have been set for superficial and bedrock geology and are based on the importance of aquifers for potable water supply and their role in supporting surface water bodies and wetland ecosystems.

The underlying London Clay Formation is classified as an 'Unproductive Strata' and the site is not within a Groundwater Source Protection Zone (SPZ)

The Environment Agency indicates that the site is not at risk from flooding. The nearest surface water to the site is the *Regent's Canal*, situated approximately 3m south of the site. Additionally, the historical *River Fleet* is noted to run some 60m west and 8m north of the site.

[5] www.environment-agency.gov.uk (September 2014)

2.6 Environmental setting

The previous report by RPS[1] provides information on the environmental setting of the site and possible sources of soil and groundwater contamination. The key points are summarised below:

- There are no recorded landfill sites within 500m of the site. However, there are two waste transfer sites, located 120m southwest and 130m south of the site.
- No 'major' or 'significant' pollution incidents are noted within 500m of the site.
- There is the potential for arsenic and lead contamination to be present within the soils at the site, resulting from the spreading of ash in private gardens during the pre-Victorian period to the 1950s.
- There are eleven industrial activities within 500m of the site, including vehicle respraying, petrol stations and dry cleaners.
- The site is not in a radon affect area

2.7 Preliminary risk assessment

The October 2009 RPS report[1] included a preliminary risk assessment, the key points of which are summarised below:

- It is likely that contamination is present within the soils due to historical land use on site and in the surrounding area.
- The potential pathways to human health receptors include dermal contact, inhalation and ingestion of contaminants. Due to the underlying London Clay Formation, there is not considered to be a pathway for contaminants to reach the underlying Chalk aquifer.
- Overall, RPS considered the risk associated with potential contamination within the Made Ground to be low due to the absence of a source-pathway-receptor linkage (hardstanding across the site).

In addition to the potential risks identified by RPS, due to the age of the buildings on site, it is considered that there is the potential for asbestos-containing material to be present within the building fabric.

3. CURRENT GROUND INVESTIGATION

3.1 Fieldwork

Intrusive investigation was undertaken at Buildings X and W (Phase 1 of the ground investigation) from 21st October to 6th November 2014, with subsequent investigation at Blocks C and D (Phase 2) from 31st October to 18th November 2014 and at Building A (Phase 3) from 24th November to 17th December 2014.

The investigation at Buildings C, D, X and W comprised six cable percussive boreholes (BH2 to BH7) to a maximum depth of -12.14mOD (39.5mbgl) and six window sampler boreholes (WS4 to WS9) to a maximum depth of 20.79mOD (5mbgl). The investigation at Building A comprised three rotary boreholes (BH8 to BH10) to a maximum depth of some -4mOD (30mbgl).The investigation was broadly undertaken in accordance with the requirements of BS 5930:1999[6].

The borehole arisings were recorded and representatively sampled by a suitably qualified geotechnical engineer from CGL in order to obtain samples for laboratory testing, and to characterise the near surface ground conditions across the site. Soil samples were obtained for chemical and geotechnical laboratory analysis. Standpipes were installed in all boreholes to enable subsequent gas and groundwater monitoring to be undertaken.

A plan showing the exploratory locations is presented as Figure 3 and the borehole logs are included as Appendix B

3.2 Monitoring

A programme of fortnightly ground gas and groundwater monitoring visits is being undertaken at the standpipes installed across the site. The monitoring commenced on 5th November 2014 following completion of the ground investigation at Buildings X and W. Three visits have been undertaken to date, on 5th and 19th November and 1st December 2014. Copies of the monitoring records to date are included as Appendix C.

[6] BS 5930:1999*; Code of practice for site investigations, Incorporating Amendment 2*, British Standards Institute. 1999.

3.3 Laboratory testing

3.3.1 Chemical

Representative soil samples and one groundwater samples were submitted to i2 Analytical Limited (a UKAS and MCERTS accredited laboratory) for chemical testing. The analysis included the following determinants.

- Soil Organic Matter (SOM);
- Heavy metals including; arsenic, barium, beryllium, boron, cadmium, chromium, copper, lead, mercury, nickel, selenium, vanadium and zinc;
- Total Petroleum Hydrocarbons (TPH) and Polycyclic Aromatic Hydrocarbons (PAH);
- Total Monohydric Phenols;
- Total Cyanide;
- Sulfate;
- Asbestos identification; and
- pH determination.

The laboratory analysis results are presented in Appendix D.

3.3.2 Geotechnical

Soil samples were sent for geotechnical laboratory analysis at Geolabs Limited. The analysis included:

- Moisture Content;
- Atterberg Limits and;
- Quick Undrained Triaxial testing.

The results of the analysis are presented in Appendix E.

4. GROUND AND GROUNDWATER CONDITIONS

4.1 Summary

The ground conditions encountered on site broadly corresponded to published geology and are summarised in Table 2. The borehole and window sampler logs are included as Appendix B.

Table 2. Summary of ground conditions (whole site)

Stratum	Depth to top of stratum (mOD) [mbgl]	Typical thickness (m)
MADE GROUND Concrete overlying soft dark brown sandy gravelly silt. Sand is fine to coarse. Gravel is fine to coarse subrounded to subangular of brick, flint and occasional concrete.	25.79 to 27.96 [0.0]	0.5 to 3.0
Form dark orange brown slightly silty CLAY with occasional fine selenite crystals [WEATHERED LONDON CLAY FORMATION].	22.79 to 25.64 [0.5 to 3.0]	7.4 to 9.8
Stiff closely fissured dark grey silty CLAY. Frequent fine selenite crystals noted. [LONDON CLAY FORMATION]	17.56 to 16.17 [8.9 to 11.2]	>29.7 (Base not encountered in boreholes)

The cable percussion boreholes extended to a maximum depth of -12.14mOD (39.5mbgl), the window sampler boreholes extended to a maximum depth of 20.79mOD (5mbgl) and the rotary boreholes extended to -4mOD (30mbgl).

The ground conditions encountered during the ground investigation generally correlated with the BGS mapping of the area, with Made Ground directly overlying the London Clay Formation. The upper surface of the London Clay Formation was found to be relatively consistent across the majority of the site.

4.2 Made Ground

The Made Ground at the site was found to be relatively consistent across the majority of the site and comprised concrete or paving slabs overlying soft dark brown sandy gravelly silt or gravelly silty clay. The gravel comprised brick and flint, with occasional concrete. A moderate hydrocarbon odour was noted from the Made Ground in WS4. No other visual or olfactory evidence of contamination was noted in the boreholes.

Deeper Made Ground was encountered at borehole WS9 in the area of Building D (Phase 2 SI), possibly due to the construction of the nearby office blocks. It is anticipated that areas of deeper Made Ground may be present across the site in areas which were inaccessible at the time of the site investigation.

4.3 London Clay Formation

The London Clay Formation was proved to a maximum depth of -12.14mOD. The upper 7.4m to 9.8m of the clay was found to consist of firm silty clay (Weathered London Clay Formation), becoming stiff (unweathered) from 17.56mOD to 16.17mOD. SPT 'N' values in this stratum ranged from 8 to >50. Undrained shear strength values can be derived from these values using established Stroud correlations[7].These values range from 36kPa to >225kPa, indicating that the clay is low to very high strength.

Laboratory testing on the London Clay Formation gave undrained shear strength (c_u) values of 47kPa to 533kPa, increasing with depth. Plots of SPT 'N' values and undrained shear strength against depth are presented as Figure 4 and Figure 5 respectively. The moisture content and atterberg limits of the clay are summarised in Table 3.

Table 3. Summary of liquid limits and Atterberg limits

Strata	Moisture content (%)	Liquid limit (%)	Plastic limit (%)	Modified plasticity index, I' (%)
London Clay Formation	20 to 34	48 to 83	23 to 31	28 to 55

These indicate that the material at this site is a high to very high plasticity clay of medium to high volume change potential. *Additional testing is to be completed.*

[7] Tomlinson, M.J. (2001) *Foundations Design and Construction (7th Ed.)*. Pearson Prentice Hall

4.4 Groundwater

No groundwater strikes were noted in the cable percussion boreholes during drilling. However, perched groundwater was encountered from 1.0mbgl to 3.0mbgl in WS9, within the Weathered London Clay Formation.

Groundwater was noted in all boreholes during the subsequent monitoring visits. The groundwater levels noted during the visits are summarised in Table 4. Due to the nature of the site, some positions were not accessible during monitoring visits due to parked vehicles.

Table 4. Summary of groundwater monitoring undertaken to date

Borehole	Depth to groundwater (mOD) [Depth to base of well (mOD)]		
	05/11/14	19/11/14	01/12/14
BH2	NR	NR	18.56 [16.23
BH3	22.06 [21.06]	22.85 [21.10]	23.36 [21.11]
BH4	NR	NR	26.19 [18.39]
BH5	NR	NR	22.57 [19.80]
BH6	NR	NR	NR
BH7	NR	18.34 [18.29]	18.55 [18.27]
WS4	25.37 [24.99]	25.64 [24.99]	25.62 [24.99]
WS5	23.99 [23.47]	23.88 [23.55]	24.11 [23.47]
WS6	NR	26.44 [25.00]	26.41 [24.97]
WS7	NR	NR	25.79 [24.98]
WS8	NR	26.53 [24.93]	26.48 [24.93]
WS9	NR	24.59 [22.96]	24.54 [23.01]

4.5 Sulfate and pH conditions

To date, seventeen samples from across the site have been tested for pH and sulfate conditions. The results of the testing are summarised in Table 5. Testing on samples of Made Ground is ongoing and the results will be included once received.

Table 5. Summary of sulphate and pH conditions

Borehole	Depth (mbgl)	Strata	Water soluble sulfate (g/l)	Acid soluble sulfate (%)	Total sulfur (%)	Total potential sulfate (%)	pH
BH2	1.5	London Clay Formation	0.11	0.11	0.039	0.12	7.7
BH2	3.5	London Clay Formation	2.4	0.64	0.27	0.81	7.6
BH2	6	London Clay Formation	2.7	1.1	0.41	1.23	7.6
BH2	15	London Clay Formation	0.4	0.086	0.32	0.96	7.7
BH3	2.5	London Clay Formation	2.3	2.9	1.0	3.0	7.5
BH3	4.5	London Clay Formation	2.4	1.5	0.59	1.77	7.5
BH3	7.5	London Clay Formation	0.72	0.18	0.41	0.42	7.6
BH3	13.5	London Clay Formation	0.65	0.15	0.64	1.92	7.7
BH4	4.5	London Clay Formation	0.85	0.18	0.071	0.033	7.5
BH4	19.5	London Clay Formation	0.43	0.087	0.43	1.203	7.9
BH5	3.5	London Clay Formation	0.061	0.049	0.017	0.002	7.9
BH5	9	London Clay Formation	0.81	0.21	0.42	1.05	7.8
BH5	18	London Clay Formation	0.36	0.086	0.72	2.074	8.1
BH6	4.5	London Clay Formation	2.8	1.9	0.62	0.04	7.9
BH6	16.5	London Clay Formation	0.42	0.094	0.44	1.226	8.1
BH7	4.5	London Clay Formation	0.77	0.16	0.071	0.053	7.2
BH7	22.5	London Clay Formation	0.28	0.056	0.85	2.494	8.3

The implications of these results are discussed in further detail in Section 7.7.

5. CONTAMINATION ASSESSMENT

5.1 Risks to human health (long-term chronic risks)

Soil Guideline Values (SGVs) have not been issued by the Environment Agency for the "*Residential (without plant uptake)*" land-use category. The soil results have therefore been compared to *Generic Assessment Criteria* (GACs) that have been derived in-house by CGL using the *Contaminated Land Exposure Assessment (CLEA)* model[8] and version 1.06 of the CLEA software to assess the risk to human health from chemical contamination in the soils.

The GACs represent conservative screening criteria and have been calculated using the default parameters for the standard land use scenario set out in the CLEA technical report and toxicological inputs in line with the requirements of *Science Report SC050021/SR2*[9] and, in the case of petroleum hydrocarbons, Science *Report P5-080/TR3*[10]. In the case of selenium, mercury, arsenic, nickel and the BTEX compounds, SGVs have been issued by the Environment Agency for other land-use categories and the physical-chemical and toxicological inputs have been taken from the published SGV reports.

The GACs have been generated assuming a sandy loam soil type and a Soil Organic Matter of 1%, which are suitable assumptions for the site in question. More detailed information on the derivation of the CGL GACs can be provided upon request.

[8] Environment Agency. (January 2009). *Updated technical background to the CLEA model*. Science Report SC050021/SR3.
[9] Environment Agency. (January 2009). *Human health toxicological assessment of contaminants in soil*. Science Report SC050021/SR2.
[10] Environment Agency. (February 2005). *The UK Approach for Evaluating Human Health Risks from Petroleum Hydrocarbons in Soils*. Science Report P5-080/TR3.

The results of the assessment are set out below in Table 6 to Table 9. Assessment against the SGVs and GACs is carried out at the 95th percentile on the sample mean (designated US_{95}), which is considered to represent a reasonable worst-case scenario. Statistical assessment of the results has been completed in accordance with the recommendations set out in the recently published CL:AIRE guidance[11]. In this regard, an assessment of the normality of the data has been undertaken. Where datasets are normally distributed the *one sample t-test* has been applied to calculate the US_{95}. In the case of non-parametric datasets, the Chebychev Theorem has been applied. The Grubbs Test has also been used to identify potential outliers within datasets. Copies of the relevant statistical analysis are available on request.

In March 2014, the Department for Environment, Food and Regional Affairs (DEFRA) issued SP1010 Development of Category 4 Screening Levels (C4SLs) for assessment of land affected by contamination - Policy companion document[12], along with the results of the work by the C4SLs development team[13]. This includes a set of C4SL values for arsenic, benzene, benzo(a)pyrene, cadmium, chromium VI and lead for sandy loam soil with SOM =6%.

These values are primarily to support site assessment with respect to Part IIA of the Environmental Protection Act 1990, being indicative of low health risk and therefore of a site not determinable under Part2A. This is in comparison with the SGVs and GACs which represent minimal risk. The C4SLs are based on revised slightly less conservative exposure models and toxicology based on Low Level of Toxicological Concern (LLTC) rather than the Heath Criteria Values (HCV) on which the SGVs/GACs are based. The difference in risk level between HCV (minimal risk) and LLTC (low risk) is slight, and it is noted that both are still within the Category 4 level and below the Category 3/4 level boundary considered by DEFRA to be the likely de facto minimum standard chosen by developers. The C4SLs are still strongly conservative in accordance with the Contaminated Land Regulations and meet the objectives of the NPPF that:

[11] J. Lowe et al. (May 2008). *Guidance on comparing soil contamination data with a critical concentration*. CL:AIRE, CIEH & SAGTA.
[12] DEFRA (March 2014) *SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Document*
[13] CL:AIRE (March 2014) *SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination*

- *the site is suitable for its new use taking account of ground conditions and land instability, including from natural hazards or former activities such as mining, pollution arising from previous uses and any proposals for mitigation including land remediation or impacts on the natural environment arising from that remediation; and*

- *after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990.*

On this basis CGL considers it is appropriate to use C4SLs for the published contaminants. In the event impacts are identified on a site above the GAC/SGV level for these contaminants, CGL will utilise the C4SLs to assess whether these pose a low risk to developments and Public Open Space applications.

It is noted that the BGS has published background levels for a number of organic and inorganic constituents. In the event that the C4SL or a GAC is found to be exceeded, the risk may still be considered to be low, unlikely to meet the definition of contaminated land under Part IIA and potentially suitable for use from a development perspective, if the contaminant concentrations are below local background levels, assuming no other contributing factors.

It is noted that the SGV for lead has been withdrawn and that the C4SL for lead will be used in its place, based on latest toxicology research, or a CGL site specific GAC may be used, derived using the SGV exposure model and latest published toxicology.

Table 6. Summary of soil contamination (risks to human health) - Made Ground

Contaminant	SGV or GAC @ 1% SOM for Residential (without plant uptake) land-use (mg/kg)	Notes on soil saturation limits (SSL)[1]	Measured range (mg/kg)	US_{95} (mg/kg)	US_{95} > Assessment Criteria? (Y/N) #- outlier detected
SOM (%)	*[2]		<0.1 to 3.2	*	*
Arsenic	35[3]	-	**7.4 to 48.0**	**35.43**	**Y**
Cadmium	85[3]	-	<0.2 to 0.6	0.48	N
Chromium (total)	38	-	13.0 to 52.0	35.87	N
Lead	310[7]	-	**29.0 to 1,100.00**	**737.52**	**Y**
Mercury (inorganic)	240[3]	-	<0.3 to 8.5	4.76	N#
Selenium	600[3]	-	<1.0	1.0	N
Boron	*		<0.2 to 10.0	6.48	*
Copper	6,700	-	30.0 to 160.0	107.21	N
Nickel	130[3]	-	11.0 to 77.0	56.16	N
Zinc	20,000	-	43.0 to 430.0	258.01	N
Barium	*		53.0 to 370.0	244.09	*
Beryllium	26	-	0.3 to 4.7	3.22	N
Vanadium	210	-	28.0 to 200.0	135.12	#
Phenols[4]	310[3]	-	<1.0	1.0	N
Cyanide	*		<1.0	1.0	*
BTEX compounds					
Benzene	0.27[5]	-	<0.001	0.001	N
Toluene	610[5]	-	<0.001	0.001	N
Ethyl benzene	170[5]	-	<0.001	0.001	N
m-xylene[6]	55[5]	-	<0.001	0.001	N
o-xylene[6]	60[5]	-	<0.001	0.001	N
p-xylene[6]	53[5]	-	<0.001	0.001	N

Notes:

1. - = green; (a) = amber i.e. GAC set to model output, [SSL provided in square brackets] ; (b) = red i.e. SSL exceeded & considered to affect interpretation. GAC calculated in accordance with the CLEA Software Handbook ; (c) = based on direct contact; (d) GAC limited to SSL.
2. * = no value currently defined
3. Based on the published Soil Guideline Value (Environment Agency, 2009), adjusted for no plant uptake and 1% SOM
4. GAC relates to Phenol (C_6H_5OH) only.
5. Based on the published SGVs for BTEX at 6% SOM (Environment Agency, 2009), adjusted for 1% SOM without plant uptake
6. Concentrations for total xylenes should be compared to the value for m-xylene for fresh spills and to o-xylene for all other cases.
7. Published C4SL for lead (DEFRA, 2014)

Table 7. Summary of soil contamination (risks to human health) - Made Ground cont.

Contaminant	SGV or GAC @ 1% SOM for Residential (without plant uptake) land-use (mg/kg)	Notes on soil saturation limits (SSL)[1]	Measured range (mg/kg)	US_{95} (mg/kg)	US_{95} > Assessment Criteria? (Y/N) #- outlier detected
Total Petroleum Hydrocarbons (TPH)					
TPH aliphatic EC5-6	24	-	<0.1 to 0.4	0.26	N#
TPH aliphatic EC>6-8	49	-	<0.1 to 64.0	35.34	N#
TPH aliphatic EC>8-10	10	-	<0.1	0.1	N
TPH aliphatic EC>10-12	540	(b)	<1.0 to 20.0	11.18	N#
TPH aliphatic EC>12-16	1,500	(b)	<2.0 to 64.0	35.34	N#
TPH aliphatic EC>16-35	89,000	(b)	<16.0 to 42.0	39.0	N
TPH aromatic EC5-7	0.27	-	<0.1	0.1	N
TPH aromatic EC>7-8	610	-	<0.1	0.1	N
TPH aromatic EC>8-10	17	-	<0.1	0.1	N
TPH aromatic EC>10-12	88	-	<1.0 to 2.9	2.24	N#
TPH aromatic EC>12-16	1,500	(b)	<2.0 to 51.0	33.27	N
TPH aromatic EC>16-21	1,300	(b)	<10.0 to 490.0	297.29	N#
TPH aromatic EC>21-35	1,300 [4.8]	(a)	<10.0 to 650.0	379.91	N#
Polycyclic Aromatic Hydrocarbons (PAH)					
Acenaphthene	4,500	(b)	<0.1 to 8.4	4.89	N#
Anthracene	24,000	(b)	<0.1 to 30.0	18.83	N
Benzo(a)anthracene	7.7 [1.7]	(a)	**<0.1 to 78.0**	**46.25**	**Y**
Benzo(a)pyrene	2.3 [0.9]	(a)	**<0.1 to 64.0**	**38.47**	**Y**
Benzo(b)fluoranthene	22 [1.2]	(a)	**<0.1 to 73.0**	**46.25**	**Y**
Benzo(g,h,i)perylene	240 [0.02]	(a)	<0.05 to 29.0	18.28	N
Benzo(k)fluoranthene	23 [0.7]	(a)	<0.1 to 31.0	18.99	N
Chrysene	170 [0.4]	(a)	<0.05 to 54.0	33.45	N
Dibenzo(a,h)anthracene	2.1 [0.004]	(a)	**<0.1 to 5.5**	**3.62**	**Y**
Fluoranthene	3,100 [19]	(a)	<0.1 to 160.0	97.99	N
Fluorene	3,100	(b)	<0.1 to 11.0	7.41	N
Indeno(1,2,3-cd)pyrene	21 [0.06]	(a)	<0.1 to 28.0	17.76	N
Naphthalene	1.6	-	<0.05 to 1.6	0.9	N#
Pyrene	2,300 [2.2]	(a)	<0.1 to 1300	79.68	N

Notes:

1. - = green; (a) = amber i.e. GAC set to model output, [SSL provided in square brackets] ; (b) = red i.e. SSL exceeded & considered to affect interpretation. GAC calculated in accordance with the CLEA Software Handbook ; (c) = based on direct contact; (d) GAC limited to SSL.

Table 8. Summary of soil contamination (risks to human health) - natural soil

Contaminant	SGV or GAC @ 1% SOM for Residential (without plant uptake) land-use (mg/kg)	Notes on soil saturation limits (SSL)[1]	Measured range (mg/kg)	Measured range > Assessment Criteria? (Y/N)
SOM (%)	*[2]		<0.1 to 0.2	*
Arsenic	35[3]	-	13.0 to 14.0	N
Cadmium	85[3]	-	<0.2 to 0.6	N
Chromium (total)	38	-	**37.0 to 47.0**	**Y[8]**
Chromium (III)	1,100	-	37.0 to 47.0	N
Chromium (VI)	4.2	-	<1.2	N
Lead	310[7]	-	14.0 to 20.0	N
Mercury (inorganic)	240[3]	-	<0.3	N
Selenium	600[3]	-	<1.0	N
Boron	*		0.5 to 4.4	*
Copper	6,700	-	22.0 to 31.0	N
Nickel	130[3]	-	30.0 to 45.0	N
Zinc	20,000	-	59.0 to 87.0	N
Barium	*		35.0 to 130.0	*
Beryllium	26	-	1.4 to 1.7	N
Vanadium	210	-	69.0 to 87.0	N
Phenols[4]	310[3]	-	<1.0	N
Cyanide	*		<1.0	*
BTEX compounds				
Benzene	0.27[5]	-	<0.001	N
Toluene	610[5]	-	<0.001	N
Ethyl benzene	170[5]	-	<0.001	N
m-xylene[6]	55[5]	-	<0.001	N
o-xylene[6]	60[5]	-	<0.001	N
p-xylene[6]	53[5]	-	<0.001	N

Notes:

1. - = green; (a) = amber i.e. GAC set to model output, [SSL provided in square brackets] ; (b) = red i.e. SSL exceeded & considered to affect interpretation. GAC calculated in accordance with the CLEA Software Handbook ; (c) = based on direct contact; (d) GAC limited to SSL.
2. * = no value currently defined
3. Based on the published Soil Guideline Value (Environment Agency, 2009), adjusted for no plant uptake and 1% SOM
4. GAC relates to Phenol (C_6H_5OH) only.
5. Based on the published SGVs for BTEX at 6% SOM (Environment Agency, 2009), adjusted for 1% SOM without plant uptake
6. Concentrations for total xylenes should be compared to the value for m-xylene for fresh spills and to o-xylene for all other cases.
7. Published C4SL for lead (DEFRA, 2014)
8. Exceedance is for Total Chromium. Further analysis indicates that the exceedance is due to Chromium III and the concentration of the more toxic Chromium VI is below the assessment criteria.

Table 9. Summary of soil contamination (risks to human health) - natural soil cont.

Contaminant	SGV or GAC @ 1% SOM for Residential (without plant uptake) land-use (mg/kg)	Notes on soil saturation limits (SSL)[1]	Measured range (mg/kg)	Measured range > Assessment Criteria? (Y/N)
Total Petroleum Hydrocarbons (TPH)				
TPH aliphatic EC5-6	24	-	<0.1	N
TPH aliphatic EC>6-8	49	-	<0.1	N
TPH aliphatic EC>8-10	10	-	<0.1	N
TPH aliphatic EC>10-12	540	(b)	<1.0	N
TPH aliphatic EC>12-16	1,500	(b)	<2.0	N
TPH aliphatic EC>16-35	89,000	(b)	<16	N
TPH aromatic EC5-7	0.27	-	<0.1	N
TPH aromatic EC>7-8	610	-	<0.1	N
TPH aromatic EC>8-10	17	-	<0.1	N
TPH aromatic EC>10-12	88	-	<1.0	N
TPH aromatic EC>12-16	1,500	(b)	<2.0	N
TPH aromatic EC>16-21	1,300	(b)	<10.0	N
TPH aromatic EC>21-35	1,300 [4.8]	(a)	<10.0 to 20.0	N
Polycyclic Aromatic Hydrocarbons (PAH)				
Acenaphthene	4,500	(b)	<0.1 to 0.18	N
Anthracene	24,000	(b)	<0.1 to 0.17	N
Benzo(a)anthracene	7.7 [1.7]	(a)	<0.1 to 0.33	N
Benzo(a)pyrene	2.3 [0.9]	(a)	<0.1 to 0.3	N
Benzo(b)fluoranthene	22 [1.2]	(a)	<0.1 to 0.3	N
Benzo(g,h,i)perylene	240 [0.02]	(a)	<0.05	N
Benzo(k)fluoranthene	23 [0.7]	(a)	<0.1 to 0.21	N
Chrysene	170 [0.4]	(a)	<0.05 to 0.36	N
Dibenzo(a,h)anthracene	2.1 [0.004]	(a)	<0.1	N
Fluoranthene	3,100 [19]	(a)	<0.1 to 0.87	N
Fluorene	3,100	(b)	<0.1 to 0.2	N
Indeno(1,2,3-cd)pyrene	21 [0.06]	(a)	<0.1	N
Naphthalene	1.6	-	<0.05 to 0.45	N
Pyrene	2,300 [2.2]	(a)	<0.1 to 0.69	N

Notes:

2. - = green; (a) = amber i.e. GAC set to model output, [SSL provided in square brackets] ; (b) = red i.e. SSL exceeded & considered to affect interpretation. GAC calculated in accordance with the CLEA Software Handbook ; (c) = based on direct contact; (d) GAC limited to SSL.

The contaminant concentrations in the natural soils were below the acceptable limit for all contaminants tested. Although the testing indicated that concentrations of total chromium recorded in the London Clay were above the assessment criteria (which is based chromium VI), further testing of these samples indicates that the concentrations of total chromium were both due to chromium III, with the recorded concentrations of the more toxic chromium VI being below the laboratory limit of detection and assessment criterion. Therefore the concentrations of chromium recorded are not considered to present an unacceptable risk to human health.

A number of contaminants within the Made Ground samples were found to exceed the acceptability criteria. The exceedances are summarised in Table 10.

Table 10. Summary of contaminant exceedances (Made Ground)

Borehole	**Depth (mbgl)**	**Contaminants which exceed acceptable limit**	**Contaminant concentration (mg/kg)**	**Acceptable limit for the *Residential (without plant uptake)* land use (mg/kg)**
BH2	0.2	Lead	570	310
BH7	0.5	Arsenic	48	35
BH6	0.3	Lead	340	310
		Benzo(a)anthracene	78	7.7
		Benzo(b)fluoranthene	73	22.0
		Benzo(a)pyrene	64	2.3
		Dibenzo(a,h)anthracene	5.5	2.1
WS5	0.2	Lead	1,100.0	310
		Benzo(a)pyrene	5.8	2.3
WS6	0.7	Benzo(a)pyrene	3.7	2.3
WS9	0.3	Benzo(a)anthracene	29	7.7
		Benzo(b)fluoranthene	28	22.0
		Benzo(a)pyrene	26	2.3
		Dibenzo(a,h)anthracene	3.4	2.1

In addition, an asbestos screen was undertaken on ten samples of Made Ground. Loose fibres of chrysotile asbestos were detected in one sample (BH6 at 0.3mbgl).

5.2 Risks to plant growth

As indicated in Section 5.1, concentrations of phytotoxic chemicals are below the human health assessment criteria prescribed by the Sludge Regulations. The risks to plant growth are therefore considered to be low.

5.3 Ground gas assessment

Three rounds of ground gas monitoring have been completed to date on 5th and 19th November and 1st December 2014, during atmospheric pressures in the range of 999mb to 1019mb. The local pressure system was noted to be rising during both visits. The monitoring records are presented in Appendix C and are summarised below:

- Maximum carbon dioxide concentration: 4.7 % v/v;
- Maximum methane concentration: <0.1 % v/v;
- Maximum flow rate: 1.3 l/hr;
- Minimum oxygen concentration: 7.7 % v/v.

Based on these findings, and with reference to CIRIA guidance[14], a gas screening value (GSV) of 0.0611l/hr has been calculated for the site, corresponding to a Characteristic Situation 1 (NHBC 'Green') site.

Higher values of carbon dioxide (5.3% and 5.4%) and flow rate (2.2l/hr) were encountered in boreholes WS6 and BH3, respectively. These values were not sustained and are considered to be anomalous. Additional monitoring visits are to be undertaken and the results will be used to confirm the gas regime at the site.

[14] CIRIA (2007) *Assessing the risks posed by hazardous ground gases to buildings*

6. REFINED RISK ASSESSMENT

6.1 Introduction

In accordance with Contaminated Land Report (CLR) 11[16], the conceptual site model has been updated based on the information gathered during the intrusive investigation and the potential pollutant linkages have been evaluated through a semi-quantitative risk assessment. The risks ratings identified have been assigned in accordance with the DEFRA and Contaminated Land Report (CLR) 6[17], site prioritisation and categorisation rating system which is summarised in Table 11.

Table 11. Risk Rating Terminology

Risk Rating	Description
High Risk	Contaminants very likely to represent an unacceptable risk to identified targets Site probably not suitable for proposed use Enforcement action possible, Urgent action required
Medium Risk	Contaminants likely to represent an unacceptable risk to identified targets Site probably not suitable for proposed use Action required in the medium term
Low Risk	Contaminants may be present but unlikely to create unacceptable risk to identified targets Site probably suitable for proposed use Action unlikely to be needed whilst site remains in current use
Negligible Risk	If contamination sources are present they are considered to be minor in nature and extent Site suitable for proposed use No further action required

Based on the terminology within this table, a refined assessment of the risks posed by the potential pollutant linkages at the site is outlined in Table 12. A diagrammatic representation of the conceptual site model is provided in Figure 6.

[16] The Environment Agency. (2004). *Model Procedures for the Management of Land* Contamination. CLR 11.
[17] M.J. Carter Associates. (1995*). Prioritisation and Categorisation Procedure for Sites which may be Contaminated*. Department of the Environment. CLR 6

Table 12. Semi-quantitative risk assessment

Source/Medium	Receptor	Potential Exposure Route	Risk Rating
Organic/inorganic contaminants within Made Ground	Construction workers	Direct ingestion of soil & dust, inhalation of particulates & vapours and dermal contact	Medium *(due to concentrations of lead and benzo(a)pyrene recorded in Made Ground)*
	Future site occupiers	Direct ingestion of soil & dust, inhalation of particulates & vapours, indirect ingestion by means of vegetable uptake and dermal contact	Medium *(where soil is exposed due to concentrations of lead and benzo(a) pyrene recorded in Made Ground)*
	Vegetation and plants	Root uptake	Low
	Buildings & structures	Direct contact and migration & accumulation within building spaces. Damage to water supply pipes.	Low *(assumes appropriate concrete design and agreement of water pipe materials)*
	Groundwater or surface water	Leaching and vertical migration of contaminants	Low
Explosive / asphyxiating gases from Made Ground on site, if present.	Internal building spaces & future occupiers	Migration of gases through the surface and via permeable soils	Negligible *(based on the results of the three rounds of monitoring)*
Asbestos in existing building fabric.	Construction workers	Direct ingestion of dust and inhalation of particulates	Medium

6.1.1 Risks to human health

The risk to future site occupiers is considered to be medium, given the elevated contaminant concentrations encountered in the Made Ground on site and the limited areas of communal landscaping proposed in the development. No private gardens are proposed.

The risk to construction workers from the Made Ground and possible asbestos containing material within the fabric of the existing buildings is considered to be medium. It is considered that the potential risks can be controlled through site working practices, including PPE.

6.1.2 Risks to controlled waters

The site is not situated above an aquifer and therefore the risk to groundwater is considered to be negligible. The nearest surface water receptor (*Regent's Canal*) is some 3m south of the site and consists of a clay-lined man-made canal. Given the generally low concentrations of contaminants and cohesive nature of the underlying London Clay Formation, the risk to controlled waters is considered to be low.

6.1.3 Risks to buildings and structures

Due to the generally limited nature of the Made Ground and low concentrations of contaminants recorded, the risk to buildings and structures is considered to be low. The design of buried concrete should take into consideration the pyritic nature of the London Clay Formation and the resultant risk of sulfate attack on the concrete.

6.1.4 Risks to vegetation and plants

No exceedances of phytotoxic chemicals were noted at the site and only limited soft landscaping is proposed. Therefore, the risk to vegetation and plants is considered to be low.

7. GEOTECHNICAL RECOMMENDATIONS

7.1 General

The following sections provide recommendations for the proposed development with regard to geotechnical aspects, based on the information obtained during the intrusive investigation and the laboratory results.

7.2 Geotechnical design parameters

Geotechnical design parameters are recommended based on the available information from the intrusive investigation and published information. These are summarised in Table 13. The values are unfactored (Serviceability Limit State) parameters and are considered to be characteristic values for the local soils.

Table 13. Geotechnical parameters

Stratum	γ (kN/m^3)	ϕ' (°)	Cu (kPa) [c']	Eu (MPa) [E']
Made Ground	18	30[a]	30 [0]	18[b] [13.5[c]]
London Clay Formation	20	24[d]	50+6z[e] [5]	30+3.6z [22.5+2.7z]

a. Burland et. al (Eds) (2001) Building response to tunnelling, CIRIA Special Publication 200, CIRIA
b. Based on 600c_u
c. Based on 0.75Eu
d. BS 8002:1994 Code of practice for Earth retaining structures, British Standards institution.
e. z = depth below surface of London Clay

7.3 Foundations

It is understood that a piled foundation solution is the preferred option for the proposed development of the site.

Where basements are proposed at the site, the piles will be driven from basement level. Where no basements are proposed, the piles will be installed from ground level.

Indicative pile working loads (kN) are shown below in Sections to for Buildings C, D, X and W, based on pile diameters of 0.45m to 1.5m and pile lengths of 10m to 25m. An overall design factor of safety of 2.6 and adhesion factor of 0.5 have been assumed. These factors may be modified based on the design approach adopted, the piling methodology, the further ground investigation and on the results of pre-construction pile testing.

These calculations are based on the geotechnical design parameters presented in Table 13.

7.3.1 Building C

The proposed development at Building C includes a basement to some 15mbgl and piles will therefore be installed from basement formation level (11.7mOD). Indicative working loads (kN) for this Block are shown in Table 14 and are presented graphically in Figure 7.

Table 14. Indicative pile working loads (kN) – piled from basement level at Building C (11.7mOD)

Pile Length (m)	Pile diameter (m)					
	0.45	0.6	0.75	0.9	1.2	1.5
10	510	730	970	1,230	1,820	2,510
15	800	1,100	1,480	1,860	2,690	3,640
20	1,150	1,590	2,070	2,570	3,680	4,910
25	1,530	2,110	2,720	3,370	4,780	6,320

7.3.2 Blocks A and D

The proposed development at Blocks A and D include a basement to some 5mbgl and piles will therefore be installed from basement formation level (21.7mOD). Indicative working loads (kN) for this Block are shown in Table 15 and are presented graphically in Figure 8.

Table 15. Indicative pile working loads (kN) – piled from basement level at Blocks A and D (21.7mOD)

Pile Length (m)	Pile diameter (m)					
	0.45	0.6	0.75	0.9	1.2	1.5
10	530	750	990	1,250	1,850	2,530
15	800	1,110	1,450	1,820	2,620	3,522
20	1,100	1,520	1,970	2,440	3,470	4,610
25	1,430	1,960	2,530	3,130	4,410	5,810

7.3.3 Buildings X and W

No basements are proposed for Buildings X and W and piles will therefore be installed from ground level, taken as 26.7mOD. Indicative working loads (kN) for this Block are shown in Table 16 and are presented graphically in Figure 9.

Table 16. Indicative pile working loads (kN) – piled from ground level at Buildings X and W (26.7mOD)

Pile Length (m)	Pile diameter (m)					
	0.45	0.6	0.75	0.9	1.2	1.5
10	240	350	460	600	900	1,250
15	420	590	780	990	1,450	1,980
20	640	900	1,170	1,470	2,130	2,860
25	910	1,260	1,640	2,040	2,910	3,880

7.4 Excavations and retaining structures

7.4.1 Building C

A 15m deep basement is proposed at Building C and it is proposed to adopt contiguous piled walls as the support system. In order to control ground movements, a 'top-down' construction sequence is recommended. Preliminary retaining wall analysis has been undertaken by CGL and is presented in a separate report[18].

Additionally, a Basement Impact Assessment (BIA) will be undertaken by CGL in accordance with Camden Council's guidance for basement construction to assess the impact of the basement on adjacent roads, buildings and infrastructure.

7.4.2 Blocks A and D

Blocks A and D are to include single storey basements to a maximum depth of 5mbgl. A 'bottom-up' construction methodology is recommended, utilising temporary berms and/or propping during installation of the contiguous piled wall.

A BIA is to be undertaken by CGL for these blocks to assess the impact on adjacent roads, buildings, the canal and infrastructure.

[18] CGL (2014) *Camden Lock – Preliminary Piled Wall Analysis*. Ref: CG/18067A. December 2014

7.4.3 Buildings X and W

No basements are proposed for Buildings X and W and the piled foundations are to be installed from surface.

It is anticipated that shallow excavations within the Made Ground and London Clay Formation will remain stable over the short term if dry. Where water is encountered in excavations, such as perched water within Made Ground or surface run-off, temporary sidewall support and dewatering (sump pumping) may be required to maintain excavation stability.

No operatives should enter unshored or otherwise protected excavations identified as unstable by a competent person, however shallow they are, in accordance with the guidelines presented in CIRIA Report 97[19].

7.5 Floor slabs and pavement design

The underlying London Clay Formation has been found to have a high volume change potential. Floor and basement slabs should therefore be designed as suspended in order to prevent damage due to heave movements.

Recommendations for the design of the basement slabs in relation to the design groundwater level and calculation of the potential heave movements will be included within the Basement Impact Assessments for Blocks A, C and D. These assessments will also include recommendations for heave protection for the basement slabs.

Based on the geotechnical testing undertaken at the site, a design CBR of 2.5% is recommended for pavement design.

7.6 Drainage

Soakaway drainage is not considered suitable for the site, given the cohesive nature of the underlying ground.

[19] CIRIA (1992). *Trenching Practice (Second Edition).* Construction Industry Research and Information Association Report 97.

7.7 Buried concrete

The availability of total potential sulfate (TPS) in pyritic soils is dependent on the extent to which the soils are disturbed, and the level to which the soils may oxidise, resulting in sulfate ions that may reach the concrete. In this regard, BRE SD1 guidance states that *"Concrete in pyritic ground which is initially low in soluble sulfate does not have to be designed to withstand a high potential sulfate class unless it is exposed to ground which has been disturbed to the extent that contained pyrite might oxidise and the resultant sulfate ions reach the concrete. This may prompt redesign of the structure or change to the construction process to avoid ground disturbance; for example, by using precast or cast-in-situ piles instead of constructing a spread footing within an excavation"*.

On this basis, the appropriate DS and ACEC class for the pyritic soils, i.e. based on water soluble sulfate (WSS) or total potential sulfate (TPS), should be adopted dependant on the extent to which the soils will be disturbed during construction.

Where open excavations will be required into the London Clay (i.e. during basement excavations), the soils may be disturbed to the extent that contained pyrite might oxidise and allow the resultant sulfate ions to reach the concrete, and as such the TPS DS and ACEC classes should be adopted. However, where cast-in-situ piles are adopted, as Blocks A, C and D of this site, the WSS DS and ACEC classes may be adopted.

The results of pH and sulfate testing undertaken at this site indicate that buried concrete within the London Clay Formation should be designed to Design Class DS-4 and ACEC Class AC-3s if disturbed (based on TPS) and Design Class DS-3 and ACEC Class 2s if undisturbed (based on WSS).

It is anticipated that the basement slabs will not be able to oxidise as they will not be in direct contact with the underlying ground due to the layer of heave protection which is to be installed.

8. GEOENVIRONMENTAL RECOMMENDATIONS

8.1 Contamination and remediation

Due to the contaminant exceedances noted in the Made Ground across the site, it is recommended that a capping layer is installed to prevent the migration of contaminants. For communal landscaped areas, the capping layer may comprise hardstanding or a minimum of 150mm topsoil over 300mm subsoil and a geotextile membrane. Alternatively, the Made Ground across the site may be removed and disposed of off-site at an appropriate facility.

Based on the results of the three ground gas monitoring visits undertaken to date, the site conforms to Characteristic Situation 1 and no ground gas protection measures are therefore required in the development.

8.2 Material management

A preliminary assessment of the results of analysis of Made Ground for waste classification purposes indicates that the majority of this material may be classified as 'not hazardous' with respect to waste disposal.

However, samples at 0.7mbgl from WS6 and 0.3mbgl from BH6 were found to be 'hazardous' with respect to waste disposal due to elevated pH and PAHs. In addition, the sample from 0.3mbgl at BH6 was found to contain loose fibres of chrysotile asbestos.

Waste acceptance criteria (WAC) testing demonstrates that the 'not hazardous' samples may be disposed of in an inert landfill and that the 'hazardous' samples may be disposed of as 'stable non-reactive waste in non-hazardous landfill'.

If asbestos-containing material, such as cement-bound asbestos, is visibly noted within the soil matrix, the material will be classified as *hazardous.* Hand picking of the asbestos containing material should be undertaken to reduce the volume of hazardous waste and potentially allow the residual soils to be disposed of to a non-hazardous facility, subject to the volume of fibres (categorised as *not hazardous* only if asbestos fugitive fibres comprise less than 0.1% of soil by weight). If asbestos-containing material is noted, the Environment Agency should be notified. Removal of impacted material should only be undertaken by trained operatives with appropriate PPE, including respirators and dust suppression and the material removed from site should be double bagged.

Uncontaminated natural soils, as encountered at the site, can be disposed of at an inert landfill as listed inert waste.

It should be noted that in May/June 2012 HMR&C issued Briefs 15/12 and 18/12 clarifying how construction spoil and excess soils will be assessed for landfill tax purposes. Detailed accurate descriptions of waste are required for all wastes to support the landfill tax assessment. Uncontaminated naturally occurring soils will remain inert by default and eligible for the lower rate of landfill tax. Similarly 'reworked soils' and demolition 'stone' comprising ONLY materials listed in the Schedule of the Landfill Tax (Qualifying Material) Order 2011 (SI 2011/1017) will also be eligible for the lower rate of landfill tax. However, Made Ground containing soil and foreign objects such as timber, plastic, rubber, metal, paper, plasterboard, asbestos, etc., regardless of the results of chemical analysis for waste classification purposes, will be eligible for the standard (higher) rate of landfill tax. Therefore, to maximise eligibility for lower rate landfill tax on waste construction spoil/ reworked ground, careful waste segregation and controls are necessary.

All material intended for offsite disposal should be transported and disposed in accordance with the Environmental Protection (Duty of Care) Regulations, 1991 and the Landfill (England and Wales) Regulations, 2002 (as amended). Waste legislation stipulates that hazardous and not hazardous waste should be pre-treated prior to disposal. Pre-treatment can be undertaken either at the site of origin or may be carried out at a licensed off-site facility and can include selective segregation of soils conducted on site.

8.3 Buried services

Based on the measured concentrations of contaminants within the Made Ground, it is anticipated that PE or PVC pipes will be suitable for use at the site. However, it is recommended that the water supply company is contacted to confirm this recommendation is acceptable to them.

8.4 Discovery Strategy

The investigation was limited by the presence of buildings across the majority of the site. A watching brief should therefore be undertaken by the Contractor during earthworks and construction works. Should areas of unexpected contamination be encountered or suspected, a qualified geoenvironmental engineer should be informed and the risk associated with the contamination assessed. Where necessary, an appropriate remediation strategy will be devised and implemented. The regulators will be informed of any additional areas of contamination so identified and will be provided with the risk

assessment and proposed remediation methodology for agreement before undertaking such works. Appropriate verification works to be completed if remedial measures are required will also be identified and agreed.

The following nominal discovery strategy is recommended:

1. Work to cease in that area.

2. Notify geoenvironmental engineer, to attend site and sample material. Notify Environmental Health Officer at Camden Council.

3. Geoenvironmental engineer to supervise the excavation of contaminated material, which should be placed in a bunded area and covered to prevent rainwater infiltration.

4. Soil samples should be obtained by the geoenvironmental engineer from both the excavated material and the soils in the sides and base of the excavation to demonstrate that the full area of contamination has been excavated. If appropriate, in-situ testing should be undertaken on the sides and base of the excavation to assess the presence of residual contamination in the soils.

5. On receipt of chemical test results, the soils may be appropriately classified for treatment or disposal, and dealt with accordingly.

6. Detailed records, including photographs and duty of care records, of the excavations, stockpile sizes, source and location should be kept and regularly updated to allow materials to be easily tracked from excavation until disposal off site.

7. Backfilling to be undertaken with material certificated as suitable for the proposed end land use.

8.5 Health and safety

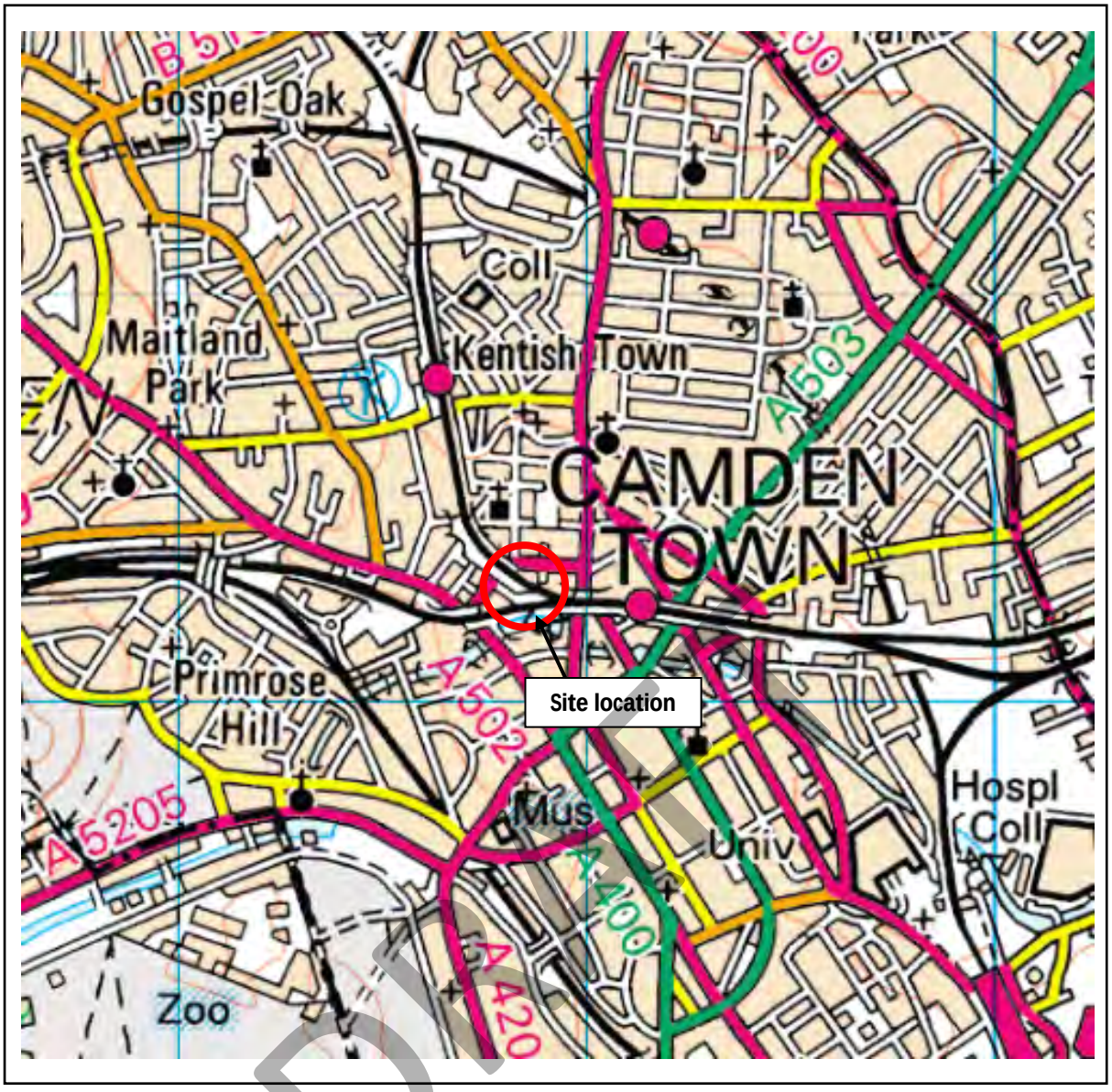
Precautions should be taken to minimise exposure of workers and the general public to any potentially harmful substances during earthworks.

The risks to construction workers can be controlled through the implementation of site safety procedures and the use of suitable personal protective equipment (PPE). Attention should also be paid to restricting possible off-site nuisance such as dust and odour emissions. All work should be carried out in accordance with the Contractor's Construction Health and Safety Plan.

Precautions will include but not be limited to:

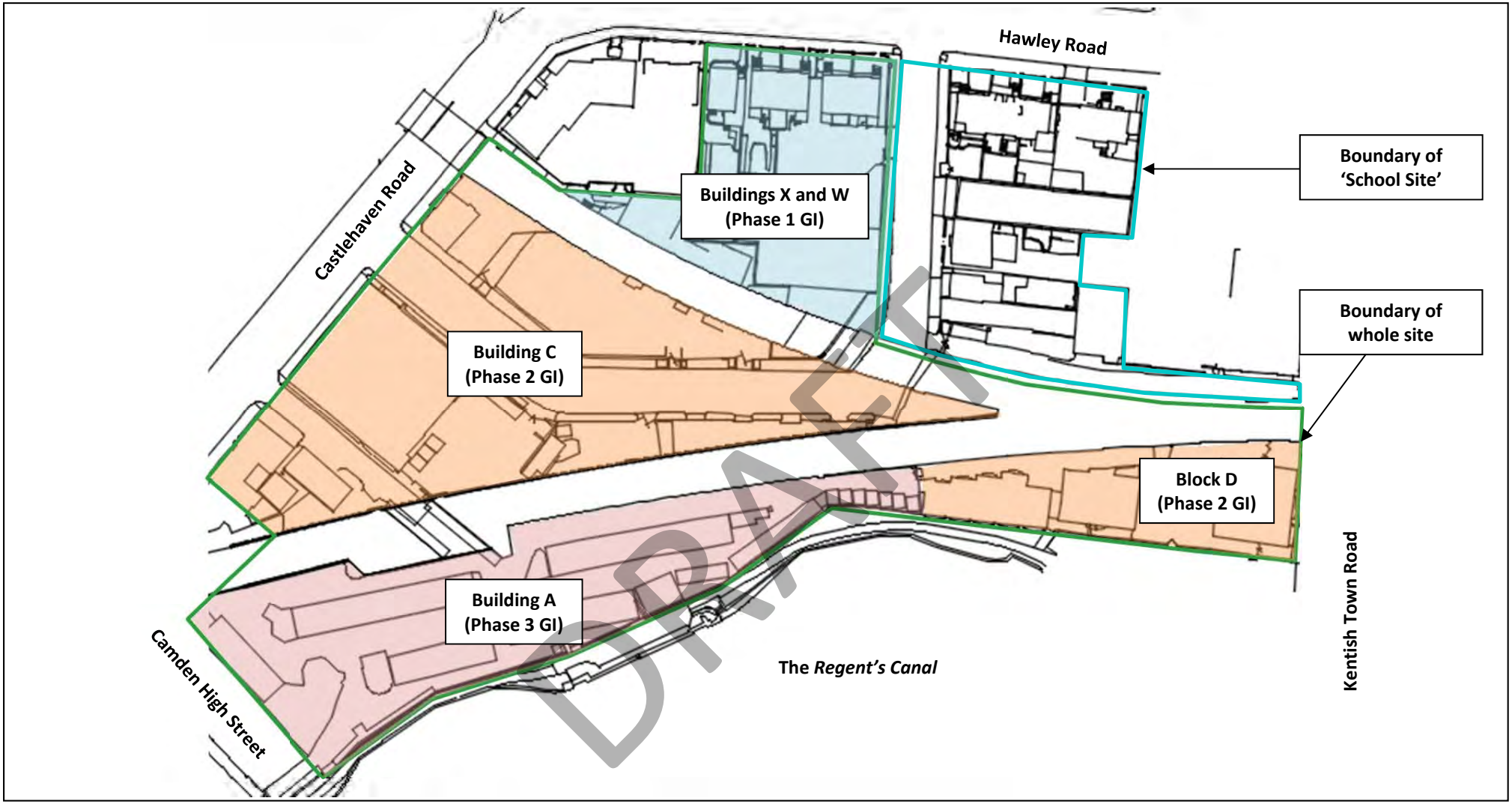
- Personal hygiene, washing and changing procedures.
- Adequate personal protective equipment.
- Dust and vapour suppression methods, including damping down, minimising the working face exposed and covering stockpiles, where required.
- Regular cleaning of all site roads, access roads and the public highway.
- Safe storage of fuel and other potentially polluting liquids and the provision of spill control and clean up facilities.
- Positive collection and disposal of on-site run-off.

FIGURES

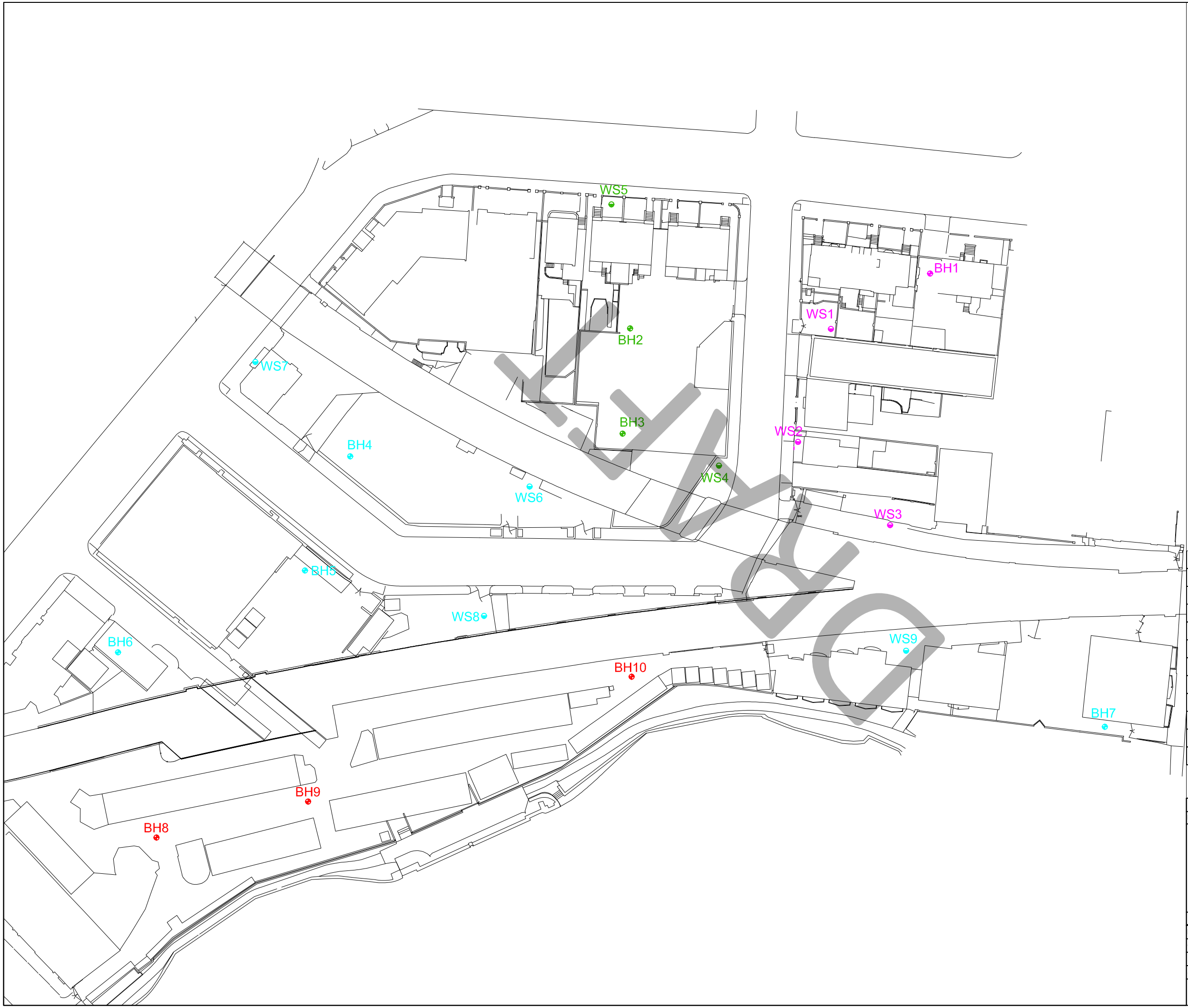


N

Client	Project	Job No
Walsh Group	**Camden Lock Village, London**	**CG/18067A**
CGL	Title: **Site location plan**	**Figure 1**



Client	Project	Job No
Walsh Group	**Camden Lock Village, London**	**CG/18067B**
CGL	Title **Site layout plan**	**Figure 2**

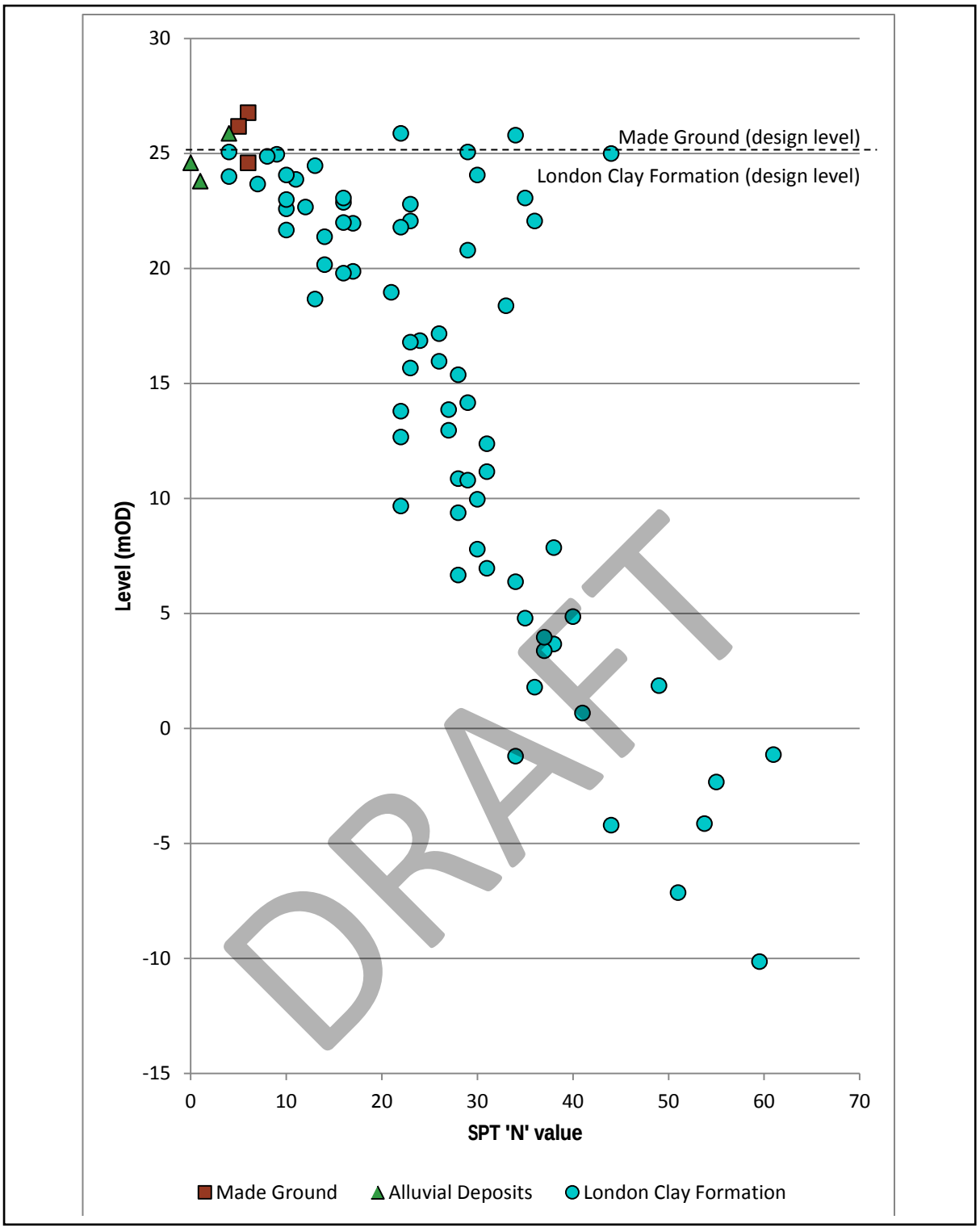


Borehole ID	SI Phase	Maximum depth (m)
BH1	1	15
WS1 - WS3	1	5
BH2	1	30
BH3	1	15
WS4 - WS5	1	5
BH4 & BH6	2	25
BH5	2	40
BH7	2	30
WS6 - WS9	2	5
BH8 & BH10	3	25
BH9	3	30

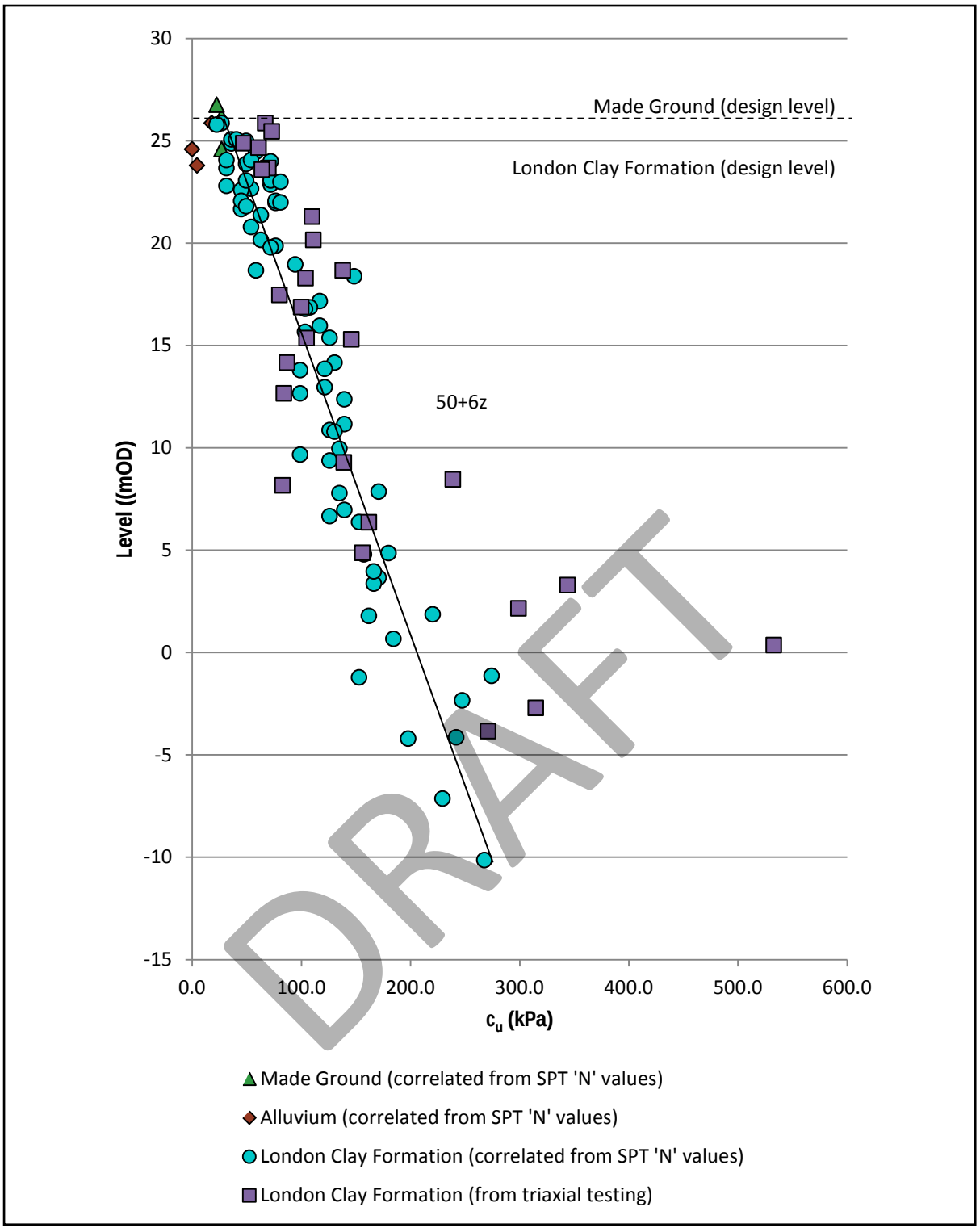
Rev.		Date:	
B	Proposed location of BH1 moved	15/10/14	

Card Geotechnics Ltd.
4 Godalming Business Centre
Woolsack Way
Godalming
Surrey
GU7 1XW
T: 01483 310600

		Date:	Project: Camden Lock Village, London	Scale:
Dwn.	JLA	7/10/14	Client: Walsh Associates	NTS
Ckd.	DRAFT	DRAFT		
Appr.	DRAFT	DRAFT	Title: Proposed exploratory hole location plan	
Job No.:	CG/18067	Drw.no.: CG/18067-001	Rev.:	C



Client	Project	Job No
Walsh Group	**Camden Lock Village, London**	**CG/18067A**
CGL	Title **Plot of SPT 'N' values against level**	**Figure 4**



Client	Project	Job No
Walsh Group	**Camden Lock Village, London**	**CG/18067A**
CGL	Title: **Plot of c_u against level**	**Figure 5**

Source

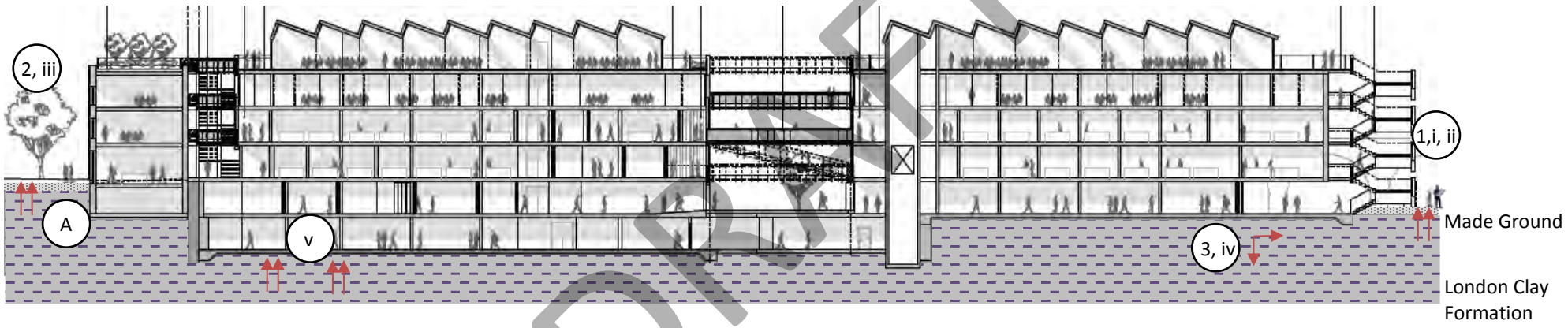
A. Contamination within Made Ground, including explosive gases or asbestos from building fabric.

Pathway

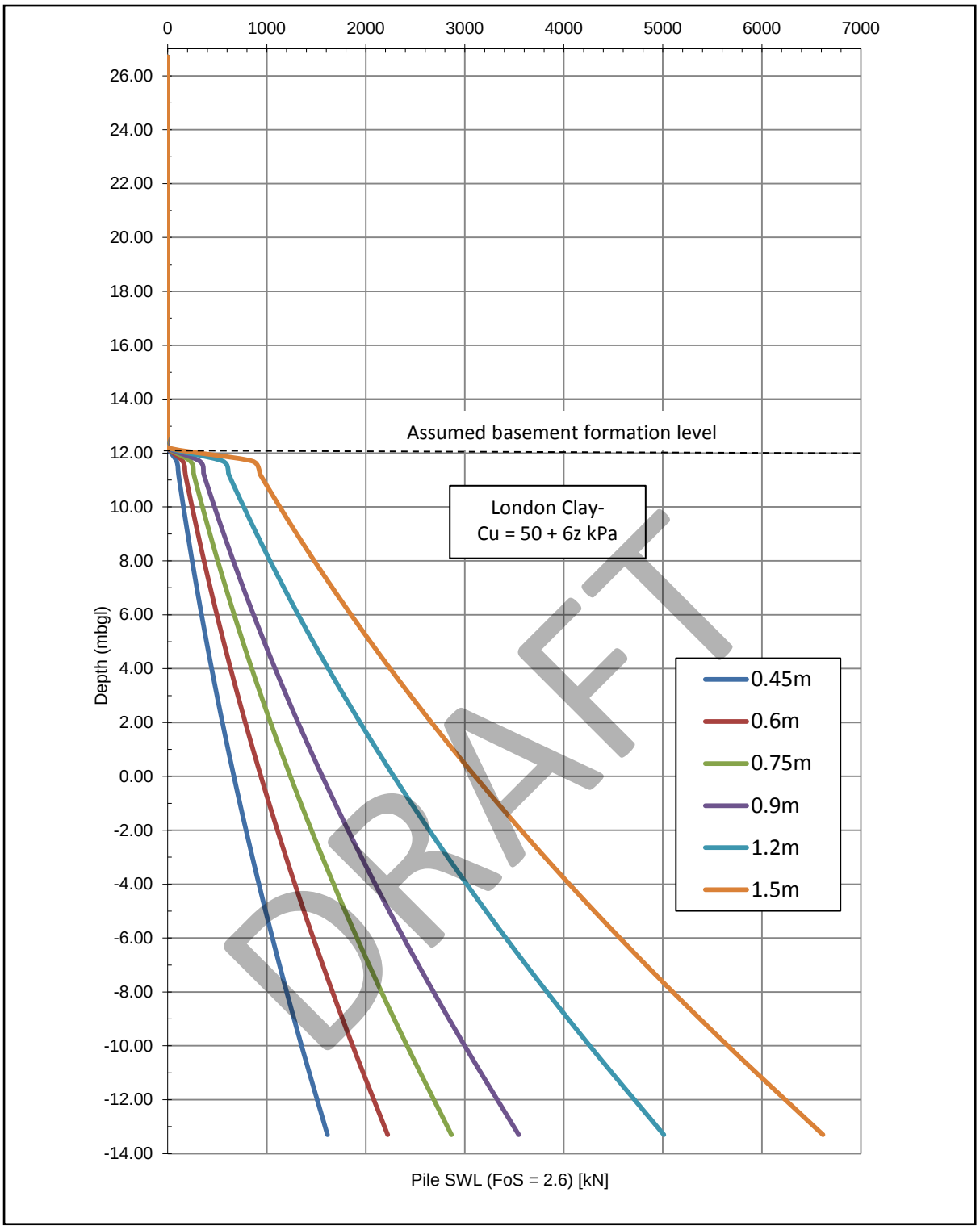
1. Ingestion, inhalation and direct contact
2. Root uptake
3. Vertical and lateral migration

Receptor

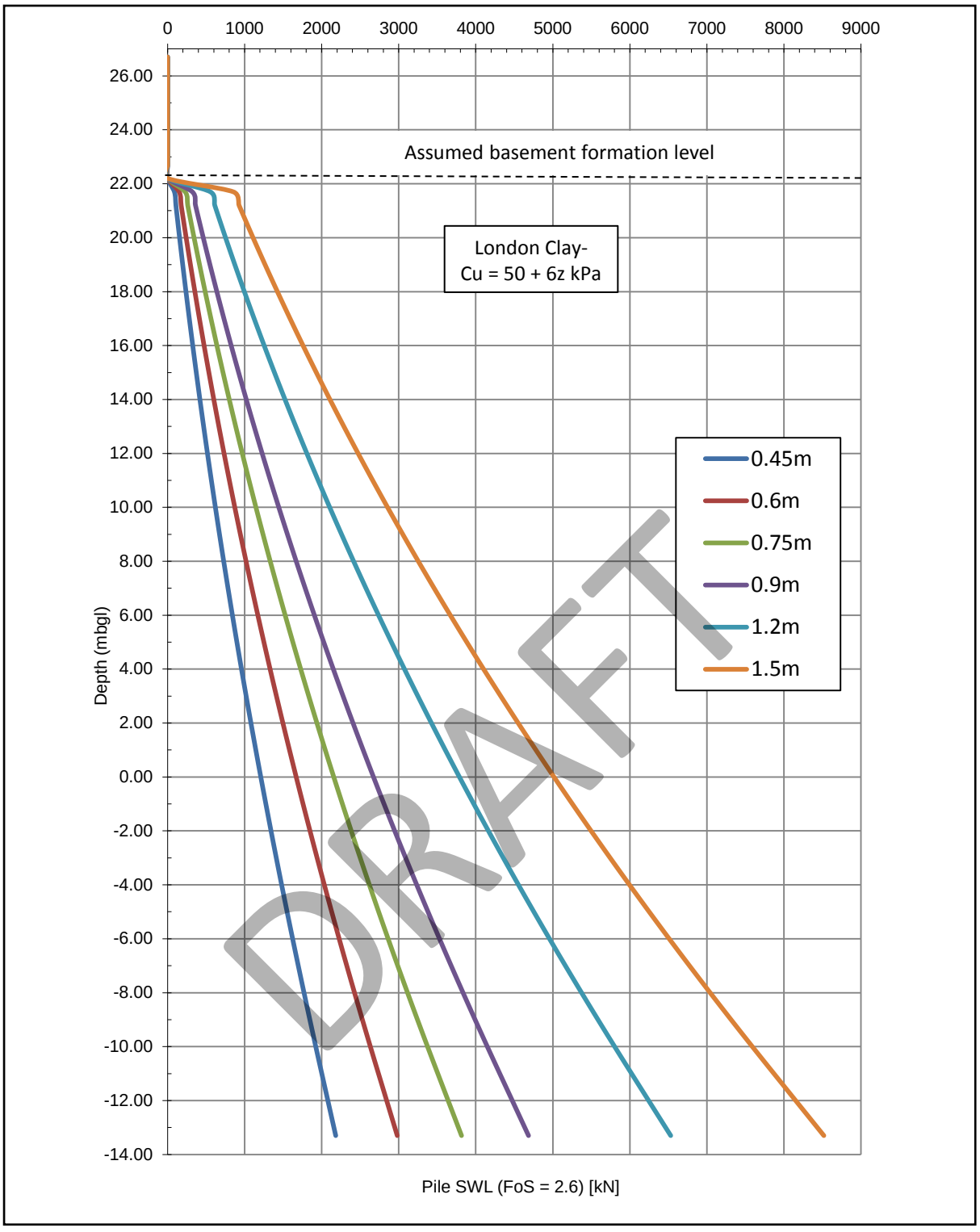
i. Current/future occupants
ii. Construction workers
iii. Vegetation and plants
iv. Groundwater or surface water
v. Buildings and structures



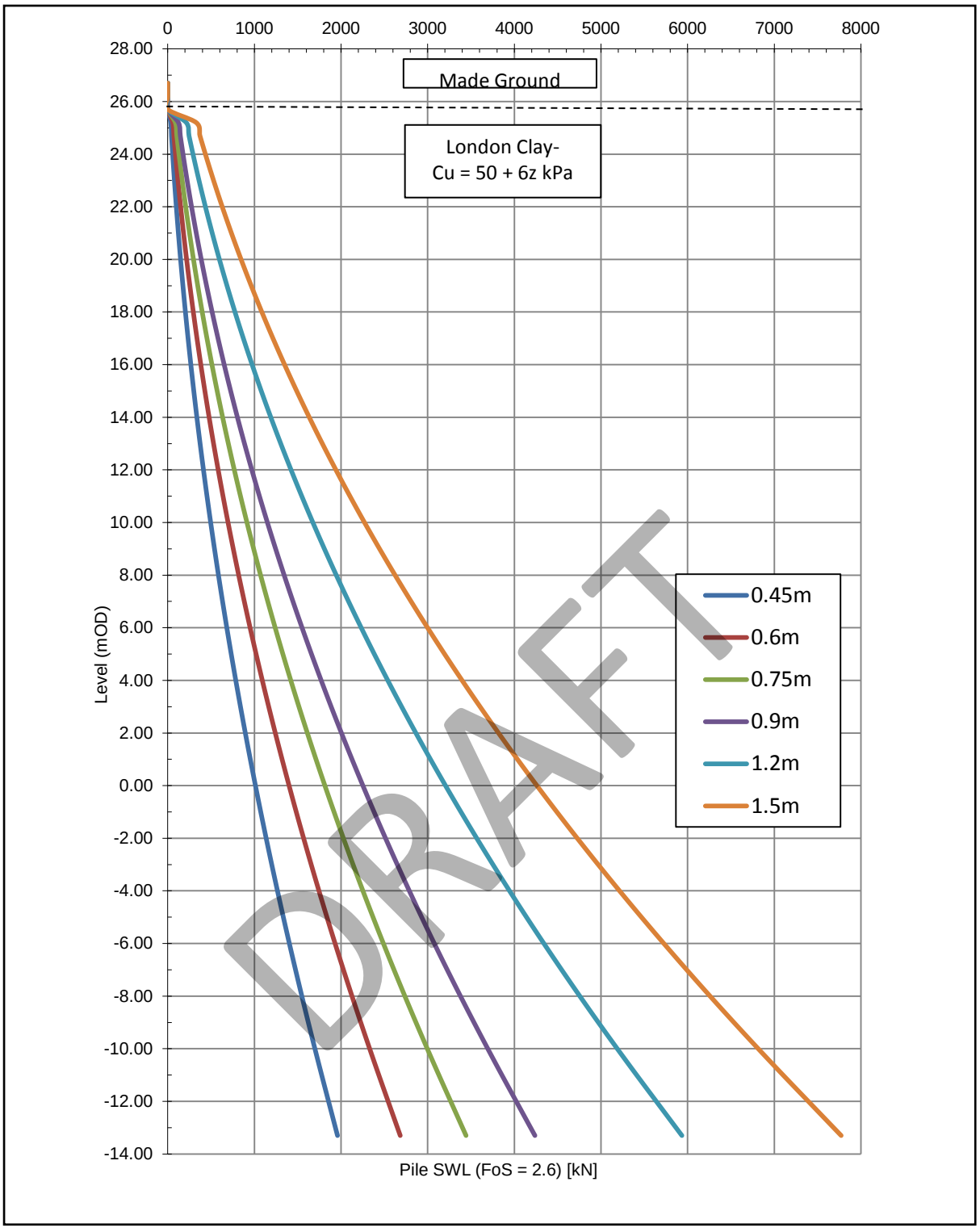
Client	Project	Job No
Walsh Group	**Camden Lock Village, London**	**CG/18067A**
CGL	Title: **Conceptual site model**	**Figure 6**



Client	Project	Job No
Walsh Group	**Camden Lock Village, London**	**CG/18067A**
CGL	Title **Plot of safe working load against level (15m deep basement)**	**Figure 7**



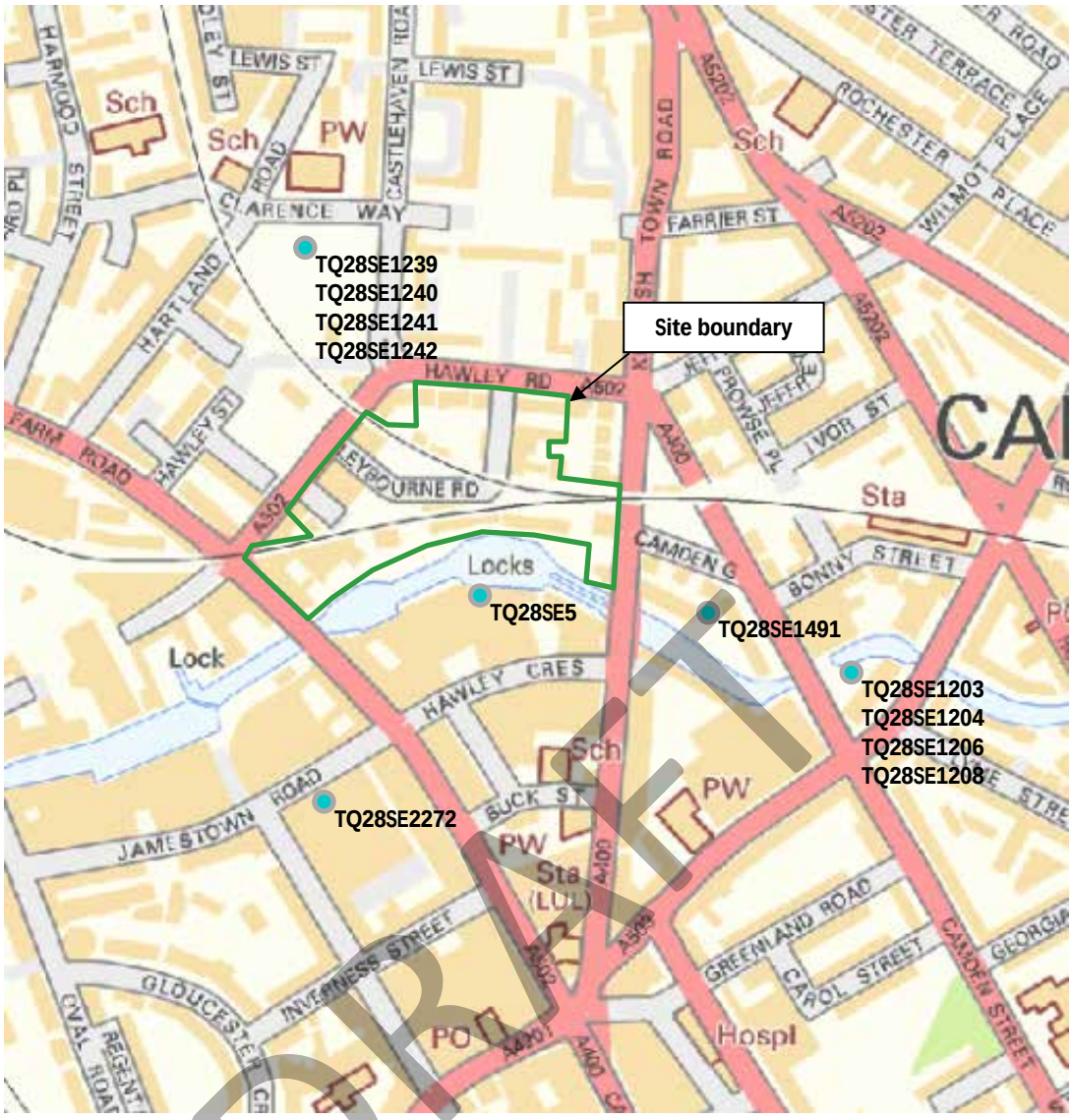
Client	Project	Job No
Walsh Group	**Camden Lock Village, London**	**CG/18067A**
CGL	Title **Plot of safe working load against level (5m deep basement)**	**Figure 8**



Client	Project	Job No
Walsh Group	**Camden Lock Village, London**	**CG/18067A**
CGL	Title **Plot of safe working load against level (no basement)**	**Figure 9**

APPENDIX A

Historical BGS boreholes logs



N

Base figure taken from BGS online

Not to scale

Client	Project	Job No
Walsh Group	**Camden Lock, London**	**CG/18067A**
CGL	Title **BGS borehole location plan**	

Project: ARLINGTON HOUSE, 220 ARLINGTON ROAD, CAMDEN, LONDON	Client: [redacted]	Trial Pit Excavation Methods: BRADFORD WATTS HAND PIT	Hole No. TH8A
	Engineer: [redacted] British Geological Survey	Pit Dimensions: Length - 1.80 m Width - 1.40 m	Sheet 1 of 1
Ground Level: 25.33 m.A.O.D.	Coordinates: m.E. m.N.	Orientation: Length -	Job No 10482

WATER		STRATA				SAMPLING/IN SITU TEST			LAB TESTING				
Date/Time at Depth	Depth to Water m	Description	Legend	Level m.A.O.D.	Depth m	Depth m	Type & No.	Test Result	% <425	W %	W_P %	W_L %	OTHER TESTS AND NOTES
		Made Ground (Brickwork wall)				0.20	D1						TH8A logged from north west face of Trial hole CLEA screen with speciated polyaromatic hydrocarbons (D1)
						0.50	D2		100	34	27	75	No groundwater recorded during fieldwork
				24.60	0.73								
30/10/06	DRY C	Made Ground (Concrete)											Water in hole from Diamond Drilling corehole in wall above pit
				24.25	1.08								Trial pit complete at 1.09m

Pit Stability, Shoring, etc.

No collapse of sides of trial pit

Water Level observations during digging, depths below GL.					
Strike	Depth Obs.	Depth after 5min	10 min	15 min	20 min

WATER
- ▼ 1 First Strike
- ▽ 2 Subsequent Strike
- N - Overnight Depth
- C- Completion Depth
- S Seepage not rising

SAMPLE AND TEST KEY
- D Small disturbed sample
- B Bulk disturbed sample
- W Water sample
- U Undisturbed sample
- K Percolation Test
- PP Perth Penetrometer Test
- HV Hand shear vane test
- SRD Sand replacement density test
- CBR In situ CBR test
- PB Plate Bearing Test

TEST RESULT
- Np = Np Value
- V = Average Hand Shear Vane Strength - kN/m^2
- BD = In-Situ Bulk Density - Mg/m^3
- CBR = California Bearing Ratio - %

Fieldwork By	GJB
Dates	30/10/03
Log	GJB

Sheet 1 of 1

TH8A

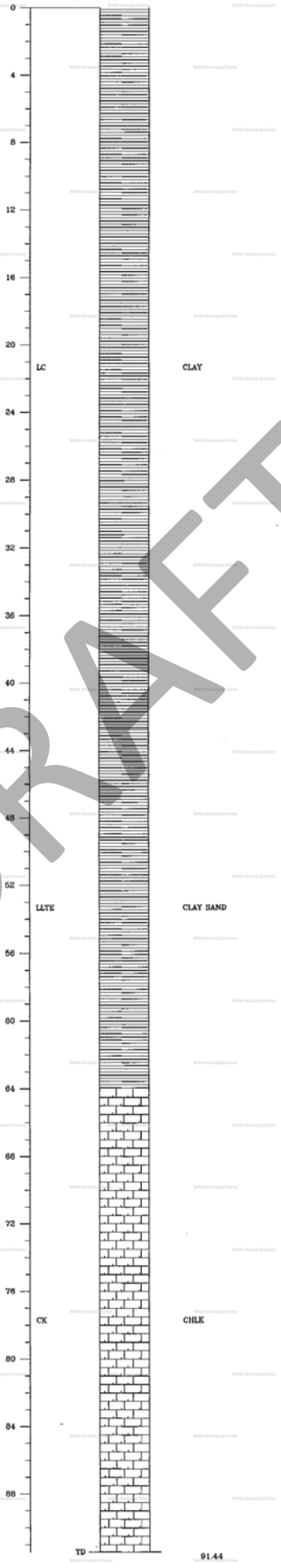
RSA GEOTECHNICS LTD (01449) 723723

5 TQ28SE 5

N–WHITAKERS BREWERY HAMPSTEAD

Grid Reference: 28850 84138

Scale: 1:200 Ordnance Datum: 25.00



TERRESEARCH LIMITED

BOREHOLE NO. 1

TQ28SE
1203

Contract Name Camden Town

Report No. S. 808/15

Client S. Bettis Ltd.

Site Address Corner of Camden Street and Camden Road

Engineers: Leonard & Partners, 344 - 360 South Lambeth Rd, London S.W.8.

2708 8'40

Standing Water Level 55'0" 17.6.65.
30'0" 21.6.65.

Diameter 8"

Water Struck 3'6"

Method of Boring Shell/Auger

Ground Level 78.49

Start 14.6.65. Finish 16.6.65.

Remarks:

Description of Strata	Thickness	Depth	Disturbed Samples	'U' Cores and 'N' P. Test
Made ground (sand, bricks stones etc.)	1'0"	1'0"	J2101 0'6"	
Soft brown mottled clay	2'6"	3'6"	J2102 2'6"	
Brown sandy clay with gravel	5'0"	8'6"	B2103 5'0" J2104 7'6"	5'0" N=14
Stiff brown mottled clay with layers of silt and sulphate crystals	8'0"	16'6"	J2106 12'6"	U2105 10'0" U2107 14'0"
Stiff fissured brown clay with sulphate crystals	5'6"	22'0"	J2108 17'6"	U2109 19'0"
Hard fissured grey silty clay with traces of organic material	6'0"	28'0"	J2110 22'6" J2112 27'6"	U2111 24'0"
Hard fissured silty grey clay	10'0"	38'0"	J2114 32'6" J2116 37'6"	U2113 29'0" U2115 34'0"
Hard fissured grey clay with layers of silt and occasional sulphate crystals	23'6"	61'6"	J2118 42'6" J2120 47'6" J2122 52'6" J2124 57'6"	U2117 39'0" J2119 45'0" U2121 49'0" U2123 54'0" U2125 60'0"
			W2126	
TOTALS	61'6"	61'6"		

NOTES: 1. Descriptions are given in accordance with the B.S. Civil Engineering Code of Practice C.P.2001 "Site Investigations"

2. J indicates Jar Samples.
   B " Bulk Samples.
   W " Water Samples.
   U " Undisturbed Core Samples. These are nominal 4 in. diam. and 18 in. long. Depths shown are top of sample.
   N " Number of blows per ft. penetration with Standard Penetration Tests.

TERRESEARCH LIMITED

BOREHOLE NO. 2 TQ28SE

Contract Name Camden Town — Report No. S. 808/15 1204

Client H. Dutton Ltd. — Site Address Corner of Camden Street.

Engineers: Leonard & Partners, — and Camden Road.

344 - 360 South Lambeth Rd., — London N.W.1.

London S.W.8. — 270, 3406

Standing Water Level None — Diameter 8"

Water Struck None — Method of Boring Shell/Auger

Ground Level 78.23 — Start 19.6.65. Finish 21.6.65.

Remarks:

Description of Strata	Thickness	Depth	Disturbed Samples	'U' Cores and 'N' P. Test
Made ground (concrete, grey silty clay with bricks)	3'0"	3'0"	J3724 2'6"	
Brown sandy clay with gravel	2'6"	5'6"	B3725 5'0"	
Stiff fissured mottled brown clay with occasional sulphate crystals and layers of silt	17'6"	23'0"	J3727 8'6" J3729 12'6" J3731 17'6" J3733 22'6"	U3726 6'0" U3728 10'0" U3730 14'0" U2732 19'0"
Hard silty mottled grey clay with sulphate crystals	5'0"	28'0"	J3735 27'6"	U3734 24'0"
Stiff to hard fissured grey silty clay with layers of light grey silt. Small crystalline aggregates of pyrites towards the base	32'6"	60'6"	J3737 32'6" J3739 37'6" J3741 42'6" J3743 47'6" J3745 52'6" J3747 57'6"	U3736 29'0" U3738 34'0" U3740 39'0" U3742 44'0" U3744 49'0" U3746 54'0" U3748 59'0"
TOTALS	60'6"	60'6"		

Notes: 1. Descriptions are given in accordance with the B.S. Civil Engineering Code of Practice C.P.2001 "Site Investigations"

2. J indicates Jar Samples.
B " Bulk Samples.
W " Water Samples.
U " Undisturbed Core Samples. These are nominal 4 in. diam. and 18 in. long. Depths shown are top of sample.
N " Number of blows per ft. penetration with Standard Penetration Tests.

TERRESEARCH LIMITED

BOREHOLE NO. 4 TQ28SE

Contract Name Camden Town

Client: G. Baltin Ltd.,

Engineers: Leonard & Partners.

344-360 South Lambeth Rd.

London. S.W.8.

Report No. S. 808/15 1206

Site Address Corner of Camden Street, and Camden Road

2910, 8410

Standing Water Level 25'0" 17.6.65.
25'9" 21.6.65.

Water Struck 3'6"

Ground Level 79.60

Diameter 8"

Method of Boring Shell/Auger

Start 16.6.65 Finish 16.6.65

Remarks:

Description of Strata		Thickness	Depth	Disturbed Samples	'U' Cores and 'N' P. Test
MADE	Sand bricks and stones etc.	0'9"	0'9"		
GROUND	Brown sandy clay with bricks and stones	2'9"	3'6"	J2127 2'6"	
Grey silty clay		7'0"	10'6"	B2128 5'0" J2129 7'6"	U2130 9'0"
Brown mottled clay		12'6"	23'0"	J2131 12'6" J2133 17'6" J2135 22'6"	U2132 14'0" U2134 19'0"
Grey clay		8'6"	31'6"	J3127 27'6"	U2136 24'0" U2138 30'0"
				W2139	
TOTALS		31'6"	31'6"		

Notes: 1. Descriptions are given in accordance with the B.S. Civil Engineering Code of Practice C.P.2001 "Site Investigations"

2. J indicates Jar Samples.

B " Bulk Samples.

W " Water Samples.

U " Undisturbed Core Samples. These are nominal 4 in. diam. and 18 in. long. Depths shown are top of sample.

N " Number of blows per ft. penetration with Standard Penetration Tests.

TERRESEARCH LIMITED

BOREHOLE NO. 6 TQ28SE

Contract Name Camden Town Report No. S. 808/15 1208

Client LL Baltic Ltd. Site Address Corner of Camden Street,

Engineers Halliwell and Partners, and Camden Road

344-360 South Lambeth Rd.

London, S.W.8. 2913, 8411

Standing Water Level Diameter 8"

Water Struck None Method of Boring Shell/Auger

Ground Level 76.27 Start 17.6.65 Finish 17.6.65

Remarks: 2 men breaking out concrete from ground level to 6" and pitting to 1'6".

Description of Strata		Thickness	Depth	Disturbed Samples	'U' Cores and 'N' P. Test
MADE GROUND	Concrete	0'6"	0'6"		
	Cobble stones	1'0"	1'6"		
Brown mottled silty clay		4'6"	6'0"	J3712 2'6" J3713 5'0"	
Mottled brown clay		14'0"	20'0"	J3714 7'6" J3716 12'6" J3718 17'6"	U3715 9'0" U3717 15'0" U3719 19'6"
Grey clay		4'0"	24'0"	J2720 22'6"	
Grey clay with layers of silt		7'0"	31'0"	J3722 27'6"	U3721 25'0" U3723 29'6"
TOTALS		31'0"	31'0"		

NOTES: 1. Descriptions are given in accordance with the B.S. Civil Engineering Code of Practice C.P.2001 "Site Investigations"

2. J indicates Jar Samples.
B " Bulk Samples.
W " Water Samples.
U " Undisturbed Core Samples. These are nominal 4 in. diam. and 18 in. long. Depths shown are top of sample.
N " Number of blows per ft. penetration with Standard Penetration Tests.

Terresearch

Contract: Hawley Road, Camden

Client: Materials Science Consultants Ltd

Borehole No. 1

Sheet No. 1 Of 1.
Depth 0 to 5 metres.

Equipment and Methods
Hand Auger 100mm diameter

Orientation : Vertical

Ground Level : m.O.D.

Coordinates : 287, 843

Job Number : S91/191
Location : TP28SE 1239
Dates : 20/11/91

Daily Prog.	Water Levels	Remarks	In Situ Tests	Samples Taken	Depth (Thick)	Reduced Level	Description	Legend
					0.00			
					0.05		MADE GROUND (tarmac)	
					0.15		MADE GROUND (concrete)	
				J 12	(0.48)		Firm greyish brown silty CLAY with scattered gravel traces	
				J 13	0.63			
				U 14			Firm to stiff brown slightly silty CLAY with occasional blue-grey reduction zones and traces of selenite crystals	
				J 15				
					(2.37)			
				U 16				
				J 17				
				J 18				
				U 19				
20/11					3.00		End of Borehole	

Operator
NF

Scale
5m/sheet

General Remarks:

Appendix
1

Sheet No.
1

Terresearch Limited, Taywood Road, Northolt, Middlesex UB5 6RL. Tel: 081 575 4901 Fax: 081 575 4462

Terresearch

Contract: Hawley Road, Camden

Client: Materials Science Consultants Ltd

Borehole No. 2

Sheet No. 1 Of 1.
Depth 0 to 5 metres.

Equipment and Methods
Hand Auger 100mm diameter

Orientation : Vertical

Ground Level : m.O.D.

Coordinates : 287,483

Job Number : S91/191

Location : TQ28SE 1240

Dates : 20/11/91

Daily Prog.	Water Levels	Remarks	In Situ Tests	Samples Taken	Depth (Thick)	Reduced Level	Description	Legend
					0.00			
					0.05		MADE GROUND (tarmac)	
					0.15		MADE GROUND (concrete)	
					(0.35)		Firm greyish brown silty CLAY	
				J 20	0.50		Firm brown silty CLAY with frequent blue-grey reduction zones, occasional pockets of orange-brown sandy clay and traces of selenite crystals becoming more abundant with depth	
				J 21				
				U*				
				U 22				
				J 23				
					(2.50)			
				U 24				
				J 25				
				J 26				
				U 27				
20/11					3.00		End of Borehole	

Operator NF

General Remarks:

Appendix 1

Scale 5m/sheet

Sheet No. 2

Terresearch Limited, Taywood Road, Northolt, Middlesex UB5 6RL. Tel: 081 575 4901 Fax: 081 575 4462

Terresearch

Contract: Hawley Road, Camden
Client: Materials Science Consultants Ltd

Borehole No. 3
Sheet No. 1 Of 1.
Depth 0 to 5 metres.

Equipment and Methods
Hand Auger 100mm diameter

Orientation : Vertical

Ground Level : m.O.D.

Coordinates : 287, 843

Job Number : S91/191
Location : TQ21SE 1241
Dates : 19/11/91

Daily Prog.	Water Levels	Remarks	In Situ Tests	Samples Taken	Depth (Thick)	Reduced Level	Description	Legend
					0.00			
				J 1	0.05		MADE GROUND (tarmac)	
					0.15		MADE GROUND (concrete)	
					(0.45)		MADE GROUND (dark grey clayey sand with bricks and stones)	
				J 2				
					0.60			
				J 3	(0.20)		MADE GROUND (ash with bricks and stones)	
	19/11			W 11	0.80			
				J 4			Firm brown silty CLAY with occasional blue-grey reduction zones	
				U 5				
				J 6				
					(2.20)			
				U 7				
				J 8				
				J 9				
				U 10				
19/11					3.00		End of Borehole	

Operator NF

General Remarks:

Appendix 1

Scale 5m/sheet

Sheet No. 3

Terresearch Limited, Taywood Road, Northolt, Middlesex UB5 6RL. Tel: 081 575 4901 Fax: 081 575 4462

Terresearch

Contract: Hawley Road, Camden
Client: Materials Science Consultants Ltd

Borehole No. 4
Sheet No. 1 Of 1.
Depth 0 to 5 metres.

Equipment and Methods
Hand Auger 100mm diameter

Orientation : Vertical

Ground Level : m.O.D.

Coordinates : 287, 843

Job Number : S91/191
Location : TQ28SE 1242
Dates : 20/11/91

Daily Prog.	Water Levels	Remarks	In Situ Tests	Samples Taken	Depth (Thick)	Reduced Level	Description	Legend
					0.00			
					0.05		MADE GROUND (tarmac)	
					0.15		MADE GROUND (concrete)	
				J 28	(0.45)		MADE GROUND (soft silty sandy brown clay with occasional gravel and brick traces)	
				J 29	0.60			
					(0.55)		Soft to firm dark brownish grey silty CLAY with organic traces	
				U 30				
				J 31	1.15			
				J 32			Firm to stiff brown silty CLAY with some blue-grey reduction zones and occasional organic traces	
				U 33				
				J 34	(1.85)			
				J 35				
				U 36				
20/11					3.00		End of Borehole	

Operator
NF

General Remarks:

Appendix
1

Scale
5m/sheet

Sheet No.
4

Terresearch Limited, Taywood Road, Northolt, Middlesex UB5 6RL. Tel: 081 575 4901 Fax: 081 575 4462

C16 2 398

RECORD of WELL or BORING

Survey No. 1" N.S. 256
1" O.S.

at (or farm) Camden Road 2 No. 1 NW
Town, village or estate Camden Town NW St. Pancras. County London
Six-inch map 5 NW
Exact site (unless a tracing from a map is supplied, give distance and direction from parish church, cross-roads, or other objects shown on maps). A little S the SW from Camden Town Stn. Popular edition (Sheet of one-inch map. (Square) TQ 28/50
Surface level of ground c 65 ft. above Ordnance Datum. Well or Bore commenced at ...... ft. below surface level of ground.
Sunk 4 ft., diameter 14x14 ft. Bored ...... ft.; diameter of boring: at top ...... in., at bottom ...... in.
Details of lining tubes (internal diameters preferred) 34' 2" of 16 in. Top. 2'4" b/o
197' 6" " 12 " " 2' 6" "
Water struck at depths of (feet) 301', 315' 333'. NGR TQ 2902 8412
Rest-level of water below top of well or bore 278 ft. Pumping level 278 ft. Time of recovery ...... hours.
Suction at 598 ft. depth. Yield: (i) on test 7000/8000 galls. per hour, (ii) normal ...... galls. per ......
Quality (attach copy of analysis if available) Standards Perm 0° Temp 4° Total 4°
Made by LE GRAND, SUTCLIFF & GELL, LD. for Aerated Bread Co. Ltd Date of boring Aug/Oct, 1934
Information from LE GRAND, SUTCLIFF & GELL, LD. 8134/p. 673.

(For Survey use only). GEOLOGICAL CLASSIFICATION.	NATURE OF STRATA. (and any additional remarks)	THICKNESS. Feet.	Inches.	DEPTH. Feet.	Inches.
Made 2	Made ground	2	.	2	.
	Brown clay	20	.	22	.
L.C. 106	Blue clay	28	.	50	.
	Blue clay & stone	25	.	75	.
	Blue clay	33	.	108	.
	Mottled clay	39	.	147	.
W.R.B. 50	Conglomerate	6	.	153	.
	Green loamy sand	5	.	158	.
T.S. 20	Thanet Sand	19	.	177	.
	Green flints	1	.	178	.
CK. 474	Chalk & flints	232	.	410	.
	Hard grey Chalk	242	.	652	.

SB
26:10:35.

Site visited 30th July 1946.
Pumping controlled by demand &
Well top in basement 10' below ground level.

Confidential Water very soft. — have to harden it.

~~Rev. L.~~ P.W.L. 300 Yield 10,328 Nov. 1937 [2 July 1946]

GEOLOGICAL SURVEY AND MUSEUM, SOUTH KENSINGTON, LONDON, S.W. 7.

For Survey use only.

Date received.	G.S.M.	M. of H. notified.	Site marked on 1" map.
Oct 1935.			

(11969B) Wt 10256/0175 2,500 9/32 H, J, R & L, Ld