Providing Ground Solutions

A2 Dominion

# 156 West End Lane, West Hampstead

*Geotechnical and Geoenvironmental Interpretative Report – Phase 2*

*Revision 2*

October, 2020

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## EXECUTIVE SUMMARY

Card Geotechnics Limited (CGL) has been commissioned by Westfield Construction Ltd on behalf of A2 Dominion, to carry out a ground investigation to assist with the discharge of planning condition 26b of Planning Permission 2015/6455/P for the redevelopment of 156 West End Lane, West Hampstead.

The site was most recently occupied by a retail showroom and builders' merchant with associated yard, however this use ceased in January 2020. The approved development includes self-contained residential dwellings across two multi-storey blocks, with ground floor flexible commercial floorspace, accessible parking spaces and areas of communal landscaping.

There is a Network Rail retaining wall along the southern boundary of the site and accordingly, the design team and main contractor will continue its liaison with Network Rail throughout the works and all necessary approvals will be obtained from Network Rail.

The site has previously been the subject of a desk study by RSA Geotechnics Limited and their findings have been reviewed as part of this report. From the earliest available mapping from 1871, the site was part of open fields with a railway cutting present encroaching on the south western corner of the site associated with the *Midland Railway* line butting the southern boundary. In the following years the site was occupied by small buildings in the western quarter of the site with the remainder of the site as tennis courts. The railway cutting extended along the southern edge of the site to facilitate railway sidings. By 1946, a *Garage* and petrol forecourt had been constructed in the western area of the site. By 1985, the site was developed into its current layout.

CGL completed a geotechnical and geoenvironmental investigation across the central and eastern parts of the site (referred to as Phase 1), presented in the report dated April 2020. The ground conditions encountered during the CGL investigation generally comprised between >1.6m and 3.2m of Made Ground overlying bedrock geology of the London Clay Formation. Perched water was encountered during the works within the Made Ground. Visual evidence of contamination was identified in the form of a hydrocarbon sheen on perched water adjacent to a former above ground fuel tank, an isolated pocket of black stained gravel with hydrocarbon odour in one of the boundary foundation inspection pits, and ashy material within three central exploratory locations. Elevated concentrations of arsenic, lead, and polycyclic aromatic hydrocarbons were encountered within the Made Ground, representing a moderate risk to long-term human health.

A second phase of investigations was subsequently undertaken in July 2020 across the western part of the site not previously accessible, with the main objective to investigate potential contamination

resulting from the former garage and petrol filling station located in the north-west corner of the site. The ground conditions encountered were generally consistent with Phase 1, encountering surficial Made Ground of between 2.0 and 4.5m thick overlying the London Clay Formation. Perched water was encountered within the Made Ground at two investigation locations, however was not found to be laterally continuous across the site.

Olfactory evidence of contamination was identified in the form of a slight hydrocarbon odour within thin lenses of Made Ground at the north-western corner of the site, with these lenses comprising of a black stained sand/gravel. Chemical laboratory testing indicated this material had elevated concentrations of lead and polycyclic aromatic hydrocarbons, representing a moderate risk to long-term human health. The remaining samples of Made Ground tested did not exhibit any significant concentrations of contaminants. The investigation indicated only a minor migration of contaminants has occurred within the site in proximity to the tanks, however there remains a risk of localised contamination at the former tank location.

It is not known if the buried tanks were removed during previous redevelopment of the former petrol filling station in the 1970's. If the buried tanks are encountered during construction these should be decommissioned and removed by a tank removal specialist under the supervision of a suitably qualified geo-environmental engineer.

The ground gas monitoring indicated carbon dioxide <5%, no measurable concentrations of methane and no sustained flow – corresponding to Characteristic Situation 1 or low risk.

Based on the investigation completed to date, is it considered that the future development will require the following remediation measures:

- Provision of soil capping layers in areas of soft landscaping,
- Protective pipework for water supply pipes, and
- Implementation of a watching brief and discovery strategy during construction.

The samples tested of Made Ground may be classified as 'not-hazardous' for off-site waste disposal purposes and may be disposed of to a suitably licensed inert or non-hazardous waste facilities subject to Waste Acceptance Criteria Testing. Uncontaminated natural soils can be disposed of as inert waste.

Based on the ground conditions encountered and anticipated structural loads, Continuous Flight Auger (CFA) piled foundations are recommended for the development. Suspended floor slabs are

recommended, and pavements formed within the Made Ground should be designed to a CBR value of <2.5%, although proof rolling and retesting may achieve a higher CBR value.

Excavations are likely to require temporary support, particularly along the southern edge of the site in the infilled cutting, and perched water control measures may be required.

Concrete should be designed to design sulfate classes DS-3 and AC-3 (concrete in Made Ground) and DS4 and AC-3s (concrete and piles in London Clay).

# 1. INTRODUCTION

Card Geotechnics Limited (CGL) has been instructed to carry out a ground investigation to assist with the discharge of planning condition 26b of Planning Permission 2015/6455/P for the proposed development of No. 156 West End Lane. It is understood that the approved development is for self-contained residential dwellings arranged across two buildings ranging in height from three to seven storeys. The development will also include ground floor commercial units, areas of accessible parking and areas of communal soft landscaping.

The site has been the subject of a previous desk study by RSA Geotechnical[1] which has been made available to CGL for review.

CGL has previously produced a Geotechnical and Geoenvironmental Interpretative Report (GGIR) for the eastern part of the site, referred to as the 'Phase 1' investigation[2]. At the time of the Phase 1 investigation between 10 January 2020 and 4 March 2020, access to the western part of the site was precluded by the presence of existing, occupied structures.

This report presents the details and results of a supplementary investigation that has been carried in the western area of the site since the buildings in this area have been vacated.

The objectives of this report are to:

- Undertake a review of the previous desk study and Phase 1 ground investigation information, and provide commentary with respect to the environmental, historical and geological setting of the site, in conjunction with geotechnical and geoenvironmental risks based on available published data sources;
- Provide information on the ground conditions encountered within the western part of the site, and provide analysis and interpretation of chemical and geotechnical laboratory testing undertaken on representative soil samples;
- Present an updated source-pathway-receptor risk assessment based on the findings of the Phase 2 intrusive investigation and results of chemical testing;
- Provide geoenvironmental recommendations for soil and water contamination and ground gas;

[1] RSA Geotechnics Limited. (2015). *Desk Study Report – 156 West End Lane, West Hampstead, London, NW6 1UF*. Report Reference: 14151DS. Dated November 2015.
[2] CGL (April 2020). *156 West End Lane, West Hampstead. Geotechnical and Geoenvironmental Interpretative Report. Revision 1*

- Provide recommendations for remediation and verification (where required); and
- Provide geotechnical recommendations for foundation design, roads/pavement design and sulfate protection for buried concrete.

# 2. SITE CONTEXT

## 2.1 General

This report should be read in conjunction with the previous reports[1,3], which provide detailed information on the site context. A summary of pertinent information is presented in the following report sections.

## 2.2 Site location

The site is located at 156 West End Lane in West Hampstead, London, NW6 1SD. The Ordnance Survey grid reference for the approximate centre of the site is 525600E, 184870N. A site location plan is presented as Figure 1.

The site is bounded to the south by Potteries Path and beyond by the West Hampstead Thameslink railway station, to the east by a Multi-Use Games Area (MUGA), and to the north by the rear gardens of housing fronting onto Lymington Road and to the west by the north to south trending West End Lane

## 2.3 Site description

The site is approximately rectangular in shape, covering an area of approximately 0.64 hectares, and can be split into two distinct areas. The western third of the site comprises a five-storey building fronting onto West End Lane. The upper floors of the building were formerly used as council offices, with the ground floor previously occupied with a retail showroom and builder's merchant. At the time of investigation, the retail showroom and builder's merchants were vacant.

The remainder of the site comprises the former builder's merchant yard. An access road to the rear yard is present along the southern boundary of the existing building. The yard was previously used as external storage (aggregate, timber etc.) for the builder's merchant and is currently unoccupied with concrete hardstanding across the entire yard.

Within the south western corner of the site, a retaining wall structure (up to approximately 5.5m high) with associated cantilevered structure is present immediately beyond the site boundary, which is currently utilised as car-parking spaces. The cantilever is present above the adjacent off-site Platform 1 of the West Hampstead Thameslink railway station.

A site layout plan is included in Figure 2.

## 2.4 Proposed development

It is understood that the development following demolition of all existing buildings will involve self-contained residential dwellings (Class C3), flexible non-residential use (Class A-A3, D1, D2), employment floorspace (Class B1) and community meeting space (Class D1) in buildings ranging from 3 to 7 storeys. New vehicular access from West End Lane and provision of accessible car parking spaces. Provision of new public open space and widening of Potteries Path and associated cycle parking and landscaping

A proposed development plan is included as Appendix A.

## 2.5 Site History

Selected sources have been reviewed to assess the site's historical development and potential for historical contamination.

### *2.5.1 Historical Development*

CGL has undertaken a review of a previous desk study RSA Geotechnical[3], which indicates that from the earliest available maps of 1871, the site was part of a larger field, with a small road crossing the north eastern corner and a railway cutting within the south westernmost section of the site, associated with the Midland Railway abutting the southern boundary of the site.

From 1915, the site comprised various small buildings and a Hall in the western quarter, with tennis courts and associated pavilion building in the remainder of the eastern area of the site at this time. The cutting in the south western section of the site is indicated to have been extended along the southern edge of the site to incorporate two railway sidings associated with the Midland Railway. This can be seen clearly in the 1935 mapping and the aerial map from 1946 also shows the southern edge of the site to be separate from the remainder of the site, indicating the cutting is still present. Additionally, the aerial map shows two large buildings had been constructed within the western quarter of the site. Later maps identified the larger building as a *Garage* and in 1974 a *Depot* as presented in Plate 1, which also indicates an apparent forecourt / filling station between the western edge of the structure and West End Lane.

By 1985, the cutting along the southern strip of the site is no longer present and is assumed to have been infilled (with unknown materials). Access to the site was revised to extend over the location of the former cutting, and there is a void beneath the south westernmost extent of the site due to a

[3] RSA Geotechnics Limited. (2015). *Desk Study Report – 156 West End Lane, West Hampstead, London, NW6 1UF*. Report Reference: 14151DS. Dated November 2015.

retaining wall and cantilever structure. The site layout remains unchanged on later map editions. Plate 1 and Plate 2 below presents a summary of key historical development across the site.

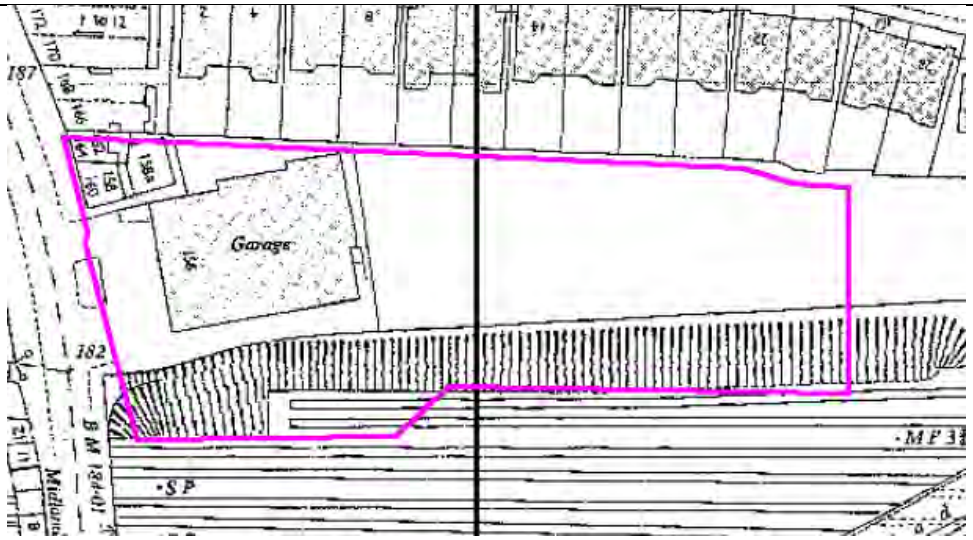



**Plate 1**. Extract of 1954-1960 Envirocheck Historical Map presented within RSA Desk Study Appendices.

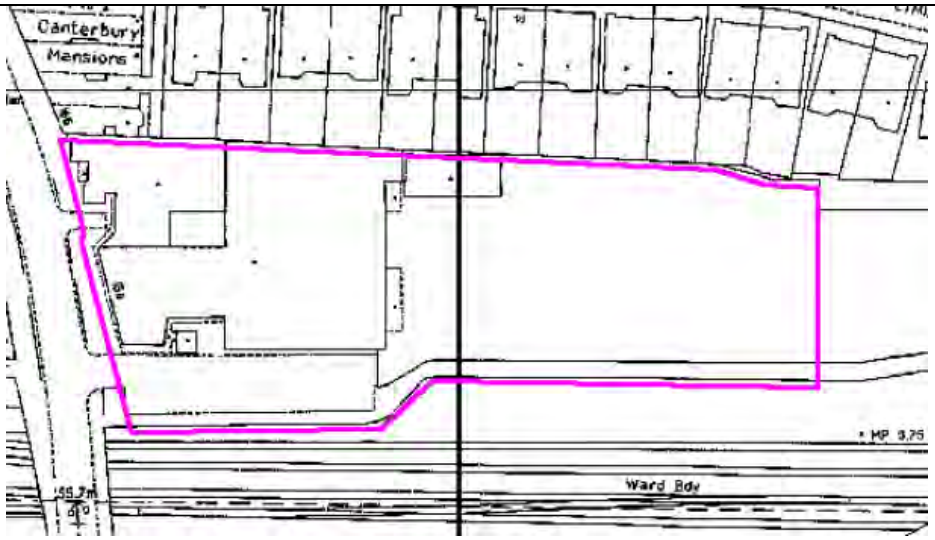



**Plate 2.** Extract of 1992-1995 Envirocheck Historical Map presented within RSA Desk Study Appendices.

## *2.5.2 Planning History*

The planning history for the site indicates that the garage in the western half was historically used as a car showroom and petrol station with associated fuel tanks. The site (and fuel station) was redeveloped in the 1970s to provide the current site layout. No information is available regarding the treatment of the tanks at the time of redevelopment.

In 1964, an application was also made for a temporary extension to the car-parking facilities into the eastern third of the site. A plan included within the application details that the central area of the site immediately behind the *Garage* building was an existing car park with surfaced with an '*Ash Finish'* and

that the temporary car-park would be surfaced the same. It is unknown if this extension was granted or took place.

## 2.6 Unexploded Ordnance (UXO)

The RSA Desk Study reviewed the 1945 London Bombing Maps and the online Second World War bomb map website[4], which indicated that high-explosive bombs were dropped within 150m of the site.

In order to assess the risk further, CGL previously instructed a Preliminary Unexploded Ordnance (UXO) Threat Assessment Report prior to the Phase 1 ground investigation which confirmed the site was considered a high risk. The follow on Detailed UXO Threat Assessment recommended that during intrusive works the risks of UXO need to be considered and watching brief undertaken by component and trained persons.

Copies of the preliminary and detailed UXO threat assessment reports are included within Appendix B of this report.

## 2.7 Geology

With reference to the British Geological Survey (BGS) Geological Sheet Map 256[5], the site is recorded to be underlain by solid geology of the London Clay Formation. The London Clay Formation is expected to be some 25m thick in the area and typically consists of a firm to stiff blue grey fissured clay, weathering to brown near the surface. The Lambeth Group comprises a mix of laterally and vertically inconsistent clays, sands and gravels which can be interbedded. Locally can contain cemented bands and concretions. The Thanet Sand Formation is typically comprised of pale grey fine glauconitic sand. Towards the base of the formation the sand becomes interbedded with silt and clay. The White Chalk Subgroup is expected at approximately -60m OD and consists of chalk with flints.

No superficial deposits are shown to be present at the site.

## 2.8 Hydrogeology and Hydrology

The solid London Clay Formation strata are classified by the Environmental Agency as “Unproductive” aquifer strata. The underlying Lambeth Group and Thanet Sand Formation are also Secondary A Aquifers, and the White Chalk Subgroup at depth is a Principal Aquifer. The site is not situated within a groundwater Source Protection Zone. The nearest surface water feature is the concrete-lined Regents Canal, located some 2.4km to the south east of the site.

[4] http://bombsight.org/#17/51.54885/-0.18929 (accessed September 2020)
[5] British Geological Survey. (2006). *North London*. England and Wales Sheet 253. Bedrock and Superficial Geology. 1:50,000.

# 3. PREVIOUS PHASE 1 GROUND INVESTIGATION

## 3.1 Fieldwork

The intrusive works were undertaken over several non-consecutive days between 19 December 2019 and 13 March 2020, and comprised:

- Five foundation inspection pits (FIPs),
- Two cable percussion (CP) boreholes,
- Four window sample (WS) boreholes (Including two abandoned due to dense soils), and
- Two machine excavated trial pits (TP).

For details of the investigation works undertaken please refer to the information presented within the April 2020 Geotechnical and Geo-environmental Interpretative Report (GGIR) [6]. The location of the investigations is indicated on Figure 2. Exploratory hole records for the Phase 1 investigations are presented in Appendix D.

## 3.2 Ground conditions

A summary of the ground conditions encountered during the previous CGL investigation is presented in Table 1 below.

**Table 1: Summary of ground conditions**

| *Stratum* | *Depth to Top of Stratum (m bgl)* | *Thickness (m)* |
|---|---|---|
| CONCRETE hardstanding<br>*Over…* | 0 | 0.1 to 0.3 |
| Loose to dense dark brown, dark grey, brown, and orangish brown clayey sandy gravel / clayey gravelly sand. Sand is fine to coarse. Gravel is fine to coarse, angular to subrounded flint, brick, concrete, sandstone. Ash was encountered within WS6, and clinker fragments were recorded within TP1 and TP2.<br>*Over…* | 0.1 and 0.3 | 0.3 to 2.5 |
| Firm brown mottled grey sandy clay / gravelly sandy clay. Gravel is fine to coarse, angular to subrounded flint and occasional brick and sandstone.<br>*FIP4 only – Strong hydrocarbon odour within isolated pocket of concrete gravel at 0.75m bgl in south east corner of the pit.*<br>[MADE GROUND] | 0.4 to 2.6 | 0.45 to 1.8 |
| **FIP2 and FIP3 only**<br>Firm dark grey mottled black slightly sandy organic clay. Rootlets and organic matter. Occasional brick fragments in FIP3.<br>[MADE GROUND] | 1.1 and 1.2 | >0.5 |

[6] CGL (April 2020). *156 West End Lane, West Hampstead. Geotechnical and Geoenvironmental Interpretative Report. Revision 1*

| *Stratum* | *Depth to Top of Stratum (m bgl)* | *Thickness (m)* |
|---|---|---|
| **WS7, TP1 and TP2 only**<br>Dense orange brown and brown clayey gravelly fine to coarse sand. Gravel is angular to subrounded fine to coarse flint and sandstone. Occasional flint cobbles.<br>[MADE GROUND] | 1.1 to 1.2 | >1.7 to 2.80 |
| **BH2 only**<br>Firm becoming stiff light brown and orange brown gravelly silty CLAY. Gravel is fine to coarse, rounded to subrounded flint.<br>[Possible HEAD DEPOSITS] | 2.2 | 3.8 |
| Firm becoming stiff brown and orange brown silty CLAY<br>*Over…*<br>Stiff brown mottled blue grey and blue grey silty CLAY with very fine selenite crystals. Claystone gravel encountered within BH1<br>[LONDON CLAY FORMATION] | 2.2 to 6.0 | >26.8<br>Base not proven |

## 3.3 Perched water

Perched water was encountered at shallow depths, either within or at the base of the granular Made Ground, at depths of 0.7m, 0.75m and 0.4m within FIP4, FIP6, and WS7 respectively. No other groundwater was encountered during the intrusive works.

During the subsequent monitoring visit, resting groundwater was recorded at depths of 0.71m and 1.2m within boreholes BH2 and WS7 respectively, which corresponds to the Made Ground. No groundwater was recorded within borehole WS7. It is noted that the rubber bung to borehole BH1 was unable to be removed during the monitoring and therefore a water level was not recorded.

# 4. PRELIMINARY RISK ASSESSMENT

## 4.1 Introduction

Historical contamination of land may present harm to human health and the environment. Current UK legislation stipulates that the risk associated with potential land contamination is assessed and remediated, if necessary. Under the Town and Country Planning Act 1990 (as amended), potential land contamination is a "material planning consideration" together with the National Planning Policy Framework (February 2019), which means that a planning authority must consider contamination when they prepare development plans or consider individual applications for planning permission. It is the responsibility of the developer to carry out the remediation where it is required and satisfy the Local Authority that the remediation has been carried out as agreed.

Additionally, Part 2A of the Environmental Protection Act 1990 requires that a significant source-pathway-receptor linkage exists to determine a site as contaminated land. This means that there has to be a contaminant present, a receptor that could be harmed by this contaminant, and a pathway linking the two. Part 2A deals with the contamination risk from a site in its current use, however, the planning system requires that the proposed use be considered. Where remediation is carried out under the planning system, it should be ensured that the site is in such a condition that it would still not meet the definition of contaminated land under Part 2A.

## 4.2 Phase 1 Contamination Assessment

The contamination assessment undertaken as part of the Phase 1 investigation for the central / eastern part of the site indicated the risks to human health due to contamination concentrations in the Made Ground were considered to be Moderate. The following exceedances, when compared against Generic Assessment Criteria (GAC), were recorded in the 15 No. soil samples tested (including 13 No. in Made Ground):

- Arsenic – WS7 only.
- Lead – FIP2, FIP4, TP2 and WS6.
- PAHs – FIP4, TP1 and TP2.

No asbestos was recorded in any of the Made Ground samples across the site. Additionally, the risks of ground gas and to vegetation and plants were considered to be Low.

## 4.3 Preliminary Conceptual Site Model

A preliminary conceptual site model has been compiled for the site with respect to the proposed development to identify the potential sources of contamination and the associated potential pollutant linkages. This model also informs the potential need for further investigation at the site.

### *4.3.1 Potential Sources*

Potential contamination sources can include both current and historical activities on site and in the surrounding area. The following potential sources have been identified at the site:

- *On-site sources* – Historically a garage, car showroom and petrol station (with associated filling station) were present in the western area of the site, and the remainder of the site was used as tennis courts and a railway cutting (which has since been infilled). There is potential that the central and eastern area of the site may have been developed with a temporary ash surfaced car-park, but this is unconfirmed. Although the site has since been redeveloped to the current layout, the historical on-site activities have the potential to be a source of a wide range of contaminants including metals, polycyclic aromatic hydrocarbons (PAHs) and total petroleum hydrocarbons (TPHs). Additionally, given the site was redeveloped by 1985, there is potential for asbestos containing materials to be present within the Made Ground. Furthermore, Made Ground can be a source of ground gas where an appreciable organic content is present. In addition, degradation of hydrocarbons/organic chemicals in the ground can produce organic vapours and ground gases.

- *Off-site sources* – Historical and current off-site activities including a number of *unspecified Factories and Works, Cocoa Factory*, *Depots, Corporation Yards and Railway Lines/Yards.* These current and former off-site activities have the potential to be a source of a wide range of contaminants including metals, TPH, chlorinated solvents, ammonia, PAHs which could migrate onto and beneath the site.

### *4.3.2 Potential Pathways*

The potential migration pathways that may be present at the site include:

- *Ingestion and inhalation* – contamination within the Made Ground can result in the ingestion or inhalation of contaminated soils (and asbestos fibres if present) and inhalation of ground gases/vapours.

- *Direct/dermal contact* – direct/dermal contact with contaminated soils or shallow perched water can result in the uptake of contaminants through the skin or permeation of contaminants through structures.

- *Lateral/vertical migration* – lateral and vertical migration of ground gases/vapours or contaminants through the permeable soil matrix.

- *Drainage and services* – could provide a preferential pathway for dissolved phase contamination migration and/or ground gases/vapour transport.

- *Root uptake* - uptake of phytotoxic contaminants by plants and vegetation; and

### *4.3.3 Potential Receptors*

Based on the proposed end use of the site for residential purposes, the main receptors at the site are considered to be:

- *Future site occupants/users* – future residential users are primarily at risk from direct contact, inhalation or ingestion where contaminated soil is exposed at surface, inhalation of asbestos fibres, and from ground gas/vapour accumulation within buildings.

- *Construction workers* – primarily at risk from direct contact, inhalation or ingestion of contaminants, and inhalation of asbestos fibres.

- *Buildings and structures* – buried concrete and services, such as plastic water supply pipes, can be at risk from chemically aggressive ground. Ground gases and vapours may also accumulate in buildings and structures presenting an explosive risk.

- *Vegetation and plants* – primarily at risk from phytotoxic contaminants such as copper, nickel and zinc.

- *Off-site receptors (particularly neighbouring residential areas)* – primarily at risk from inhalation or ingestion of dust and/or asbestos fibres from contaminated soils during development works, and from ground gas/vapour accumulation in buildings.

  It is noted that controlled waters have been discounted as both a receptor and pathway due to no shallow groundwater being anticipated beneath the site and that the underlying London Clay Formation affords protection to the underlying hydrogeology. In addition, the nearest surface water feature is 2.4km south and comprises a lined canal. As such, controlled waters

are not considered to be viable receptors or pathways for the current site development and have been discounted.

## 4.4 Preliminary Qualitative Risk Assessment

A preliminary qualitative risk assessment has been carried out based on the findings of the conceptual site model and the potential pollutant linkages that may exist at the site in accordance with Contaminated Land Report (CLR) 11[7] (noting this is to be withdrawn later in 2020 and replaced with Land contamination: risk management guidance). Using criteria broadly based on those presented in CIRIA Report C552[8], the magnitude of the risk associated with potential pollutant linkages has then been assessed and is summarised below. The risk assessment methodology is included as Appendix C.

**Table 2: Preliminary qualitative Risk Assessment**

| *Potential Source/Medium* | *Potential Exposure Route* | *Potential Receptor* | *Severity* | *Probability* | *Risk Rating* |
|---|---|---|---|---|---|
| Explosive/ asphyxiating gases/vapours from underlying Made Ground and potential on and off-site sources | Migration of gases and vapours through the surface via permeable soils and drainage & services | Internal building spaces & future occupiers | Severe | Low | Moderate |
| | Inhalation of ground gases and/or vapours | Future site users | Severe | Low | Moderate |
| Organic/ inorganic contaminants such as hydrocarbons, metals and asbestos within underlying soils (based on potential on and off-site sources) | Direct/indirect ingestion of soil and dust, inhalation of particle vapours and/or asbestos fibres, and dermal contact with contaminants | Construction workers | Medium | Likely | Moderate |
| | | Future site users | Medium | Low | Moderate / Low |
| | | Off-site residents | Medium | Low | Moderate / Low |
| | Direct contact with underground structures and services | Buildings and structures | Mild | Likely | Moderate / Low |
| | Root uptake | Plants and vegetation | Minor | Likely | Low |

[7] The Environment Agency (2004) Model Procedures for the Management of Land Contamination. CLR 11.
[8] CIRIA (2001) Contaminated Land Risk Assessment. A guide to good practice. C552.

# 5. PHASE 2 GROUND INVESTIGATION

## 5.1 Introduction

A ground investigation was carried out by CGL across the western part of the site not previously accessible during the Phase 1 investigations. The purpose of the investigation was to investigate areas of the site previously not accessible and assess potential for contamination associated with the former garage historically in this area of the site. The design of the second phase of investigation (prior to commencement of demolition) was undertaken by CGL.

## 5.2 Fieldwork

The works were undertaken between 16th and 21st July 2020, prior to the demolition of the existing structures, and comprised:

- One cable percussion borehole (BH03), using a cut-down rig, within the existing Wickes showroom, to a depth of 30mbgl; and
- Four windowless sample boreholes within the existing warehouse structure to a depth of 5mbgl.

The investigation was generally undertaken in accordance with the requirements set out within BS 5930:2015[9] and BS 10175:2017[10] . An exploratory hole location plan is presented as Figure 2. The exploratory hole logs are presented within Appendix E.

Exploratory hole arisings were logged and representatively sampled by suitably qualified engineers from CGL. Prior to commencing ground penetrating works, a buried services survey was undertaken by a specialist service location contractor.

### *5.2.1 Sampling*

Environmental samples were taken from each investigation location for subsequent laboratory testing. These samples were retrieved in line with the CGL internal Standard Operating Procedure (SOP), which includes using the appropriate amber glass jars for the collection of samples for hydrocarbon analysis and plastic tubs to collect samples for inorganics analysis. Samples were compacted/filled into the relevant containers to minimise headspace.

Samples were stored in cool boxes with ice packs prior to dispatch to the laboratory and no non-conforming samples were reported by the laboratory.

[9] British Standards Institution. (2020). *Code of practice for site investigations*. BS5930:2015+A1:2020.
[10] British Standards Institution. (2011). *Investigation of potentially contaminated sites: Code of practice.* BS10175:2011

Geotechnical samples were taken from the cable percussion borehole consisting of bulk, disturbed and undisturbed (U100) samples. In-situ Standard Penetration Tests (SPTs) were also undertaken.

### *5.2.2 Installations*

Three combined ground gas and groundwater monitoring standpipe piezometers were installed in the cable percussion and windowless sample boreholes (BH03, WS01 and WS03) to allow further gas and groundwater monitoring to take place. The design and construction of the monitoring well is indicated on the logs in Appendix E, with a summary of the monitoring installation depths and target strata is presented in Table 3 below.

**Table 3: Summary of borehole installations**

| *Borehole ID* | *Depth to base of installation (mbgl)* | *Response zone (mbgl)* | *Target Strata* |
|---|---|---|---|
| BH03 | 4.0 | 2.0 to 4.0 | Made Ground / Weathered London Clay |
| WS201 | 4.0 | 1.0 to 4.0 | Made Ground |
| WS203 | 3.0 | 1.0 to 3.0 | Made Ground / Weathered London Clay |

## 5.3 Monitoring

Following completion of the investigation, three monitoring visits were undertaken between 28 July and 24 August 2020, to record groundwater levels. Ground gas monitoring was also undertaken on 24 August 2020 and 10 September 2020. A GFM435 gas analyser was used to measure gas flow, oxygen, carbon dioxide and methane concentrations.

A summary of the monitoring results is presented in Sections 6.6 and 6.7 of this report and the full ground gas and groundwater monitoring records are provided in Appendix F and discussed further below.

## 5.4 Laboratory testing

### *5.4.1 Chemical*

Representative soil samples were collected from site and sent to i2 Analytical Limited (a UKAS and MCERTS accredited laboratory) for chemical testing. The analysis included testing for the following contaminants:

- Soil Organic Matter (SOM);
- Metals including; arsenic, barium, beryllium, boron, cadmium, chromium, copper, lead, mercury, nickel, selenium, vanadium and zinc;
- Polycyclic Aromatic Hydrocarbons (PAH);

- Total Petroleum Hydrocarbons (TPH CWG);
- Benzene, Toluene, Ethyl benzene, and Xylenes (BTEX)
- pH determination;
- Asbestos screening and identification;
- Total Monohydric Phenols; and
- Total cyanide.

The full results are presented in Appendix G.

### *5.4.2 Geotechnical*

Representative soil samples were sent to i2 Analytical Limited for geotechnical testing, including:

- Particle size distribution testing (including sedimentation);
- Single-stage quick undrained triaxial testing;
- Four-point Atterberg Limits and moisture content; and
- Sulphate testing to Building Research Establishment (BRE) Special Digest (SD) Suite – including 2:1 water soluble sulfate, total sulfate, total sulfur and pH.

The full results are presented in Appendix H.

# 6. GROUND AND GROUNDWATER CONDITIONS

## 6.1 Summary

The ground conditions encountered during the investigation were generally consistent with the published geology for the site and those encountered during the Phase 1 investigation, comprising Made Ground over London Clay Formation. A summary of the ground conditions encountered is presented in Table 4 below and discussed in the following sections. No survey levels within the existing structure have been provided, however the external ground level surrounding the structure generally lies at 18.3mOD which has been adopted as the approximate internal slab level.

**Table 4: Summary of Ground Conditions**

| *Stratum* | *Depth to Top of Stratum (m bgl) [mOD]* | *Thickness (m)* |
|---|---|---|
| CONCRETE; overlying | 0<br>[55.3] | 0.25 to 0.35 |
| Medium dense orangish brown silty gravelly SAND. Gravel of fine to coarse rounded flint and angular red brick. Sand is fine to coarse; overlying | 0.25 to 0.35<br>[54.95 to 55.05] | 0.55 to 1.25 |
| Yellowish brown to orangish brown sandy GRAVEL to gravelly SAND, occasionally silty/clayey. Gravel of fine to coarse rounded to tabular flint.<br>**[MADE GROUND]** | 0.8 to 1.5<br>[53.8 to 54.5] | 1.55 to 3.65 |
| Firm brownish grey gravelly silty CLAY. Gravel of fine to medium rounded flint and occasional brick.<br>**[MADE GROUND]**<br>**BH03 only** | 1.2<br>[54.1] | 1.7 |
| Black medium to coarse SAND with high cobble content. Cobbles are angular brick. Slight hydrocarbon odour; or<br>Firm a black clayey SILT. Slight hydrocarbon odour.<br>**[MADE GROUND]**<br>**WS203 and WS204 only** | 1.25 to 2.65<br>[52.65 to 54.05] | 0.1 to 0.2 |
| Firm orangish brown to brown mottled bluish grey silty CLAY with rare fine sand-sized selenite crystals.<br>**[WEATHERED LONDON CLAY FORMATION]** | 2 to 4.5<br>[50.8 to 53.3] | 3.8 |
| Very stiff bluish grey silty CLAY with few fine selenite crystals.<br>Band of claystone encountered at 21.4-21.8mbgl.<br>**[LONDON CLAY FORMATION]** | 7.7<br>[47.6] | >22.3<br>Base not proven |

Plots of SPT 'N' and $c_u$ versus depth are presented as Figure 3 and Figure 4 respectively. Details of the ground conditions are summarised in the following report sections.

## 6.2 Made Ground

Made Ground was encountered in each exploratory hole. The Made Ground comprised concrete hardstanding over orangish brown silty gravelly sand, assessed as medium dense based on the difficulty to excavate by hand. The gravel fraction comprised fine to coarse, rounded flint and angular red brick. This was in turn underlain by a distinct layer of Made ground comprising a yellowish brown to orangish brown very sandy sand / very gravelly sand, with gravel of fine to coarse rounded flint.

Occasional cohesive horizons were encountered within BH03, WS03 and WS04, the most significant of which was encountered in BH03 comprising a 1.7m thick layer of firm, brownish grey sandy silty clay.

Black, cobbly sand material with a slight odour of hydrocarbons was encountered within WS03 and WS04 at 2.65m and 1.25m respectively. However, no evidence of gross hydrocarbon contamination was observed in the areas investigated

A total of three SPTs were undertaken within the Made Ground at BH03 which recorded 'N' values of ranging between 9 and 30 corresponding to a relative density of 'loose' to 'medium dense' for the granular soils and correlating undrained shear strength ($c_u$) of 40 to 135kPa (where $f_1$ = 4.5), corresponding medium to high strength within the cohesive Made Ground in accordance with BS5930:2015+A1:2020[9].

A summary of the geotechnical classification testing is presented in Table 5.

**Table 5: Summary of the classification testing for the Made Ground**

| Made Ground | Particle Size Distribution – Sample proportions | | | |
|---|---|---|---|---|
| | Gravel | Sand | Silt | Clay |
| | (%) | (kPa) | (%) | (%) |
| BH03 - granular | 60.70 | 25.30 | 7.0 | 7.0 |
| BH03 – cohesive | 1.0 | 10.60 | 36.20 | 52.20 |

## 6.3 Weathered London Clay Formation

The Weathered London Clay Formation was encountered within all borehole at depths between 2.2m to 6.0mbgl, however the base of this stratum was only proven within BH03 at 7.7mbgl.

The Weathered Clay was described as firm becoming stiff brown and orangish brown silty clay with very fine selenite crystals and bluish grey mottling become more pronounced with depth.

A single SPT was undertaken within the stratum at a depth of 6mbgl, recording an 'N' value of 21, correlating undrained shear strength ($c_u$) of 94kPa (where $f_1$ = 4.5), or medium strength in accordance with BS5930:2015+A1:2020. Two single-stage, quick undrained tests were undertaken on undisturbed (U100) samples obtained during the investigation, which recorded undrained strengths of 78kPa and 105kPa, which is corresponds to medium to high strength in accordance with BS5930:2015+A1:2020.

A summary of the geotechnical classification testing is presented in Table 6.

**Table 6: Summary of the classification testing for the Weathered London Clay Formation.**

| London Clay | Atterberg Limit Testing | | | | |
|---|---|---|---|---|---|
| | MC | PL | LL | PI | material <425µm |
| | (%) | (kPa) | (%) | (%) | (%) |
| BH03 | 32 | 32 | 70 | 38 | 100 |

Based on the above results, the Weathered London Clay Formation may be classified as clay with high to very high plasticity[11] with a high volume change potential[12].

## 6.4 London Clay Formation

The depth to the London Clay Formation was only proven within BH03 (the other exploratory locations were terminated within the Weathered London Clay Formation) at a depth of 7.7mbgl and was proven to a maximum depth of 30mbgl. Although the base of the London Clay Formation was not proven during the site works, based the geological records the London Clay is anticipated to be approximately 50m thick.

The London Clay was described as very stiff bluish grey silty clay with a few very fine selenite crystals. Claystone gravel was encountered between 21.4 and 21.8mbgl.

SPT 'N' values recorded within the London Clay Formation were typically between 24 to 52 correlating to values of undrained shear strength ($c_u$) between 108kPa and 234kPa (where $f_1$ = 4.5), or a relative consistency of 'stiff' to 'very stiff'. Two single-stage quick undrained triaxial tests were undertaken on undisturbed (U100) samples obtained during the investigation which recorded undrained shear strengths of 124kPa and 140kPa, which is slightly lower than those inferred with the in-situ SPTs testing indicating a consistency of stiff or strength classification of 'high' as per BS5930:2015+A1:2020[9].

A summary of the geotechnical laboratory testing is presented in Table 7, and included in Appendix H.

**Table 7: Summary of the classification testing for the London Clay Formation.**

| Borehole ID | Atterberg Limit Testing | | | | |
|---|---|---|---|---|---|
| | MC | PL | LL | PI | material <425µm |
| | (%) | (%) | (%) | (%) | (%) |
| BH03 | 24 to 31 | 34 to 35 | 69 to 82 | 35 to 47 | 100 |

Based on the above results, the London Clay Formation may be classified as clay with high to very high plasticity[11] with a high volume change potential[12].

[11] BS EN ISO 14688 2:208 Geotechnical investigation and testing – Identification and classification of soil.
[12] NHBC Standards. (2017). *Chapter 4.2 Building near trees*.

## 6.5 Visual/Olfactory Evidence of Contamination

Visual and olfactory evidence of contamination was recorded within WS03 and WS04 at depths of 2.65mbgl and 1.25mbgl respectively, comprising a 0.1m to 0.2m thick horizon of black sands with a high cobble content and a slight hydrocarbon odour.

Within these locations, visual and olfactory evidence of contamination was not recorded within the underlying strata. Additionally, a black clayey SILT with a slight hydrocarbon odour was encountered within WS04 at 1.9mbgl. Each of these layers were very thin at the borehole locations between 0.1 and 0.2m, and the hydrocarbon odour was not apparent within overlying / underlying strata.

No visual or olfactory evidence of contamination was noted within the groundwater encountered during monitoring visits.

## 6.6 Ground Gas

Two gas monitoring visits have been completed at the site on 24 August and 10 September, the results of which are summarised in Table 8 below. The full monitoring records are included in Appendix F.

**Table 8. Ground Gas Monitoring Summary**

| Borehole | Response zone | Peak Flow (l/hr) | Residual flow (l/hr) | Min $O_2$ (% vol) | Max $CO_2$ (% vol) | Max $CH_4$ (% vol) | Max PID (ppm) |
|---|---|---|---|---|---|---|---|
| BH03 | 2.0m to 4.0m (Made Ground / Weathered London Clay) | <0.1 | <0.1 | 18.7 | 1.1 | <0.1 | 0.9 |
| WS201 | 1.0m to 4.0m (Made Ground) | <0.1 | <0.1 | 18.9 | 0.8 | <0.1 | 0.9 |
| WS203 | 1.0m to 3.0m (Made Ground / Weathered London Clay) | <0.1 | <0.1 | 18.5 | 0.9 | <0.1 | 0.9 |

Notes: NR = Not recorded, $O_2$ = Oxygen, $CO_2$ = Carbon Dioxide, $CH_4$ = Methane, PID = Photoionising Detector for volatile organic compounds.

The results indicate that negligible flow was recorded in all locations, below the limit of detection (<0.1 l/hr). Additionally, oxygen concentrations were not depleted.

## 6.7 Water

Three monitoring visits were undertaken following completion of the investigation between 28 July and 24 August 2020. Perched water was encountered at shallow depths within the granular Made Ground near the contact with the underlying Weathered London Clay Formation. A summary of the groundwater monitoring readings is presented in Table 9 below, with full monitoring results presented in Appendix F.

**Table 9: Summary of groundwater monitoring**

| *Borehole ID* | *Depth to base of installation (mbgl)* | *Groundwater level reading (mbgl)* | | |
|---|---|---|---|---|
| | | *28/7/20* | *6/8/20* | *24/8/20* |
| BH03 | 4.0 | Dry | Dry | 3.82 |
| WS201 | 4.0 | Dry | Dry | Dry |
| WS203 | 3.0 | 2.10 | 2.08 | 2.03 |

No groundwater strikes were observed within the investigation.

The monitoring indicates that localised perched water is present, typically between the interface of the Made Ground and the London Clay Formation. The monitoring provided no evidence of a laterally continuous groundwater table.

## 6.8 Sulfate and pH Conditions

Testing for geotechnical sulfate and pH conditions was undertaken on six soil samples as part of the ground investigation, in accordance with BRE SD1[13]. The results of the testing are summarised in Table 10, below, with the full test results included in Appendix H.

**Table 10: Summary of pH and sulfate test results**

| Strata | No. of samples | pH | Water soluble sulfate (mg/l) |
|---|---|---|---|
| Made Ground | 2 | 7.8 to 10.8 | 150 to 1700 |
| Weathered London Clay Formation | 1 | 7.8 | 3900 |
| London Clay Formation | 2 | 8.0 to 8.4 | 990 to 1500 |

The implications for the development are discussed in Section 9.7 of this report.

[13] Building Research Establishment Construction Division. (2005). *Concrete in aggressive ground*. Special Digest 1, 3rd Edition.

# 7. CONTAMINATION ASSESSMENT

## 7.1 Introduction

This section evaluates risks to potential receptors at the site from identified chemical contamination. Potential receptors have been identified with reference to the Part 2A regime and associated DEFRA guidance[14]. As with the Part 2A regime, under the planning regime all receptors (humans, controlled waters, ecology, vegetation and buildings) have been considered if there is the potential for them to be adversely affected by exposure to contamination. CGL's approach and rationale to assessment criteria adoption is included in Appendix I.

## 7.2 Risk to Human Health

### *7.2.1 General*

A total of eight samples of Made Ground have been analysed for a suite of contaminants from the CGL boreholes. An assessment of the samples has been undertaken and the findings are summarised in Table I2 in Appendix I.

The results have been compared against the human health Generic Assessment Criteria (GAC) for a "*residential land use without plant uptake"* end use. This is conservative, given the proposed mixed-use development comprising residential dwellings, flexible non-residential use, employment floorspace, and community meeting spaces.

### *7.2.2 Risks from Soil Contaminants*

The results of the Made Ground chemical assessment presented in Appendix I for soils recovered from the western part of the site (Phase 2 investigation) indicate that the concentrations of lead and Dibenzo(a,h)anthracene, are above their respective assessment criteria. No asbestos fibres were identified within the soil samples screened. A summary of the exceedances are presented below:

- Lead – WS202 at 0.3m and WS204 at 1.2m.
- Dibenzo(a,h)anthracene – WS202 at 0.3m and WS204 at 1.2m.

A single borehole (BH03) was undertaken in the anticipated area of the former petrol filling station forecourt, and gross hydrocarbon contamination/buried tanks were not recorded in that location.

[14] DEFRA (2012). *Environmental Protection Act 1990:Part 2A Contaminated Land Statutory Guidance.*

On this basis, the risks to future site users are considered to be **moderate**, based on the concentrations of potential contaminants found within the shallow soils and the anticipated proposed development. This is consistent with the Phase 1 risk assessment presented in the report dated April 2020[2] for the central and eastern part of the site.

The criteria used for the assessment of risks to human health are based on a "*residential without plant update"* end use, which uses a chronic risk assessment, rather than an acute risk assessment. Therefore, the assessment is considered to be conservative when assessed against the short-term potential exposure that may occur to a construction worker supplied with appropriate Personal Protective Equipment (PPE). Notwithstanding this, the risks to construction workers are considered to **moderate to low**, and may be controlled through the appropriate site management practices including good hygiene, dust control and PPE.

The risks to off-site human health receptors from contaminants within the shallow soils, preliminary demolition due to dust generation, are generally considered to be **very low**, and may be mitigated with appropriate site management practices including dust control.

## 7.3 Ground Gas Risk

Based on the gas monitoring undertake, a preliminary Gas Screening Value (GSV) has been calculated in general accordance with BS8485:2015[15]. The calculations are based on the maximum flow rate (0.1l/hr), the maximum value of carbon dioxide (1.1%) and methane (<0.1%) recorded in the three monitored boreholes. It is noted that these readings are consistent with those recording during the Phase 1 CGL investigation within the eastern part of the site, from standpipes within the Made Ground.

The calculated GSVs are presented in Table 11, below.

**Table 11: Gas Screening Value Calculation Table**

| *Ground gas* | *Maximum site concentration (%)* | *Peak flow rate (l/hr)* | *Worst case calculated GSV (l/hr)* |
|---|---|---|---|
| Methane | <0.1 | <0.1 | 0.0001 |
| Carbon dioxide | 1.1 | | 0.0011 |

Notes: GSV Calculation = max recorded value/100 x max flow rate = GSV

In accordance with BS8485:2015, the calculated interim GSVs in Table 10 correlate to Characteristic Situation 1 (CS1), therefore no ground gas protection measures are anticipated to be required for future development of the site. As such, the risks associated with ground gas are considered to be **low**.

[15] British Standards Institute. (2015). Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings. BH 8485:2015.

## 7.4 Risks to Vegetation

The risk to vegetation and plants from phytotoxic contaminants present within the Made Ground has been assessed and details are presented in Appendix I. The $US_{95}$ concentrations of zinc, copper, nickel, and boron are all generally below the assessment criteria, with the exception of outliers identified for zinc and nickel (WS02), and boron (WS04).

On this basis the risk to vegetation and plants is considered to be low. This is consistent with the findings of the Phase 1 assessment undertaken for the central and eastern parts of the site.

## 7.5 Risks to Buildings and Structures

### *7.5.1 Buried Concrete*

There is considered to be a low to moderate risk to concrete due to the concentrations of sulfate identified within the London Clay during the intrusive investigation, although the risks may be mitigated with appropriate concrete mix design (see Section 9.7).

### *7.5.2 Water Supply Pipes*

The available chemical test data from the soils has been compared against the UKWIR[16] values for water supply pipe assessment. With reference to Appendix G, the concentrations of contaminants recorded at typical water pipe depths (0.75m to 1.35m below ground level) do not exceed the threshold for standard plastic water pipes, indicating that protective water pipes may not be required for the development. However, the threshold was exceeded for TPH C10 - 16 at a shallower depth in WS02 (13mg/kg at 0.3-0.7m below ground level, against a threshold of 10mg/kg) and at a depth of 1.50m in WS03 (39mg/kg).

The exact water pipe specification should be confirmed with the local water supply company prior to the commencement of the development.

## 7.6 Updated Conceptual Site Model

The preliminary conceptual site model has revised based on the findings of the intrusive investigation, the potential pollutant linkages identified at the site and the quantitative risk assessment, in accordance with Contaminated Land Report (CLR) 11[17]. Using criteria broadly based on those

[16] UK Water Industry Research. (2010). *Guidance for the selection of water pipes to be used in brownfield sites.* Ref 10/WM/03/21.
[17] The Environment Agency (2004) *Model Procedures for the Management of Land Contamination*, CLR 11

presented in CIRIA Report C552[18] included in Appendix C, the magnitude of the risk associated with potential pollutant linkages has then been assessed in Table 12, below, and illustrated in Figure 5.

The updated CSM presented below also takes into account the previous risk assessment undertaken for the central and eastern part of the site presented in the report dated April 2020[2], and therefore is considered to be applicable for the entire site footprint.

**Table 12: Refined Qualitative Risk Assessment**

| *Potential Source/Medium* | *Potential Exposure Route* | *Potential Receptor* | *Severity* | *Probability* | *Risk Rating* | *Comments* |
|---|---|---|---|---|---|---|
| Explosive/ asphyxiating gases/vapours from underlying Made Ground and potential on and off-site sources | Migration of gases and vapours through the surface via permeable soils and drainage & services | Internal building spaces & future occupiers | Medium | Unlikely | Low | Ground conditions and ground gas monitoring indicate the site may be classified as CS1 where protection measures are unlikely to be required. The western half has not been assessed at this time. |
| | Inhalation of ground gases and/or vapours | Future site users | Medium | Unlikely | Low | |
| Organic/ inorganic contaminants such as hydrocarbons, metals and asbestos within underlying soils (based on potential on and off-site sources) | Direct/indirect ingestion of soil and dust, inhalation of particle vapours and/or asbestos fibres, and dermal contact with contaminants | Construction workers | Severe | Low Likelihood | Moderate | Contamination assessment to date indicates some areas with elevated concentrations of contaminants, however presence of former petrol tanks presents risk of localised contaminated soil which may pose significant health and safety issues. Risks can be mitigated with the correct use of PPE and site procedures. |
| | | Future site users | Mild | Unlikely | Very Low | Risks are likely to be mitigated by either hardstanding or the provision of capping layers within landscaping areas. |
| | | Off-site residents | Mild | Unlikely | Very Low | |
| | Direct contact with underground structures and services | Buildings and structures | Severe | Likely | Moderate/Low | Concrete will require appropriate design based on sulphate class. Barrier water supply pipes may be required for the development but should be confirmed by local water supply company. |
| | Root uptake | Plants and vegetation | Minor | Likely | Low | Contaminant conditions recorded to date do not present a risk to plants, however, a capping layer is required for the development which will mitigate against residual risks. |

The findings of the refined conceptual site model indicate that given the low contaminants concentrations recorded in the soils, the intended use for the site, and that no sources or

[18] CIRIA (2001) Contaminated Land Risk Assessment. A guide to good practice. C552.

visual/olfactory indications of contamination were identified during the ground works, the risks are considered to be very low to moderate/low. There remains a risk of localised hydrocarbon contamination at the location of the former petrol station buried tanks, however the investigation undertaken in close proximity to the inferred location of this tank indicates limited migration of contaminants has occurred.

Incorporating the results of the Phase 1 assessment, the site in its entirety is considered to be **low to moderate risk.** The elevated risk of localised contamination at the former buried tanks necessitates a watching brief and discovery strategy in this area, to provide appropriate mitigation should residual contamination and/or fuel tanks be encountered.

# 8. GEOENVIRONMENTAL RECOMMENDATIONS

## 8.1 Introduction

This section presents geoenvironmental recommendations for the site based on the results of recent ground investigation, taking into consideration the results of the Phase 1 investigation. The recommendations that follow are considered suitable to be adopted across the entire site footprint.

The investigation undertaken to date indicates that contaminant concentrations within the Made Ground across the site present a low to moderate risk to long-term human health and plant growth. However, sands/gravels were recorded in thin lenses apparently impacted by hydrocarbons in the west of the site in an area close to a historic fuel tank in this area. A discovery strategy and watching brief is therefore recommended such that gross contamination encountered during the excavation works is appropriate treated and/or disposed of.

It is not known whether the fuel tanks formerly on site were removed when the site was redeveloped in the 1970's and a methodology for their removal (if present) is provided. It is note that hydrocarbon contamination associated with the former fuel tanks is expected to have been contained by the impermeable London Clay with limited potential for lateral and vertical migration of contaminants

The ground gas monitoring undertaken has not identified elevated concentrations of carbon dioxide or methane, which is consistent with the monitoring undertaken during Phase 1 investigations.

Geoenvironmental recommendations are presented below based on the current CSM and risk assessment. It is considered that the recommendations are suitably protective to mitigate potential risks notwithstanding the need for confirmatory investigation and further assessment.

1. Provision of capping layers in areas of soft landscaping;
2. Protection of underground services by specification of suitable materials;
3. Watching brief and discovery strategy during construction; and
4. Implementation of environmental controls and health and safety procedures to protect construction workers and adjacent site users from potential risks associated with dust, vapours and nuisance odours.

Further details for the outline remediation strategy are provided in the following sections of this report.

## 8.2 Capping Layers

Soil capping layers should be placed in areas of soft landscaping where Made Ground remains at formation level to prevent contact and to break-up potential pathways (for both human health and vegetation) with potential contaminants within the underlying Made Ground.

In areas of communal soft landscaping, a capping layer of clean imported topsoil should be a minimum of 450mm thick, including a minimum of 150mm imported topsoil (or 100mm of topsoil and 50mm sod/turf), with a geotextile separator at the base.

Where the Made Ground is removed and natural uncontaminated soils are confirmed at formation level by a suitably qualified geoenvironmental engineer and chemical analysis, a growth medium including a minimum of 150mm of topsoil (or greater subject to the requirements of the landscape architect) over 300mm of suitably loosened subsoil should be placed.

All imported subsoil and topsoil materials will be clean soil, from a known and reputable source. Chemical certification of the source material and details of the source should be provided by the Contractor prior to capping material being brought to site. The results should be inspected by a suitably qualified geoenvironmental engineer to confirm that the material can be accepted at the site. Topsoil should conform to the requirements of BS 3882[19].

Once imported to site, representative samples should be taken by the geoenvironmental engineer for chemical laboratory analysis, for each type/source of material imported, at a minimum frequency of one test per 150m$^3$ of imported material, or a minimum of three tests per source.

Once placed, the capping layer or growth medium construction should be verified by the geoenvironmental engineer at a minimum frequency of 1 pit per 50m$^2$ area of placed soil.

## 8.3 Buried Services

Based on the contaminant concentrations encountered during the investigation to date, barrier pipework may be required for water supply pipes. The final specification for water supply pipework at the site should be agreed with the relevant water company.

## 8.4 Material Management and Waste Disposal

It should be noted that the management of construction waste should be carried out in accordance with the Waste (England and Wales) Regulations 2011. This places an emphasis on the Waste

[19] British Standards. (2015). BS 3882. *Specification for topsoil and requirements for use*.

Hierarchy, which requires an avoidance of waste in the first instance followed by reducing the volume that requires disposal after it has been generated.

### *8.4.1 Re-use, Recycling and Recovery*

In order to minimise the volumes of soils being disposed to landfill facilities, it is prudent to consider material management options prior to waste disposal. Screening of shallow uncontaminated natural arisings may permit recycling/reuse of the material on site or for other sites under the WRAP[20] protocol (uncontaminated granular soils only) or the CL:AIRE[21] protocol and could lead to a reduction in disposal requirements.

### *8.4.2 Waste Disposal*

A preliminary assessment of the soil at the site for waste classification purposes has been undertaken in accordance with the guidance in Technical Guidance WM3[22] based on the results of the analyses undertaken.

The samples tested of Made Ground may be classified as 'not-hazardous' for off-site waste disposal purposes and may be disposed of to a suitably licensed inert or non-hazardous waste facilities subject to Waste Acceptance Criteria Testing. Uncontaminated natural soils can be disposed of as inert waste.

Under the Landfill (England and Wales) Regulations 2002 (as amended), there are three types of landfill: 'inert', 'non-hazardous' and 'hazardous'.

It should be noted that all waste will require pre-treatment, where possible, before disposal to a licensed landfill. 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. However, there is no pre-treatment requirement if waste is sent for recovery instead of disposal.

Uncontaminated natural soils may be disposed to an inert landfill as listed inert waste. The chemical testing results and exploratory hole logs should be provided to the chosen landfill to confirm if they can accept the material based on requirements of their licence.

It may also be possible to dispose of the Made Ground to a soil hospital/ recycling facility, where disposal does not incur landfill tax. This should be discussed with a suitable facility.

[20] WRAP. (n.d.) The Quality Protocol.
[21] CL:AIRE (2011). The Definition of Waste: Development Industry Code of Practice. Version 2.
[22] Environment Agency. 2015. Technical Guidance WM3. Waste Classification: Guidance on the Classification and Assessment of waste. (1st Edition, May2015)

All material intended for off-site 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).

## 8.5 Watching Brief and Discovery Strategy

It is recommended that a watching brief is maintained, during redevelopment, by the Main Contractor. Where unexpected gross contamination, such as fibrous material, oily material or material of an unusual colour or odour, is encountered, a qualified geoenvironmental engineer should be informed and the risk associated with the contamination assessed. The regulators should also be informed of unexpected contamination observations and should be provided with the risk assessment and the verification records of remediation works to be completed if required.

The following strategy is recommended:

1. Work to cease in that area.

2. Notify geoenvironmental engineer to attend site and sample material for appropriate analysis. Notify Contaminated Land Officers of the Local Authority as appropriate.

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

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. In-situ testing should be undertaken, if appropriate, 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 disposal, or treatment if appropriate, and dealt with accordingly.

6. Detailed records of the stockpile sizes, source and location should be kept and regularly updated to allow materials to be easily tracked from excavation until leaving the site.

7. Records of excavated areas and the results of chemical testing should be incorporated within the final verification report for the site.

To facilitate appropriate waste disposal and potential re-use of materials all excavated soils should be segregated and stockpiled depending on their soil classification.

If no observations of unexpected conditions are made, this should be recorded as a statement from the contractor undertaking the watching brief for inclusion in the site Health and Safety file or remediation verification report, as appropriate.

## 8.6 Tank Removal

It is not known whether the fuel tanks formerly on site were removed when the site was redeveloped in the 1970's and a methodology for their removal (if present) is provided below. It is noted that hydrocarbon contamination associated with the former fuel tanks is expected to have been contained by the impermeable London Clay with limited potential for lateral and vertical migration of contaminants.

If the fuel tanks are found to have remained in place following previous redevelopment of petrol filling station, these should be decommissioned and removed by a tank removal specialist in accordance with Code of Practice from Defra[23], APEA Guidance[24] and although noted to no longer be current, the following guidance documents are also considered to present best practice: Health and Safety Executive Guide CS 15[25]: Cleaning and gas freeing of tanks containing flammable residues and Guide HSG41 Petroleum Filling Stations Construction and Operation and other available guidance where appropriate.

The works should be carried out and validated under the observation of a suitably qualified geo-environmental engineer. The sides and base of the resulting excavations should be verified by visual/olfactory observations supported by use of a photo ionisation detector (PID) to monitor Volatile Organic Compounds (VOCs) and sampling and laboratory analysis for speciated hydrocarbons to verify the successful removal of the tank and associated impacted soils. Results of soil samples should be screened against applicable human health generic assessment criteria (GAC), although it is noted that if the tanks are encountered within the Made Ground, then the surrounding soils will be removed as part of the basement excavation.

The soils beneath the tank should be inspected by a suitably qualified geo-environmental engineer – if previously unidentified grossly contaminated soils are present, further assessment will be undertaken and a revised remediation strategy will be produced.

[23] Defra. (2016). *Prevent groundwater pollution from underground storage tanks*. June 2016.
[24] APEA. *Guidance for Design, Construction, Modification, Maintenance and Decommissioning of Filling Stations, 4th Edition*.
[25] HSE. Health and Safety Executive Guide CS15. *Cleaning and gas freeing of tanks containing flammable residues*

## 8.7 Health and Safety

All site works should be undertaken in accordance with the guidelines prepared by the Health and Safety Executive (HSE, 1991)[26] and CIRIA Reports C132[27] and C650[28]. Although asbestos has not been detected during the current site investigation there is the potential for undiscovered asbestos fibres and/or asbestos containing materials (ACMs). Where necessary, ACMs should be handled/removed in accordance with current regulations and guidance[29,30,31,32]. All work should also be carried out in accordance with the Contractor's Construction Health and Safety Plan.

During the redevelopment, precautions should be taken to minimise exposure of workers and the general public to potentially harmful substances. Attention should also be paid to restricting possible off-site nuisance such as dust and odour emissions. Such precautions should include, but not be limited to:

- Personal hygiene, washing and changing procedures;
- Adequate PPE including disposable overalls, gloves and particulate filter masks/vapour respirators, where required;
- Dust and vapour suppression methods, including dampening 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; and
- Positive collection and disposal of on-site run-off including prevention of run-off migrating to pumped drainage in basement.

Excavations should be planned and inspected regularly by a competent person. No operatives should be permitted to enter un-shored or otherwise protected excavations identified as unstable by a competent person, however shallow they are.

[26] HSE (1991). Protection of Workers and the General Public during the development of contaminated land. Guidance Note HS(G)66, Health and Safety Executive, HMSO, 1991.
[27] CIRIA (1996). A guide for safe working on contaminated sites. Steeds JE, Shepherd E & Barry DL. CIRIA Report 132.
[28] CIRIA (2005) Environmental good practice – Site guide, 2nd Edition. CIRIA Report C650.
[29] HSG247 (2006) *Asbestos: The licensed contractors' guide*
[30] HSE (2006). *Work with materials containing asbestos- Control of Asbestos Regulations 2006- Approved Code of practice and guidance*, HSE 2006.
[31] Health and Safety Executive (2012). *The Control of Asbestos Regulations*.
[32] Health & Safety Executive. (January 2010). *Asbestos: The Survey Guide*. HSG 264

The stockpiled material and excavations should be dampened during all earthworks excavation and earth moving activities and vehicles should be washed before leaving site, with washings contained on site and suitably disposed.

Site staff undertaking groundworks should be advised of the potential for asbestos fragments and fibres being present and be trained in basic visual recognition of asbestos. Soils being handled should be dampened, taking care that damping is carried out at the appropriate time and with appropriate amounts of water to suppress dust but not saturate the soils. Soils movement should be minimised and double handling avoided.

As outlined in the Detailed UXO Risk Assessment undertaken for the site, which identified the UXO risk as 'high', intrusive magnetometer surveys of all pile locations should be undertaken to at least the maximum bomb penetration depth.

# 9. GEOTECHNICAL RECOMMENDATIONS

## 9.1 General

This section presents geotechnical recommendations for the site based on the results of recent ground investigation, taking into consideration the results of the Phase 1 investigation. The geotechnical recommendations set out below supersede the recommendations in the Phase 1 report dated April 2020[2] are considered to be suitable for design across the entire site footprint.

The recommendations have been made assuming the development will comprise residential dwellings arranged across two buildings ranging in height from three to seven storeys.

## 9.2 Geotechnical Design Parameters

Geotechnical design parameters have been derived for the encountered strata based on the soil descriptions, laboratory testing results and in-situ testing, supplemented with published data and our experience with similar geological strata. A summary of the design parameters is presented in Table 13 below. It should be noted that the Weathered London Clay and London Clay Formation were found to exhibit a consistent strength profile across the two strata and therefore have been assessed as a single stratum for geotechnical design.

**Table 13: Summary of Geotechnical Design Parameters**

| Stratum | Bulk Unit Weight $\gamma_b$ (kN/m³) | Undrained Cohesion $c_u$ (kPa) [c'] | Friction Angle $\phi'$ (°) | Young's Modulus E (MPa) [E'] |
|---|---|---|---|---|
| Made Ground (Granular) | 18 | - | 33[a] | [15][g] |
| London Clay Formation (Cohesive) | 20 | 60 + 6.7z[c,f]<br>[5][b] | 21[b] | 36 + 4z[d,f]<br>[27 + 3z][e,f] |

*Notes*

*a. Peck, R.B., Hanson, W.E., and Thornburn, T.H., Foundation Engineering, 2nd Edn, John Wiley, New York, 1967, p.310.*
*b. BS 8002:2015 Code of practice for Earth retaining structures, British Standards institution.*
*c. Stroud, M.A. (1975). The standard penetration test in insensitive clay and soft rock. Proceedings of the European. Symposium on Penetration Testing, 2, 367-375.*
*d. Based on Eu = 600 x Cu - Burland, Standing J.R., and Jardine F.M. (eds) (2001), Building response to tunnelling, case studies from construction of the Jubilee Line Extension London, CIRIA Special Publication 200.*
*e. Based on 0.75 x Eu. Burland, J.B et al (Ed.) (2001) Building response to tunnelling, case studies from construction of the Jubilee Line Extension London, CIRIA Special Publication 200.*
*f. z = m below top of stratum.*
*g. CIRIA (2017). CIRIA C760. Guidance on embedded retaining wall design.*

## 9.3 Foundations

The details of the proposed foundations for the development are currently unknown, however, based on the ground conditions encountered and the approved development layout it is considered that shallow foundations will not be appropriate for the development due to the thickness of the Made

Ground encountered across the site. Therefore, piled foundations are recommended for the approved development, with Continuous Flight Auger (CFA) methodology considered to be appropriate.

Indicative preliminary pile working loads (kN) are presented in Figure 6 for pile diameters of 0.6m, 0.75m and 0.9m, which have been calculated for a maximum pile depth of 25 m bgl. The preliminary pile working loads have been calculated using moderately conservative strata levels across the site to create a design profile. The pile cut off has been assumed at approximately 1mbgl and any capacity contributed from the Made Ground has been ignored.

The following design assumptions should be considered by the piling contractor and are assumed for the preliminary pile design:

- An adhesion value (α) of 0.5 has been assumed;
- A limiting shaft friction of 110kPa has been assumed;
- A Factor of safety (FoS) of 1.6 has been used for the skin friction FoS and 2 for the base capacity, with a model factor of 1.4. These values have been selected based on Eurocode 7 Design Approach 1 Combination 2 (GEO) factoring.

Final detailed pile design and installation method should be undertaken and specified by the specialist piling contractor awarded the work. The piling contractor may show different pile toe levels and greater load capacity based on their design approach, interpretation of the ground model and design parameters, and also their experience with piling in similar ground conditions.

## 9.4 Thameslink Infrastructure

There is a Network Rail retaining wall along the southern boundary of the site and accordingly, the design team and main contractor will be required to liaise with Network Rail throughout the works.

## 9.5 Excavations

The ground conditions encountered across the site during the ground investigation are not anticipated to present difficulties for conventional earth moving plant.

Based on the findings of the current ground investigation, excavations within the Made Ground, particularly within the southern extent of the site are likely to become unstable and temporary support or battering back will be required to maintain stability. Excavations in the Made Ground may encounter perched water, and control measures, such as a sump and pump system, may be required.

All excavation works should be suitably shored or otherwise supported and be regularly inspected by a suitably competent person. Under no circumstances should operatives enter unsupported or otherwise

unprotected excavations or excavations identified as unstable by a competent person, this is in accordance with the guidelines presented in the CIRIA Report 97[33].

## 9.6 Floor Slabs and Pavement Design

Based on the ground conditions encountered, suspended floor slabs are recommended for the development. A design CBR of <2.5% should be adopted for pavements in the Made Ground. It is noted that this can be improved by proof rolling the Made Ground and re-testing.

## 9.7 Buried Concrete

The design sulfate (DS) and Aggressive Chemical Environmental for Concrete (ACEC) classes for the different strata onsite are presented below in Table 14. The information is based on the results of the geotechnical sulfate and pH testing from both Phase 1 and Phase 2 investigations.

The London Clay Formation is potentially pyritic, and on this basis, the percentage of oxidisable sulfate has been calculated for the London Clay. The results indicate oxidisable sulfate above 0.3% in each sample of the London Clay and the total potential sulfate (TPS) has therefore been considered in the selection of design sulfate class.

**Table 14. Summary of DS and ACEC classes.**

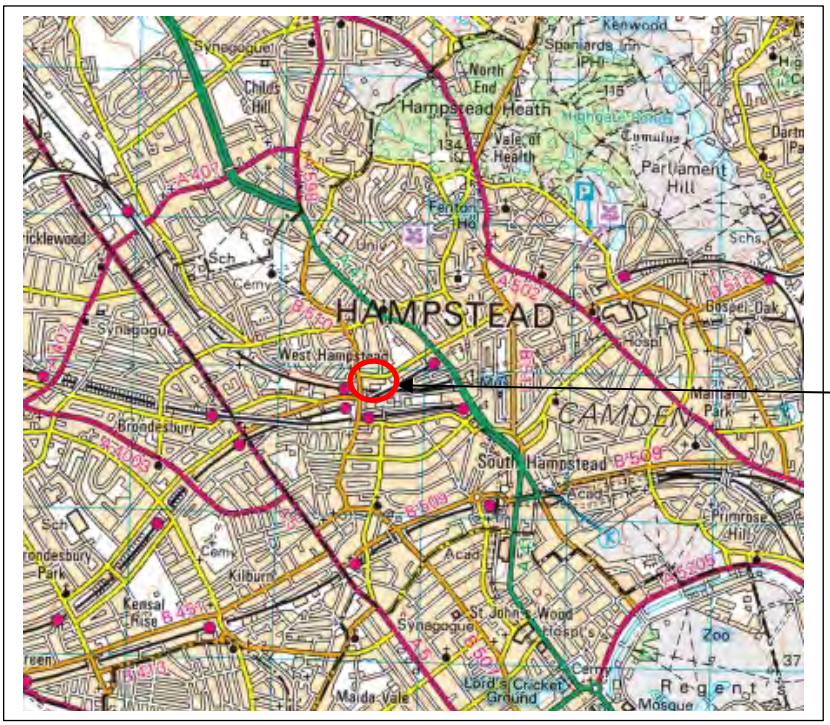
| Stratum | Water Soluble Sulfate (WSS) | | Total Potential Sulfate (TPS) | |
|---|---|---|---|---|
| | DS class | ACEC Class | DS class | ACEC Class |
| Made Ground | DS-3 | AC-3 | N/A | |
| Weathered London Clay Formation | DS-4 | AC-3s | DS-4 | AC-3s |
| London Clay Formation | DS-4 | AC-3s | DS-4 | AC-3s |

The availability of total potential sulfate (TPS) in pyritic soils (i.e. London Clay Formation) is dependent on the extent to which 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[34] 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".*

[33] CIRIA (1992) Report 97. Trenching Practice. 2nd Edition
[34] BRE (2005) *Concrete in Aggressive Ground.* BRE Special Digest 1:2005.

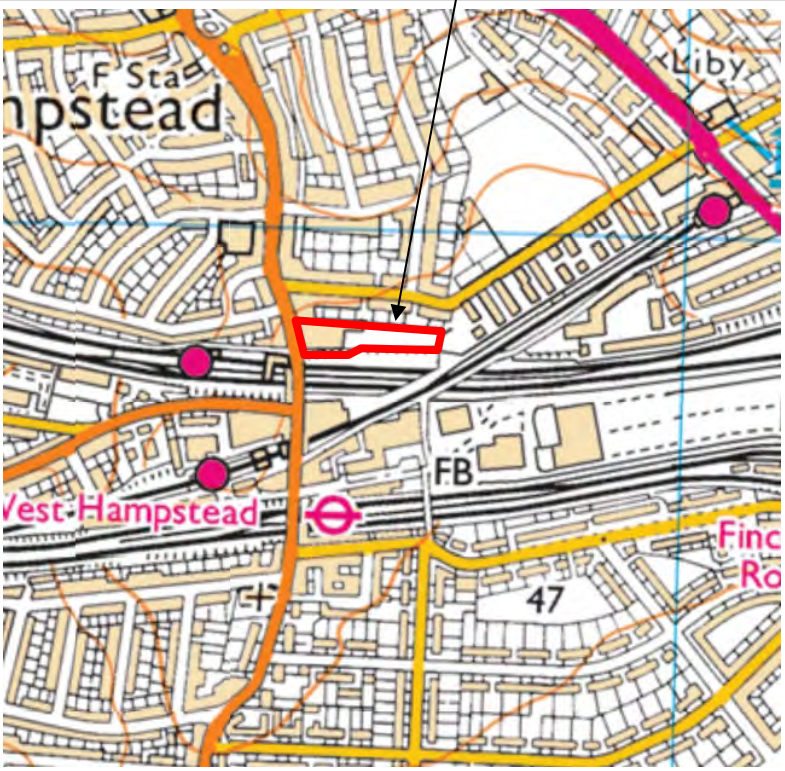
On this basis, the appropriate DS and ACEC class for the pyritic soils, i.e. based on water soluble sulfate or total potential sulfate, should be adopted dependant on the extent to which the soils will be disturbed during construction.

# FIGURES



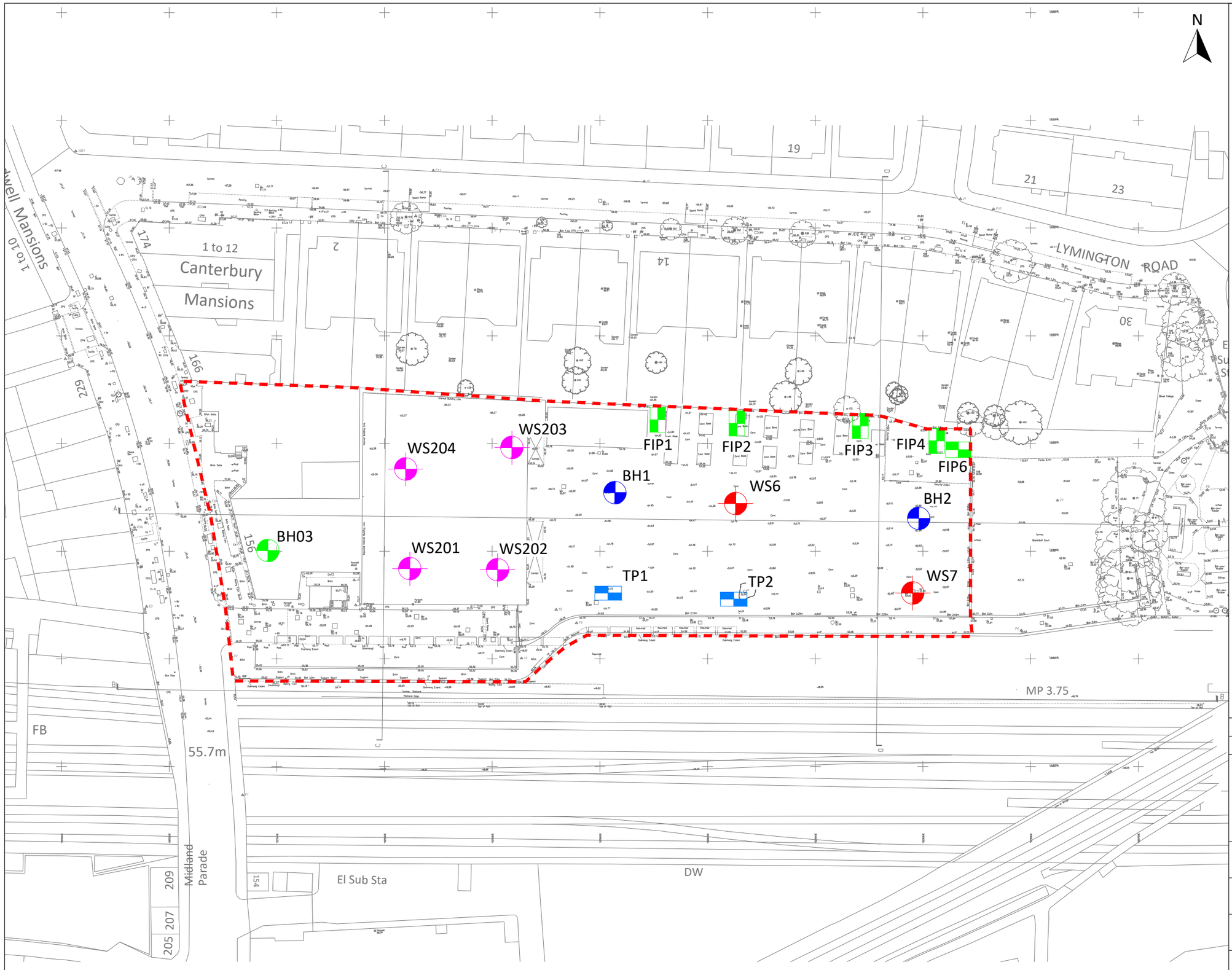

N

Site






| Client | Project | Job No |
|---|---|---|
| **A2 Dominion** | **156 West End Lane, West Hampstead** | **CG/38293a** |
| CGL | Title: **Site Location Plan** | **Figure 1** |




**KEY**

- Foundation Inspection Pit (March 2020)
- Window Sample Borehole (March 2020)
- Cable Percussion Borehole (March 2020)
- Trial Pit (March 2020)
- Window Sample Borehole (July 2020)
- Cable Percussion Borehole (July 2020)
- Site Boundary

**Notes.**

1. Do not scale from drawing.
2. Topographical base plan taken from Cadmap survey 'CM/15172-T' Rev A (27.05.15).

| Rev | Date | Comments |
|---|---|---|
| 0 | 24/08/2020 | |


Card Geotechnics Ltd
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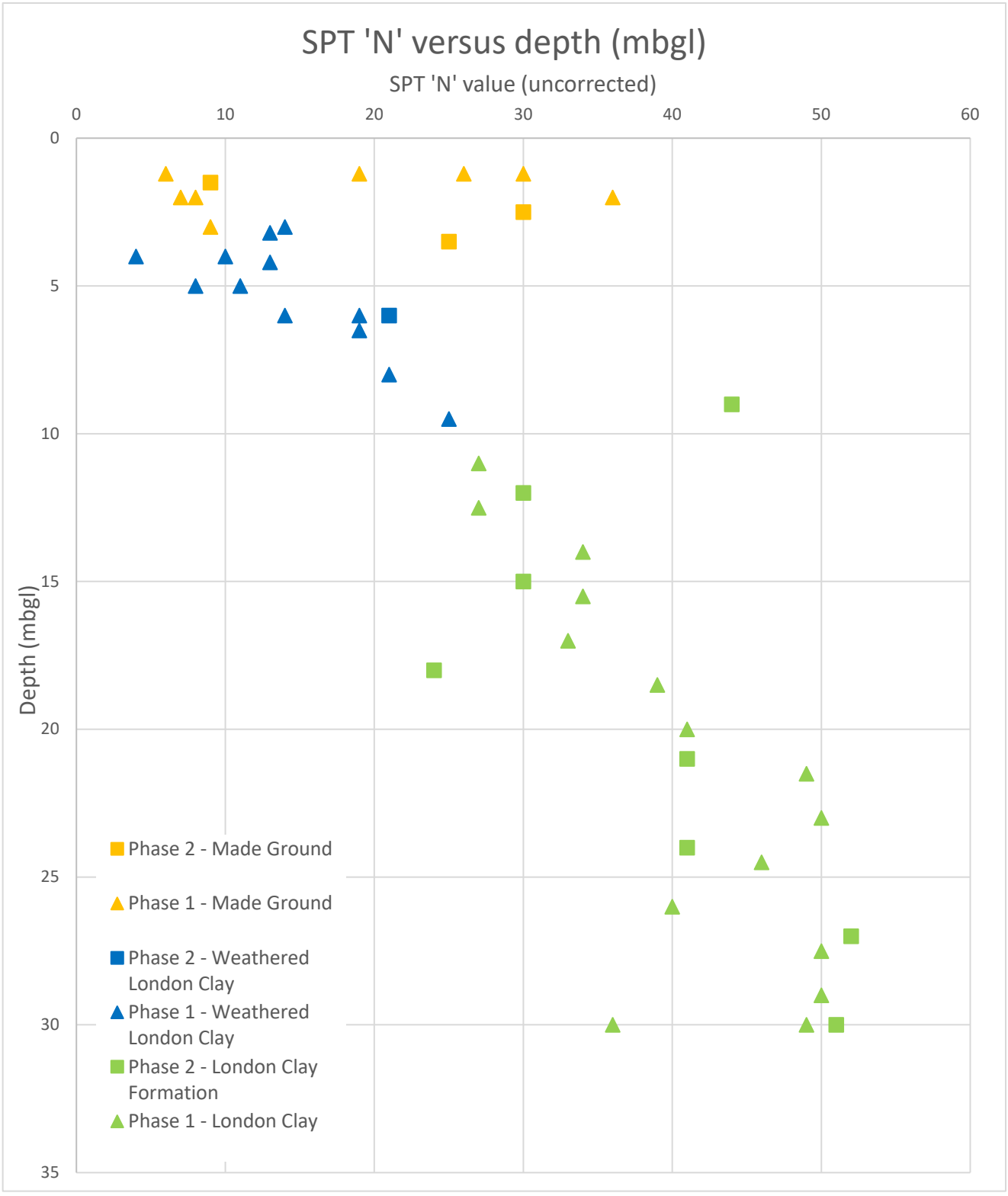
Project
**156 West End Lane, West Hampstead**

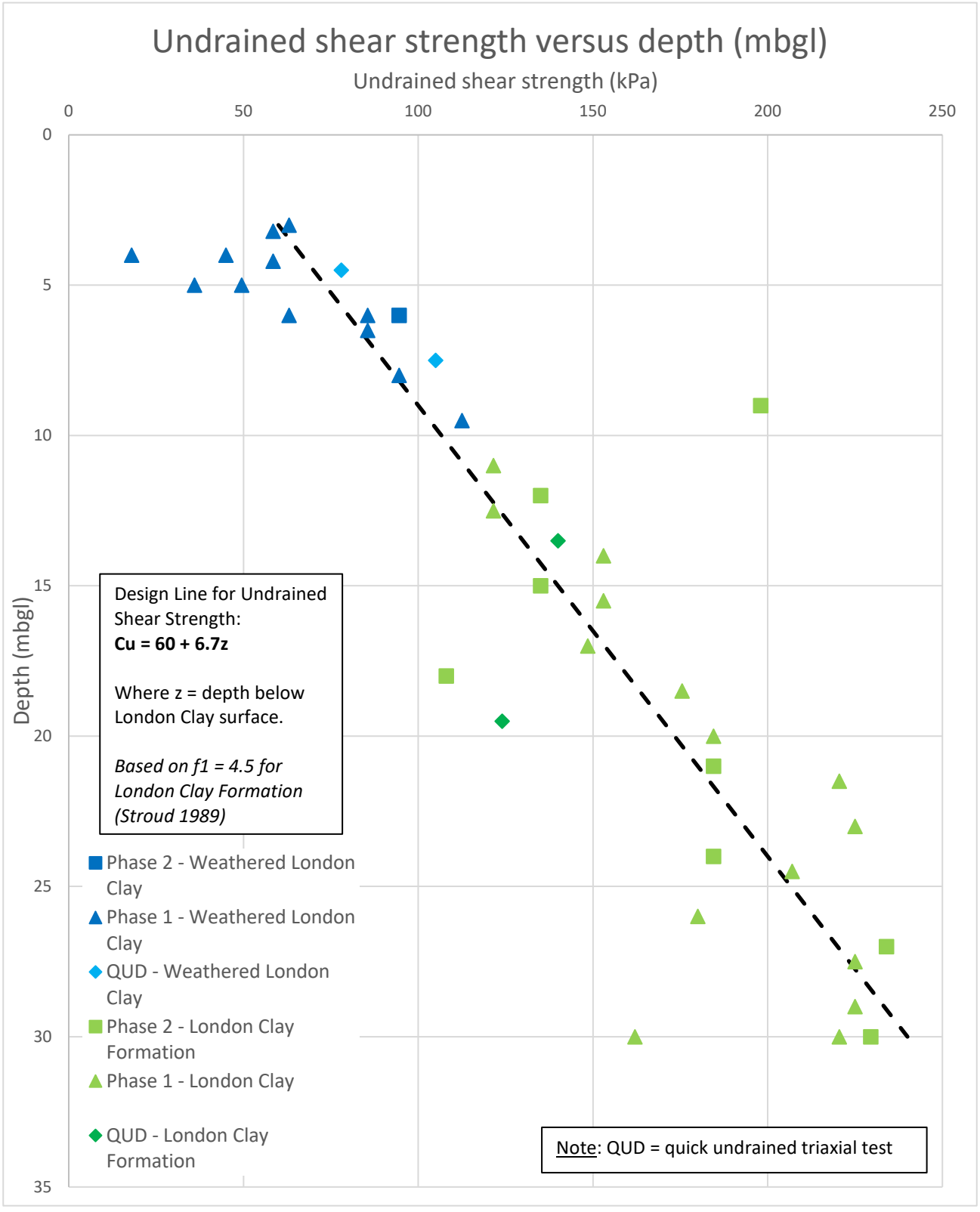
Client
**A2 Dominion**

Drawing title
**Figure 2 - Exploratory Hole Location Plan**

| Scale(s) | Job No. | |
|---|---|---|
| **NTS** | **CG/38293a** | |
| Drawn: RSW 24/08/20 | Dwg No. **CG/38293a-001** | Rev. **0** |
| Checked | | |
| Approved | | |




| Client | Project | Job No |
|---|---|---|
| **A2 Dominion** | **West End Lane, West Hampstead** | **CG/38293a** |
| CGL | Title: **SPT 'N' Values versus depth (mbgl)** | **Figure 3** |




| Client | Project | Job No |
|---|---|---|
| **A2 Dominion** | **156 West End Lane, West Hampstead** | **CG/38293a** |
| CGL | Title: **Undrained shear strength ($c_u$) versus depth (mbgl)** | **Figure 4** |

**Relevant pollutant linkages and associated risks:**

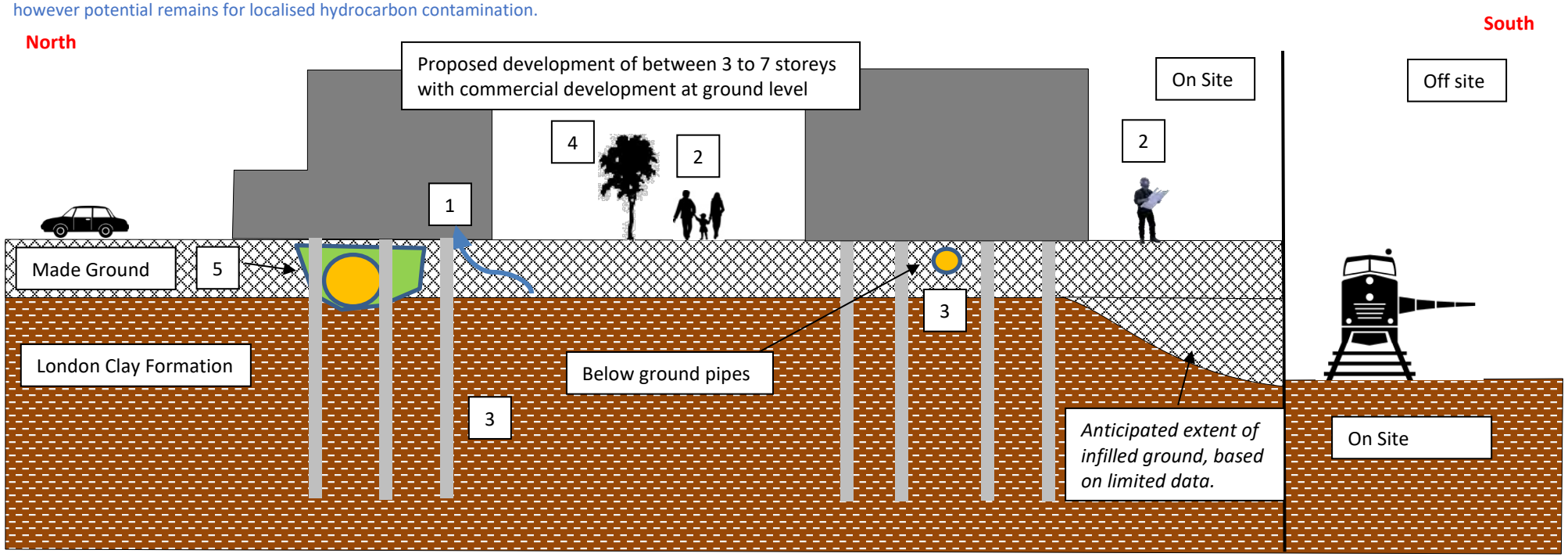
**1**.Ingress of explosive/ asphyxiating gases/vapours from underlying Made Ground and potential on and off-site sources → Moderate/Low risk → Ground conditions and round gas monitoring indicates the site may be classified as CS1 where protection measures are unlikely to be required.

**2.** Ingestion, direct/dermal contact and inhalation of organic/inorganic contaminants from soils/dust by construction workers and future site users and neighbours → Very low to moderate risk → Low contaminant concentrations recorded in soils. Risks to construction workers can be mitigated with the correct use of PPE and site procedures. Risks to future site users are likely to be mitigated by either hardstanding or the provision of capping layers within landscaping areas.

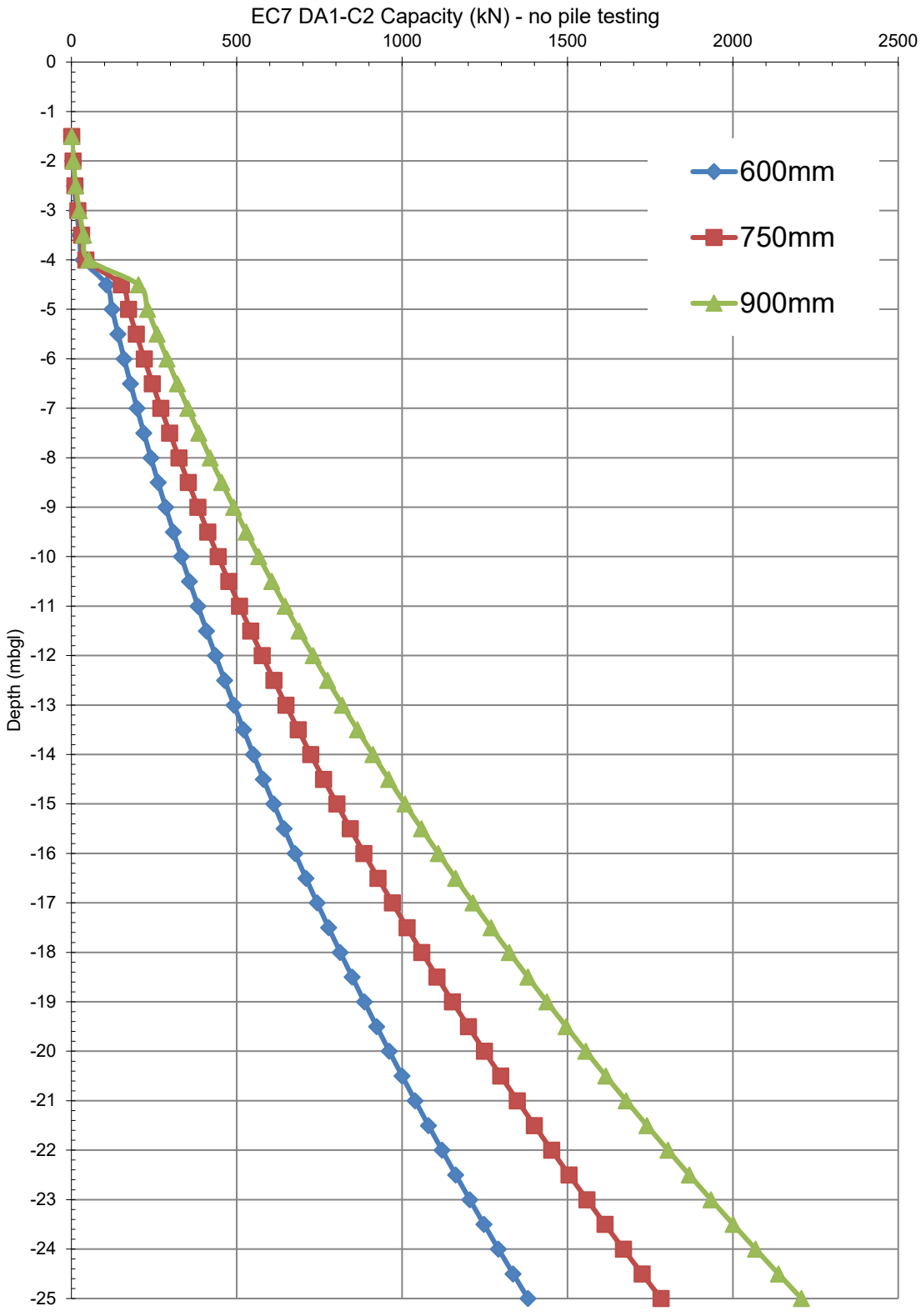
**3.** Direct contact of contamination with underground concrete structures → Moderate/Low risk → Concrete will require appropriate design based on sulphate class. Barrier water supply pipes may be required for the development but should be confirmed by local water supply company.

**4.** Uptake of organic/inorganic contaminants by plant roots → Low risk → Contaminant conditions recorded to date do not present a risk to plants, however, a capping layer is required for the development which will mitigate against residual risks.

**5.** High concentrations of contaminants from buried tanks related to former petrol station→ High risk → Investigations in proximity to buried tanks do not indicate significant migration of contamination, however potential remains for localised hydrocarbon contamination.




| Client | Project | Job No |
|---|---|---|
| **A2 Dominion** | **156 West End Lane, West Hampstead** | **CG/38293a** |
| CGL | Title: **Conceptual Site Model** | **Figure 5** |




| Client | Project | Job No |
|---|---|---|
| **A2 Dominion** | **156 West End Lane, West Hampstead** | **CG/38293a** |
| CGL | Title: **Pile Capacities (no pile testing)** | **Figure 6** |

# APPENDIX A

*Proposed Development Plan*


Key

- Private Sale
- Shared Ownership

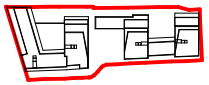
NOTES

-Do not scale from this drawing, except for planning purposes.
-Check all dimensions on site.
-Subject to survey.
-Subject to site inspection.
-Site boundary lines are indicative only.

| Rev | Date | By | Description |
|---|---|---|---|
| P | 05.08.16 | AFG | Mix updated to meet 50% affordable/private split |
| O | 02.08.16 | AB | Revisions following planners comments. |
| N | 06.06.16 | AB | Planning resubmission |
| M | 18/11/15 | AB | Notes added |
| L | 28/10/15 | AB | Change to wheelchair units and plant spaces |
| K | 20/10/15 | AB | Layout revisions following interior design comment. Cores move south, some units widened. Types rationalised. |
| J | 09/10/15 | AB | Some internal layouts and detail added |
| I | 05/10/15 | AB | Changes to mix as clouded. |
| H | 01/10/15 | AB | Scheme revised to six storeys. Plans updated in line with elevations and to rationalise unit types. Other changes following planning and client comments as clouded. |
| G | 04/09/15 | AB | Changes to mix and in line with elevations |
| F | 24/06/15 | | Revisions as clouded. General amendments to mix to acheive target affordable/ private split. |
| E | 17/06/15 | | NIA areas shown |
| D | 29/04/15 | | Vehicle access and servicing arrangements revised, no 1 bed private sale units above 3rd floor, detail added generally. |
| C | 17/04/15 | | Minor adjustments to sizes of units to affordable block, and plant |
| B | 16/04/15 | | Mix adjusted, servicing requirements incorporated |
| A | 01/04/15 | | Start-Up Units added, unit mix amended. |
| - | 19-03-2015 | | First issue |

Revision Schedule

key plan



a2dominion

project
156 WEST END LANE
WEST HAMPSTEAD

title
LOWER GROUND FLOOR PLAN

drawing status
PLANNING

| contract no. | scale |
|---|---|
| | 1 : 500 @ A3 |
| client ref. | date |
| A2 DOMINION | 19/03/15 |
| drawn by | checked by |
| AB | Checker |

| project no. | drawing number | revision |
|---|---|---|
| 13119 | SK(-1)P003 | PP |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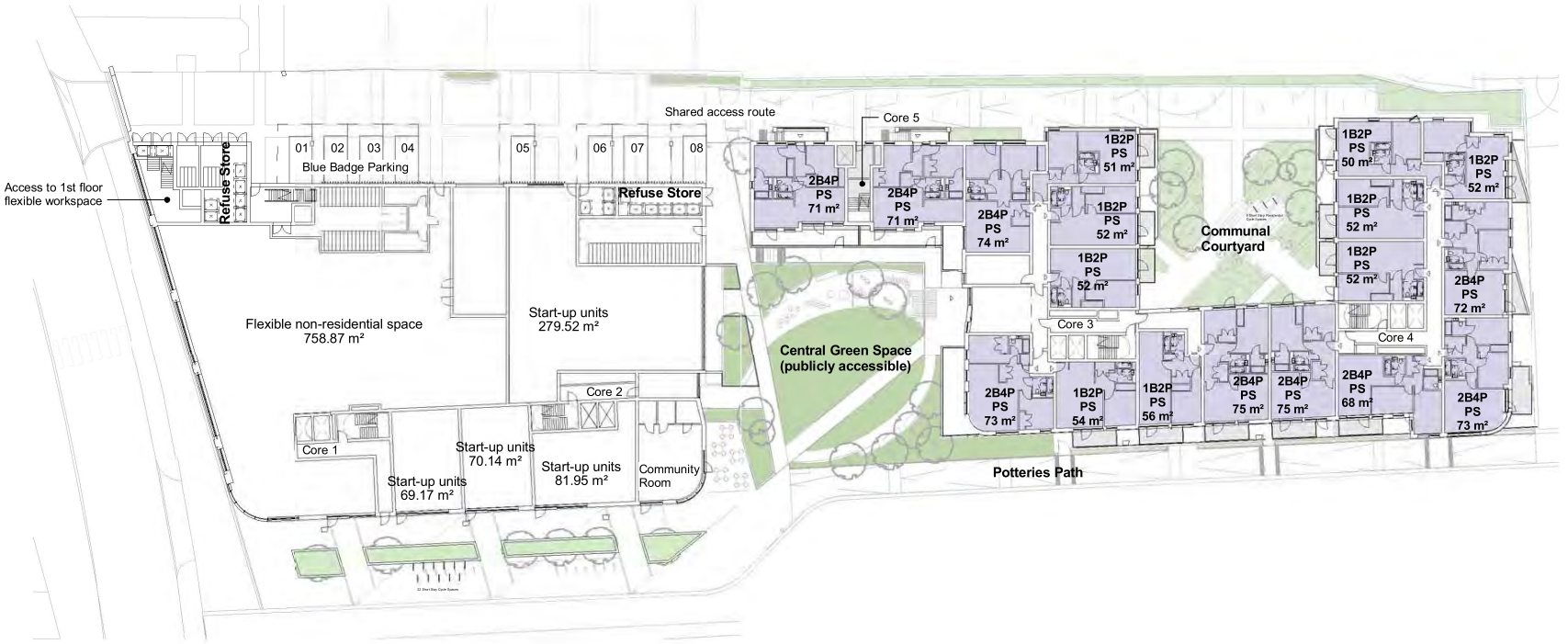



1 00 - Ground Floor
1 : 500

Key

Private Sale

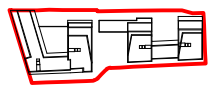
5 0 5 10 20 25m
Scale 1:500

NOTES
-Do not scale from this drawing, except for planning purposes.
-Check all dimensions on site.
-Subject to survey.
-Subject to site inspection.
-Site boundary lines are indicative only.

| Rev | Date | By | Description |
|---|---|---|---|
| O | 25.01.2017 | AFG | Parking layout amended to show 8 No. spaces |
| N | 24.11.16 | EMF | Cycle spaces added |
| M | 02.08.16 | AB | Revisions following planners comments. |
| L | 08.06.16 | AB | Planning resubmission |
| K | 13/11/15 | AB | Planning Issue |
| J | 28/10/15 | AB | Change to wheelchair units and plant spaces |
| I | 20/10/15 | AB | Layout revisions following interior design comment. Cores move south, some units widened. Types rationalised. |
| H | 09/10/15 | AB | Some internal layouts and detail added |
| G | 01/10/15 | AB | Scheme revised to six storeys. Plans updated in line with elevations and to rationalise unit types. Other changes following planning and client comments as clouded. |
| F | 04/09/15 | AB | Changes to mix and in line with elevations |
| E | 21/07/15 | AB | Minor corrections, detail added to flats |
| D | 16/07/15 | AB | Update to layout to add office cycle store and stair to podium. Other changes to layout as clouded to enable reduction of bulk on upper storeys. |
| C | 24/06/15 | | Revisions as clouded. General amendments to mix to achieve target affordable/ private split. |
| B | 17/06/15 | AB | Unit sizes increased where below GLA standard. NIA areas shown. |
| A | 10/06/15 | AB | Minor amendments. Notes added. |
| - | 19/05/15 | | First issue |

Revision Schedule

key plan



a2dominion

project
156 WEST END LANE
WEST HAMPSTEAD

title
GROUND FLOOR PLAN

| | |
|---|---|
| drawing status: PLANNING | |
| contract no. | scale: 1 : 500 @ A3 |
| client ref.: A2 DOMINION | date: 05/19/15 |
| drawn by: AB | checked by |
| project no.: 13119 | drawing number: SK(00)P007 — revision: PO |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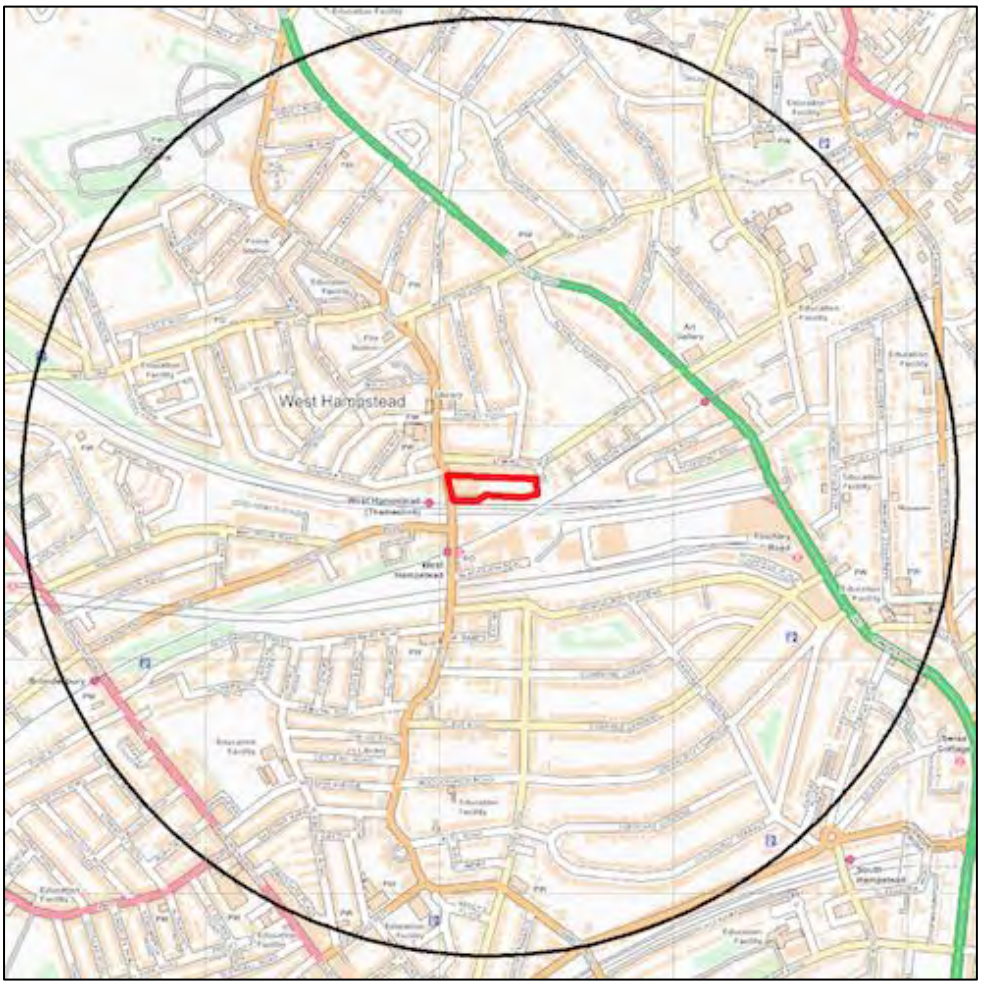
# APPENDIX B

*Unexploded Ordnance Risk Assessments*

# PRELIMINARY UNEXPLODED ORDNANCE (UXO) THREAT ASSESSMENT

Meeting the requirements of *CIRIA* C681 'Unexploded Ordnance (UXO) – A guide for the Construction Industry' Risk Management Framework




| | | | |
|---|---|---|---|
| **PROJECT NUMBER** | 7921 | **ORIGINATOR** | D. Barrett |
| **VERSION NUMBER** | 1.0 | **REVIEWED BY** | S. Barratt (13th January 2020) |
| **CLIENT** | CGL | **RELEASED BY** | J. Cole (13th January 2020) |
| **SITE** | 156 West End Lane, West Hampstead, NW6 1SD | | |
| **RECOMMENDATION** | This Site requires a Detailed UXO Threat and Risk Assessment | | |

6 alpha ASSOCIATES
special risks consultancy

6 Alpha Associates Limited, Unit 2A Woolpit Business Park, Bury St Edmunds, IP30 9UP, United Kingdom
T: +44 (0)2033 713 900 | W: www.6alpha.com

# UNEXPLODED ORDNANCE THREAT ASSESSMENT

## STUDY SITE

The Study Site is described as "156 West End Lane, West Hampstead, NW6 1SD", and it is centred on National Grid Reference 525607, 184868.

## THREAT POTENTIAL AND RECOMMENDATIONS

The potential for a UXO hazard to occur, and more specifically, the potential for unexploded WWI and WWII ordnance to exist at this site is assessed as being LIKELY (*Figure 2*).

In accordance with *CIRIA* C681 Chapter 5 on managing UXO risks, *6 Alpha* recommends that the next stage in the risk management framework is:

**DETAILED UXO THREAT & RISK ASSESSMENT**

We would be pleased to provide this service, please contact *6 Alpha Associates* for further details.

## REPORT SUMMARY

During WWII, the Study Site was situated within *Hampstead Metropolitan Borough*, which recorded 35 High Explosive (HE) bomb strikes per 100 hectares; a moderate level of bombing.

*Luftwaffe* aerial reconnaissance photography associated with the Study Site did not identify any primary bombing targets on-site or within 1,000m of the Study Site boundary.

*Air Raid Precaution* (ARP) records identified one HE bomb strike on-site. In addition, eight HE bomb strikes were identified within 95m of the Study Site boundary, the closest being 25m east. Furthermore, five unexploded bombs were identified within 880m, the closest being 740m north-west of the Study Site boundary.

*London County Council* (LCC) bomb damage mapping associated with the Study Site did not identify any bomb damage to structures on-site. Nonetheless, areas of "*serious damage; but repairable at cost*" were identified 30m west and 40m north, areas of *"blast damage; minor in nature"* were identified 75m south-south-west and areas of *"general blast damage; not structural"* were identified 85m south of the Study Site boundary.

Given that bomb strikes were identified on-site and in the immediate vicinity during WWII; it would suggest that further action is warranted to address the potential for UXO encounter.

## USING THIS REPORT

This Preliminary Assessment is designed to inform environmental and construction professionals of the potential threat of military related explosives and/or ordnance on, or in, the vicinity of the Study Site.

This assessment is designed to be employed as a site-screening tool to meet with the requirement of Phase One of the *CIRIA UXO Risk Management Framework*; there are two broad prospective outcomes; either the threat level requires a detailed threat & risk assessment; or no further action is required. In the former instance we can provide a report within 10 working days (or more quickly upon application).

Two figures accompany the report, the *Second World War* (WWII) High Explosive (HE) Bomb Density and the final Probability of UXO Encounter. The purpose of this approach is to demonstrate that whilst bomb density statistics give an indication for WWII bombing, they should not be relied upon exclusively to generate a holistic assessment.

For further information, please contact *6 Alpha*:

Website: http://www.6alpha.com

Telephone: +44 (0)2033 713 900

Email: enquiry@6alpha.com

## DATA FINDINGS

| Threat Source (within 1,000m) | | Detail | |
|---|---|---|---|
| | | Identified | Comments |
|  | Airfields/Military Facilities | ✗ | None recorded within 1,000m. |
|  | Ordnance Manufacture/Storage | ✗ | None recorded within 1,000m. |
|  | WWII Decoy Bombing Sites | ✗ | None recorded within 1,000m. |
|  | WWII Defensive Features | ✗ | None recorded within 1,000m |
|  | WWII *Luftwaffe* Designated Bombing Targets | ✗ | *Luftwaffe* aerial photography did not identify any primary bombing targets on-site or within 1,000m of the Study Site boundary. |
|  | WWII Bomb Strikes Within Site Boundary | ✓ | ARP records identified one HE bomb strike on-site. |
|  | WWII Bomb Strikes Near Site Boundary | ✓ | HE bomb strikes; 25m east, 25m south, 55m east, 75m west-north-west, 80m south-west, 85m west, 90m west-south-west, 95m east. |
|  | WWII Bomb Damage | ✓ | LCC bomb damage mapping recorded areas of *"serious damage; but repairable at cost"* 30m west and 40m north. |
|  | Abandoned Bomb Register | ✗ | The official abandoned bomb list did not identify any abandoned bombs on-site or within 1,000m of the Study Site boundary. |
|  | Potential Threat Sources | ✓ | The most probable UXO threat is posed by WWII *German* HE bombs, whilst IBs and British AAA projectiles pose a residual threat. |
|  | WWII Bombing Density Per 100 Hectares | ✓ | The Study Site was located within *Hampstead Metropolitan Borough*, which recorded 35 HE bomb strikes per 100 hectares. |

## IMPORTANT NOTES

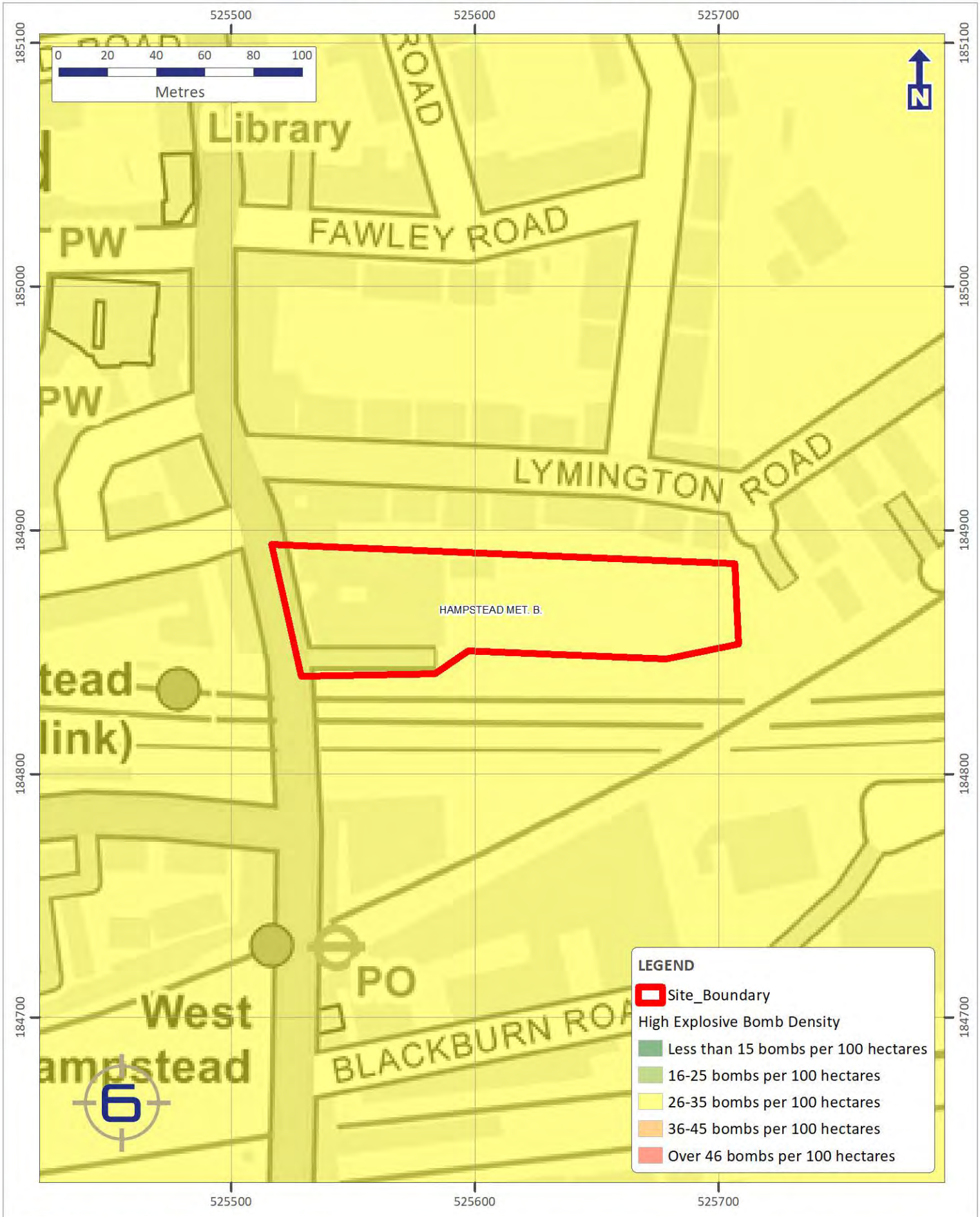
1. The term 'Preliminary UXO Threat Assessment' has been used to describe this report, to fall in line with the *CIRIA* C681 guidelines. Whilst the term 'Risk' can be justifiably used at this stage, the reader should note that the 'Consequence' function of 'Risk' is not considered. Should it be required, this would be addressed in the 'Detailed UXO Threat & Risk Assessment' (Stages 2 and 3).
2. This report is accurate and up to date at the time of writing.
3. The assessment levels have been generated from historical data and third party sources. Where possible *6 Alpha* have sought to verify the accuracy of such data, but cannot be held accountable for inherent errors that may be in third party data sets (e.g. *National Archives* or library sources).
4. *6 Alpha* have exercised all reasonable care, skill and due diligence in producing this service.
5. Whilst every effort has been used to identify all potential UXO/explosive threats, there were a number of private facilities, which may not have released privately recorded information concerning UXO/explosive threats into the public domain. It is therefore possible that some of the aforementioned sites may not be included within the database.

BRITISH NATIONAL GRID

# 156 WEST END LANE, WEST HAMPSTEAD, NW6 1SD

## WWII High Explosive Bomb Density

BOMB SEARCH
WWW.6ALPHA.COM

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BRITISH NATIONAL GRID

# 156 WEST END LANE, WEST HAMPSTEAD, NW6 1SD

## Probability of UXO Encounter

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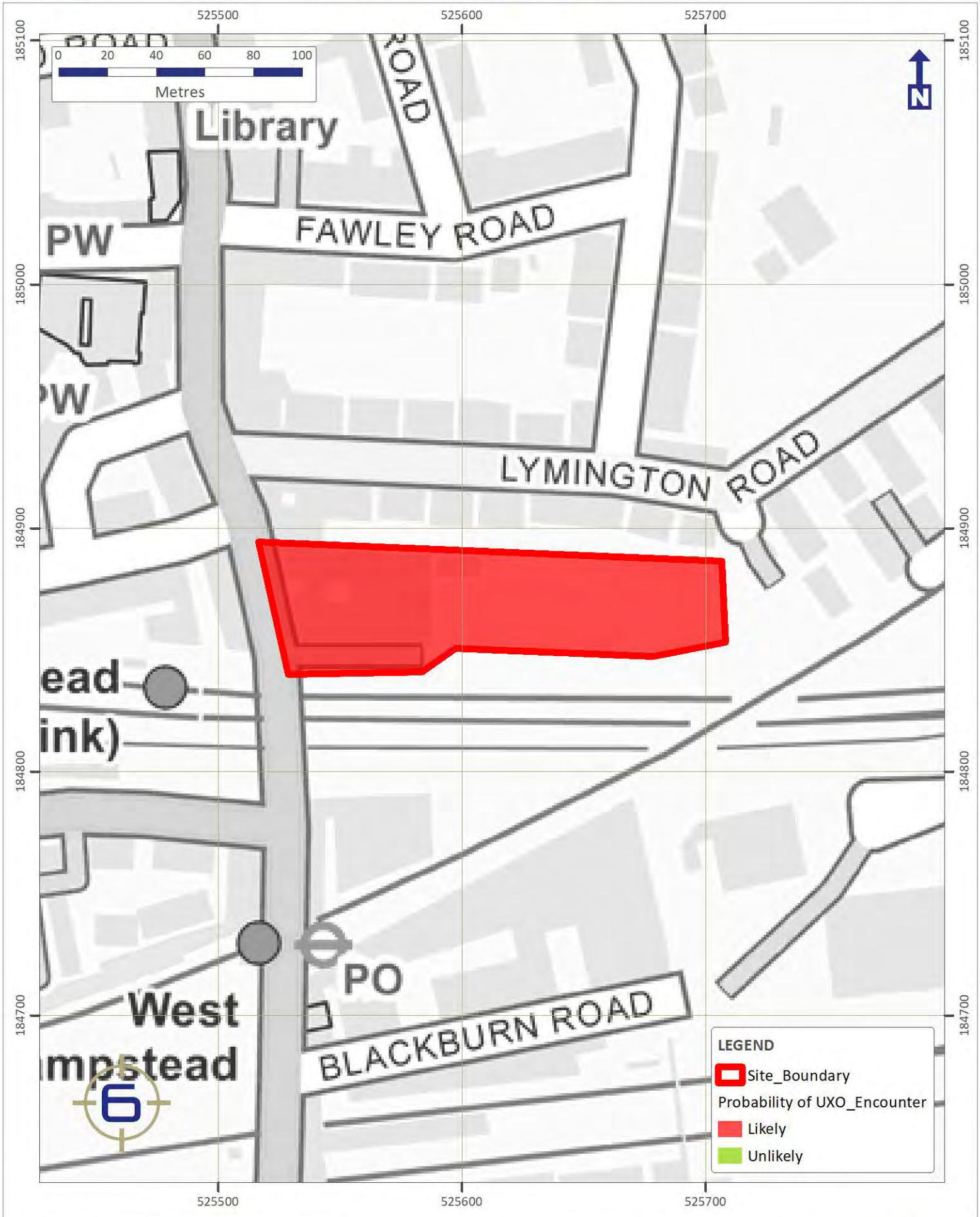


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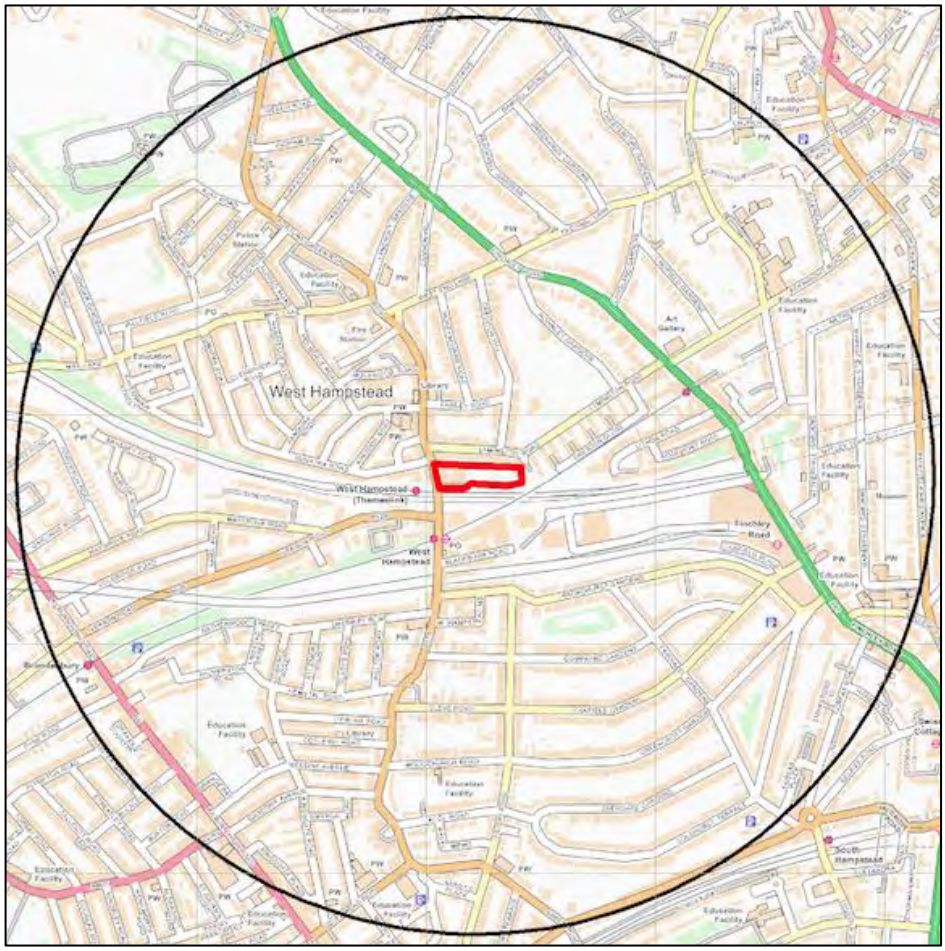
# Detailed Unexploded Ordnance (UXO) Threat & Risk Assessment

Meeting the requirements of *CIRIA* C681 'Unexploded Ordnance (UXO) A guide for the Construction Industry' Risk Management Framework

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|---|---|---|---|
| **PROJECT NUMBER** | 7921 | **ORIGINATOR** | L. Gregory |
| **VERSION NUMBER** | 1.0 | **REVIEWED BY** | B. Wilkinson (30th January 2020) |
| **CLIENT** | CGL | **RELEASED BY** | J. Cole (3rd February 2020) |
| **STUDY SITE** | 156 West End Lane, West Hampstead NW6 1SD | | |
| **RATING** | **HIGH** - This Study Site requires further action to reduce risk to ALARP during intrusive activities. | | |

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# Contents



# FIGURES

# Acronyms and Abbreviations

| | |
|---|---|
| AA | Anti-Aircraft |
| AAA | Anti-Aircraft Ammunition |
| ALARP | As Low As Reasonably Practicable |
| AOD | Above Ordnance Datum |
| ARP | Air Raid Precaution |
| AXO | Abandoned Explosive Ordnance |
| BD | Bomb Disposal |
| BDO | Bomb Disposal Officer |
| bgl | Below Ground Level |
| BGS | British Geological Survey |
| BH | Borehole |
| BPD | Bomb Penetration Depth |
| CDP | Cast Driven Piles |
| CFA | Continuous Flight Auger |
| CIRIA | Construction Industry Research and Information Association |
| CPT | Cone Penetration Testing |
| CS | County Series |
| EO | Explosive Ordnance |
| EOC | Explosive Ordnance Clearance |
| EOD | Explosive Ordnance Disposal |
| GI | Ground Investigation |
| GIS | Geographic Information Systems |
| GL | Ground Level |
| GP | General Purpose |
| GPS | Global Positioning Systems |
| HAA | Heavy Anti-Aircraft |
| HE | High Explosive |
| HO | Home Office |
| HSE | Health and Safety Executive |
| IB | Incendiary Bomb |
| kg | Kilograms |
| km | Kilometres |
| LAA | Light Anti-Aircraft |
| LCC | London County Council |
| LE | Low Explosive |
| LSA | Land Service Ammunition |
| m | Metres |
| MoD | Ministry of Defence |
| mm | Millimetres |
| NEQ | Net Explosive Quantity |
| NFF | National Filling Factory |
| NGR | National Grid Reference |
| OD | Ordnance Datum |
| OS | Ordnance Survey |
| PM | Parachute Mine |
| PoW | Prisoner of War |
| RADAR | Radio Detection And Ranging |
| RAF | Royal Air Force |
| RN | Royal Navy |
| RNAS | Royal Naval Air Service |
| ROF | Royal Ordnance Factory |
| SAA | Small Arms Ammunition |
| TA | Territorial Army |
| TNT | Trinitrotoluene |
| UK | United Kingdom |
| UN | United Nations |
| USAAF | United States Army Air Force |
| UXB | Unexploded Bomb |
| UXO | Unexploded Ordnance |
| V Weapons | *Vergeltungswaffe* – Vengeance Weapons |
| WD | War Department |
| WWI | World War One |
| WWII | World War Two |

# EXECUTIVE SUMMARY

## Study Site

The Client has defined the Study Site as "156 West End Lane, West Hampstead, NW6 1SD" and is centred on NGR 525607, 184868.

## Risk Level

**HIGH**

## Potential Threat Sources

The most probable UXO threat is posed by WWII *German* HE bombs, whilst IBs and *British* AAA projectiles (which were used to defend against *German* bombing raids) pose a residual threat.

## Risk Pathway

Given the types of UXO that might be present on-site, all types of aggressive intrusive engineering activities may generate a significant risk pathway.

## Key Findings

During WWII, the Study Site was situated within *Hampstead Metropolitan Borough,* which recorded 35 HE bomb strikes per 100 hectares, a moderate level of bombing.

*Luftwaffe* aerial reconnaissance photography associated with the Study did not identify any primary bombing targets on-site or within 1,000m of it.

ARP records associated with the Study Site noted one HE bomb strike within it. In addition, a further eight were recorded; 25m to the east, 25m to the south, 55m to the east, 75m to the west-north-west, 80m to the south-west, 85m to the west, 90m to the west-south-west and 95m to the east. Five unexploded bombs (UXBs) were also identified within 880m, the closest being 740m to the north-west of the Study Site boundary.

*London County Council* (*LCC*) bomb damage mapping associated with the Study Site did not identify any bomb damage within it. Nonetheless, *LCC* mapping recorded "*serious damage; but repairable at cost"* to structures 30m to the west and 40m to the north, *"blast damage minor in nature"* 75m to the south-south-west and *"general blast damage; not structural"* to structures located 85m to the south of the Study Site boundary. In addition, it is also likely that there would have been some degree of bomb damage on-site as a result of the HE bomb strike recorded on-site.

Pre-WWII mapping (1934-1936) and aerial photography (1945) associated with the Study Site shows that the Study Site was located in developed urban area. The majority of Study Site itself consisted of *Tennis Courts* with additional structures located in the centre and west of the Study Site. As a result, it is possible that a local civilian using the tennis courts or other facilities located on-site would have observed and reported any UXB entry holes within the Study Site, which would have been dealt with at the time.

The Study Site has undergone some post-WWII redevelopment, with the construction of a *Depot* in the late 1940s and early 1950s, which was later extended in the 1990s. Consequently, it is considered likely that any UXO within post-war disturbed and developed ground would potentially have been discovered and removed, however, the potential for deep buried UXO to be present within remaining areas is assessed to be extant. Given the Study Site was subjected to bombing, combined with limited post-WWII development in some areas, the following risk mitigation measures are recommended as a minimum, in order to reduce risks ALARP, during intrusive works in all previously undisturbed ground i.e. that which has not previously been excavated, probed, drilled or otherwise intrusively disturbed since it was potentially contaminated with UXO.

# EXECUTIVE SUMMARY (…continued)

## Recommended Risk Mitigation

**All Groundworks in All Areas:**

**1. Operational UXO Emergency Response Plan;** appropriate site management documentation should be held on-site to guide and plan for the actions which should be undertaken in the event of a suspected or confirmed UXO discovery (this plan can be supplied by *6 Alpha*);

**2. UXO Safety & Awareness Briefings;** the briefings are essential when there is a possibility of an UXO / UXB encounter and are a vital part of the general safety requirement. All personnel working on the site should receive a briefing on the identification of an UXO / UXB, what actions they should take to keep people and equipment away from such a hazard and to alert site management. Information concerning the nature of the UXO / UXB threat should be held in the site office and displayed for general information on notice boards, both for reference and as a reminder for ground workers. The Safety & Awareness briefing is an essential part of the *Health & Safety Plan* for the site and helps to evidence conformity with the principles laid down in the *CDM* regulations 2015 (this briefing can be delivered directly, or in some cases remotely, by *6 Alpha*).

**Excavations and Trenching into Previously Undisturbed Ground:**

**3. Non-intrusive UXO Survey and/or EOD Engineer in the Watching Brief Role;** Where 'open' intrusive works into previously undisturbed ground are proposed and where the extent is considered to be within the capabilities of non-intrusive UXO survey equipment and implementation of this is assessed as likely to prove effective, a non-intrusive geophysical UXO survey should be trialed and, if it proves successful, should be employed to survey site-wide, or in specific areas where 'open' intrusive works are to be implemented to identify for signs of sub-surface anomalies which may model as the target UXO in advance of said works. If the survey proves partially or wholly ineffective, an EOD Engineer should be present in the UXO Watching Brief Role to monitor ongoing 'open' intrusive works to identify any suspicious items that may be UXB or UXO related (this service can be provided by 6 Alpha).

**Window Sampling, Piling and Boreholing into Previously Undisturbed Ground:**

**4. Intrusive UXO Survey;** Where 'blind' intrusive works into previously undisturbed ground are proposed, an intrusive UXO survey (employing down-hole magnetometer or MagCone techniques) is strongly recommended. Such a survey should extend to the *assessed average bomb penetration depth* or to the maximum depth of the works, whichever is encountered first, or until geology is encountered through which it is assessed a UXB would not penetrate, to identify for signs of sub-surface anomalies which may model as the target UXO in advance of said works. (this service can be provided by *6 Alpha*).

For further information, please contact *6 Alpha Associates*:

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Telephone: +44 (0)2033 713 900

Email: enquiry@6alpha.com

# ASSESSMENT METHODOLOGY

## Approach

*6 Alpha Associates* is an independent, specialist risk management consultancy practice, which has assessed the risk of encountering UXO (as well as buried bulk high explosives) at this Study Site, by employing a process advocated for this purpose by *CIRIA*. The *CIRIA* guide for managing UXO risks in the construction industry (C681) not only represents best practice but has also been endorsed by the *HSE*. Any risk mitigation solution is recommended *only* because it delivers the Client a risk reduced to ALARP at best value.

UXO hazards can be identified through the investigation of local and national archives associated with the Study Site, *MoD* archives, local historical sources, historical mapping as well as contemporaneous aerial photography (if it is available). Hazards will have only been recorded if there is specific information that could reasonably place them within the boundaries of the Study Site. The amalgamation of information is then assessed to enable the researcher to provide relevant and accurate risk mitigation practices.

The assessment of UXO risk is a measure of *probability of encounter* and *consequence of encounter*; the former being a function of the identified hazard and proposed development methodology; the latter being a function of the type of hazard and the proximity of personnel (and/or other 'sensitive receptors', such as equipment) to the hazard, at the moment of encounter.

If UXO risks are identified, the methods of mitigation we have recommended are considered reasonably and sufficiently robust to reduce them to ALARP. We advocate the adoption of the legal ALARP principle because it is a key factor in efficiently and effectively ameliorating UXO risks. It also provides a ready means for assessing the Client's tolerability of UXO risk. In essence, the principle states that if the cost of reducing a risk significantly outweighs the benefit, then the risk may be considered tolerable. This does not mean that there is never a requirement for UXO risk mitigation, but that any mitigation must demonstrate that it is beneficial. Any additional mitigation that delivers diminishing benefits and that consume disproportionate time, money and effort are considered *de minimis* and thus unnecessary. Because of this principle, UXB and UXO risks will rarely be reduced to zero (nor need they be).

## Important Notes

Key source material is referenced within this document, whilst secondary/anecdotal information may be available upon request.

Although this report is up to date and accurate at the time of writing, our databases are continually being populated as and when additional information becomes available. Nonetheless, *6 Alpha* have exercised all reasonable care, skill and due diligence in providing this service and producing this report.

The assessment levels are based upon our professional opinion and have been supported by our interpretation of historical records and third party data sources. Wherever possible, *6 Alpha* has sought to corroborate and to verify the accuracy of all data we have employed, but we are not accountable for any inherent errors that may be contained in third party data sets (e.g. *National Archive* or other library sources), and over which *6 Alpha* cannot exercise control.

# STAGE ONE – STUDY SITE LOCATION AND DESCRIPTION

## Study Site

The Client has defined the Study Site as "156 West End Lane, West Hampstead, NW6 1SD". The Study Site is centred at NGR 525607, 184868 as presented at *Figures 1* and *2* respectively.

## Location Description

The Study Site is situated within *London Borough of Camden* and totals an area of 0.8 hectares (ha).

Furthermore, the Study Site is bounded by:

- North: Residential structures along *Lymington Road;*
- East: Hardstanding associated with a small park and small areas of undeveloped grass*;*
- South: *Potteries Path,* undeveloped ground and railway sidings*;*
- West: *West End Lane*.

## Aerial Photography (2019) (*Figure 3*)

Current aerial photography corroborates the information above and shows that the Study Site is situated within a densely developed urban area. The Study Site itself consists of multiple structures and areas of hardstanding in the central and eastern sectors.

## Proposed Works

The Client has described the following via email correspondence with *6 Alpha*:

"*We will be undertaking two 30m cable percussive boreholes and up to eight shallow window sample boreholes to 6m. Further investigation works may happen in the future and the site is due for demolition and redevelopment… The proposed development is for two 6-storey blocks – no basements are proposed. It is assumed at this stage that the foundations for the blocks will be piled…*"

## Ground Conditions

It is important to establish the specific ground conditions in order to determine the maximum *German* UXB penetration depth as well as the potential for other types of munitions to be buried.

If the site investigations and/or construction methodologies change, and/or if a specific methodology is to be employed, and/or if the scope of work is focused upon a specific part of the Study Site, then *6 Alpha* are to be informed so that the prospective UXO risks and the associated risk mitigation methodology might be re-assessed. Certain ground conditions may also constrain certain types of UXO risk mitigative works e.g. magnetometer survey is adversely affected in mineralised and made ground.

It is important to establish the provenance of made ground, where this is recorded as being part of the ground make-up, in order to accurately determine the ground levels at the time when UXO contamination may have occurred so as to accurately determine the average / maximum bomb penetration depths and make appropriate recommendations aimed at reducing the risk to ALARP.

# STAGE ONE – STUDY SITE LOCATION AND DESCRIPTION (…continued)

**Ground Conditions**

BGS borehole log "TQ28NE130 – Hampstead T.E. Extension BH3" (located 345m to the north-east of the Study Site), recorded the following strata:

| Depth bgl (m) | Strata | Description |
|---|---|---|
| 0.00m to 0.90m | Made Ground | Clay, very sandy, soft and organic with flints and brick fragments etc. |
| 0.90m to 1.50m | Clay | Clay, orange brown, slightly sandy, structureless with scattered rounded stones (solifluction deposit). |
| 1.50m to 10.00m | Clay | Brown stiff, slightly silty, extremely fissured and brittle with occasional small carbonaceous pockets.<br>Clay as above by fissuring s pronounced as to cause samples from 3.5 to 6.5m to fall apart during extrusion. There was no evidence of any polishing along the fissure surfaces.<br>Clay dark brown, stiff, silty very fissures with numerous small Gypsum crystals. Contained a few thin layers of weakly cemented yellow iron pan. |
| 10.00m to 15.00 | Clay | Grey, stiff, extremely fissured, slightly silty with isolated small lenses and layers of brown silt. Contains scattered fossil fragments and small nodules of pyrites throughout. |

# STAGE TWO – REVIEW OF HISTORICAL DATASETS

## Sources of Information Consulted

The following primary information sources have been used in order to establish the background UXO threat:

1. *6 Alpha*'s *Azimuth* Database;
2. *Home Office* WWII Bomb Census Maps;
3. WWII and post-WWII aerial photography;
4. Official Abandoned Bomb Register;
5. *LCC* Bomb Damage maps;
6. Information gathered from the *National Archives* at *Kew*;
7. Historic UXO information provided by *33 Engineer Regiment* (Explosive Ordnance Disposal) at *Carver Barracks, Wimbish*.

## Potential Sources of UXO Contamination

In general, there are several activities that might contaminate a site with UXO but the three most common ways are: legacy munitions from military training/exercises; deliberate or accidental dumping (AXO) and ordnance resulting from war fighting activities (also known as the Explosive Remnants of War (ERW)).

During WWII, the *Luftwaffe* undertook bombing campaigns all over the *UK*. The most common type of UXO discovered today is the aerially delivered high explosive (HE) bomb, which are comparatively thick-skinned and dropped from enemy aircraft. If the bomb did not detonate when it was dropped, the force of impact enabled the UXO to penetrate the ground, often leaving behind it a UXB entry hole. These entry holes were not always apparent and some went unreported, leaving the bomb buried and unrecorded. More rarely, additional forms of *German* UXO are occasionally discovered including *inter alia V1* and *V2* rockets, Incendiary Bombs (IBs), and Anti-personnel (AP) bomblets.

Although the *Luftwaffe* had designated primary bombing targets across the *UK*, their high-altitude night bombing was not accurate. As a result, thousands of buildings were damaged and civilian fatalities were common. Bombs were also jettisoned over opportunistic targets and residential areas were sometimes struck.

As the threat of invasion lingered over *Britain* during WWII, defensive actions were undertaken. The *British* and *Allied Forces* requisitioned large areas of land for military training and bomb storage (including HE bombs, naval shells, artillery and tank projectiles, explosives, LSA and SAA). Thousands of tonnes of these munitions were used for the *Allied Forces* weapon testing and military training alone. It has been estimated that at least 20 per cent of the *UK*'s land has been used for military training at some point.

*The best practice guide for dealing with your UXO risks on* land (CIRIA publication C681) suggests that approximately 10 per cent of all munitions deployed failed to function as designed. ERW are therefore, still commonly encountered, especially whist undertaking construction and civil engineering groundwork.

Furthermore, in exceptional circumstances, UXO is discovered unexpectedly and without apparent rational explanation. There are several ways this might occur:

- When *Luftwaffe* aircraft wished to swiftly escape e.g. from an aerial attack, they would jettison some or all of their bombs and flee. This is commonly referred to as *tip and run* and it has resulted in bombs being found in unexpected locations;
- Transportation of aggregate containing munitions to an area that was previously free of UXO, usually related to construction activities employing material dredged from a contaminated offshore borrow site;
- Poor precision during targeting (due to high altitude night bombing and/or poor visibility) resulted in bombs landing off target, but within the surrounding area.
- *British* decoy sites were also constructed to deliberately cause incorrect targeting. For obvious reasons, such sites were often built in remote and uninhabited areas.

## Study Site History

**From an analysis of the CS and OS historical mapping associated with the Study Site, the following history can be deduced:**

| Year | On-site |
|---|---|
| **1896 CS Map** | The Study Site was located in a developing urban area. The Study Site did not consist of any structures, although a road was located in the eastern sector. |
| **1915 CS Map** | Structures were constructed in the eastern and western sectors of the Study Site. |
| **1934-1935 CS Map** | Tennis courts were developed on-site in the central and western sectors. |
| **1955 OS Map** | Structures previously located on-site were demolished and a *Depot* was constructed in the western sector. |
| **1967-1968 OS Map** | Changes were not recorded at the Study Site. |
| **1974-1978 OS Map** | Changes were not recorded at the Study Site. |
| **1991-1996 OS Map** | The *Depot* in the western sector of the Study Site was extended. |
| **2002 Aerial Photography** | Changes were not recorded at the Study Site. |
| **2015 Aerial Photography** | Changes were not recorded at the Study Site. |
| **2020 OS Map** | Changes were not recorded at the Study Site. |

## Aerial Photography (1945) (*Figure 4*)

The aerial photography (1945) associated with the Study Site shows that it was located in a densely developed urban area. The Study Site itself appears to have development in the western sector, with the central and eastern sector undeveloped. Nonetheless, the resolution of the photograph is insufficient to be able to identify the precise local features and/or type of structures, then within the curtilage of the Study Site.

## WWII Bombing of *London*

The most intensive period of bombing over *London* was the nine months between October 1940 and May 1941, known as 'The Blitz'. During this period the *Luftwaffe* attempted to overwhelm *Britain's* air defences, destroy key military installations and industrial facilities (as well as logistical capabilities), prior to a planned invasion.

A total of 18,000 tons of bombs were dropped on *London* between 1940 and 1945. Many residential, commercial and industrial buildings were targeted during air raids and sustained large scale damage. Public services were also affected, with gas, electricity and water supplies often cut-off following damage to either the installations themselves or to the supply infrastructure. In addition, thousands of civilians were killed and injured, and many were forced to evacuate as their homes were destroyed.

## WWII Luftwaffe Bombing Targets

Prior to WWII, the *Luftwaffe* conducted numerous aerial photographic reconnaissance missions over *Britain*, recording key military, industrial and commercial facilities for attack, in the event of war. In addition, logistics infrastructure and public services, such as railways, canals, power stations, reservoirs, water and gas works were also considered viable bombing targets.

*Luftwaffe* aerial reconnaissance photography associated with the Study Site did not identify any primary bombing targets on-site or within 1,000m of it.

## WWII HE Bomb Strikes (*Figure 5*)

During WWII, ARP wardens compiled detailed logs of bomb strikes across their respective districts. However, ARP records associated with the Study Site identified one HE bomb strike within it. In addition, a further eight were recorded within 95m; 25m to the east, 25m to the south, 55m to the east, 75m to the west-north-west, 80m to the south-west, 85m to the west, 90m to the west-south-west and 95m to the east. Furthermore, whilst IBs may have fallen within the Study Site, they fell in such large numbers that accurate record keeping was either non-existent or perfunctory therefore, their prospective presence cannot be either corroborated or discounted.

In addition to IBs and HE bomb strikes, during the latter part of the war when aerial bombing had significantly declined, the main threat came from *V* type weapons. The first recorded *V1* strike on *London* was on the 13th June 1944, with the first recorded *V2* strike on *London* on the 8th September 1944. *V1* and *V2* rockets were thin-skinned, unmanned and inaccurate weapons. Both *V1* and *V2* rocket strikes were recorded 325m to the south-east, 435m to the south-east, 450m to the north-east, 45mm to the south-west, 470m to the north-north-west and 710m to the south-west of the Study Site.

The potential penetration depth of an UXB was dependent on a number of factors including but not restricted to those prior to striking the ground e.g. velocity and orientation of the UXB which in turn will be influenced on factors such as the release altitude from the aircraft and encounters with infrastructure during its fall; those encountered at the point of impact i.e. was the impact on concrete, grass, water etc and finally, the below ground level conditions which were encountered such as infrastructure e.g. services, basements, foundations, and geology e.g. made ground, clay, sand, etc. Further, as the UXB penetrated the ground, it's velocity naturally slowed where, it either came to an abrupt stop e.g. against foundations or would continue for 10's of feet along a route of least resistance which often resulted in a curving of the trajectory back towards the surface. This is known as the "J Curve" effect and often resulted in a considerable horizontal off-set from the point of entry. This is often the reason why UXBs have been discovered against or under the foundations of buildings, which were present during WWII, or many meters from the point of impact.

## WWII Bomb Damage (*Figure 6*)

An analysis of the *LCC* maps associated with the Study Site did not identify any bomb damage within it. Nonetheless, *LCC* mapping recorded *"serious damage; but repairable at cost"* to structures 30m to the west and 40m to the north, *"blast damage minor in nature"* 75m to the south-south-west and *"general blast damage; not structural"* to structures located 85m to the south of the Study Site boundary. In addition, it is also likely that there would have been some degree of bomb damage on-site as a result of the HE bomb strike.

## WWII HE Bomb Density (*Figure 7*)

The Study Site was located within the *Hampstead Metropolitan Borough,* which recorded 35 HE bombs per 100 hectares, a moderate level of bombing.

## Abandoned Bombs

An examination of the official abandoned bomb records did not identify any abandoned bombs on-site or within 1,000m of the Study Site boundary.

## Records of WWII UXB Disposal Tasks

An examination of the civil defence records listing UXBs dealt with in the *Hampstead Metropolitan Borough* from 1940-45 has identified the following tasks within the Study Site's vicinity:

- One 50kg UXB was burnt *in situ* at 20 *Agamennom Road* (situated 740m to the north-west) on the 25th February 1944;
- One 50kg UXB was burnt *in situ* at 17 *Agamennom Road* (situated 765m to the north-west) on the 23rd February 1944;
- One 50kg UXB was burnt *in situ* at 31 *Agamennom Road* (situated 795m to the north-west)) on the 25th February 1944;
- One 500kg UXB was defused and removed at 96 *Agamennom Road* (situated 815m to the north-west) on the 13th March 1944;
- One 50kg UXB was burnt *in situ* at 37A *Agamennom Road* (situated 880m to the north-west) on the 24th February 1944.

## Records of Post-WWII UXB Disposal Tasks

An examination of the post-WWII BDO tasks associated with the area has not identified any BDO operations within 1,000m of the Study Site.

## WWII Site Use

The CS mapping prior to WWII (1934-1936), shows that the Study Site was located in developed urban area. The majority of Study Site itself consisted of *Tennis Courts* with additional structures located in the centre and west of the Study Site. As a result, it is possible that a local civilian using the tennis courts or other facilities located on-site would have observed and reported any UXB entry holes within the Study Site, which would have been dealt with at the time.

## Sources of UXO Contamination

The most likely source of UXO contamination is from *German* aerially delivered ordnance, which ranges from small IBs through to large HE bombs (the latter forms the principal threat). Additional residual contamination may be present from *British* AAA projectiles (which were used to defend the UK against *German* bombing raids).

| STAGE THREE – DATA ANALYSIS | | |
|---|---|---|
| **Variable** | **Result** | **Comment** |
| Was the area considered to be a primary bombing target? | ✗ | No primary targets were identified within 1,000m. |
| Was the Study Site or the immediate area bombed during WWII? | ✓ | ARP records identified one HE bomb strike on-site and a further eight within 105m. |
| Did the Study Site or the immediate area experience bomb damage? | ✓ | *LCC* mapping recorded "serious damage; but repairable at cost" to structures 30m to the west and 40m to the north. |
| Was the ground undeveloped during WWII? | ✓ | The Study Site consisted of tennis courts and multiple other structures during WWII, however some areas of the Study Site were undeveloped. |
| Would the footfall have been high in the area? | ✓ | Given that multiple structures and tennis courts were located on-site, it is likely that footfall would have been high. |
| Would a UXB entry hole have been observed during WWII? | ✓ | Given that footfall on-site would have been high, it is considered possible that a UXB entry hole would have been observed and reported. |
| Have military personnel ever occupied the Study Site? | ✗ | No military facilities were identified within 1,000m. |
| Would munitions have been manufactured, stored and/or fired from the Study Site? | ✗ | There is no evidence to suggest munitions were located or fired from this Study Site. |
| Would previous intrusive works have removed the potential for UXO to be present? | ✗ | The Study Site has been subjected to some post-WWII redevelopment; therefore, it is likely that any UXO within post-war disturbed and developed ground would potentially have been discovered and removed, whilst the surrounding areas remain extant. |
| Are proposed intrusive works likely to extend into previously undisturbed ground? | ✓ | Some areas of the Study Site have remained undeveloped since WWII and therefore some proposed works may extend into previously undisturbed ground. |
| Is there potential for an unplanned encounter with UXO to occur during proposed intrusive works? | ✓ | Given that the Study Site was subject to bomb strikes, combined with limited post-WWII redevelopment in some areas, it is considered possible for an unplanned encounter with UXO to occur. |
| Does the probability of UXO vary across the Study Site? | ✓ | The probability of discovering UXO within post-war disturbed and developed ground is considered to be remote, however, the probability of UXO discovery within all previously undisturbed areas of the Study Site is extant. |

# STAGE FOUR – RISK ASSESSMENT

## Threat Items

The most probable UXO threat items are *German* HE bombs, whilst IBs and *British* AAA projectiles pose a residual threat. The consequences of initiating *German* HE bombs are more severe than initiating IBs or AAA projectiles, and thus they pose the greatest prospective risk to intrusive works.

## Bomb Penetration Depth

Considering the ground conditions (highlighted in Stage 1), the average BPD for a 250kg *German* HE bomb within clays is assessed to be approximately 7m bgl, with the maximum BPD considered to be approximately 16m bgl. Although it is possible that the *Luftwaffe* deployed larger bombs in the area, their deployment was infrequent, and to use such larger (or the largest) bombs for BPD calculations are not justifiable on either technical or risk management grounds.

WWII *German* bombs have a greater penetration depth when compared to IBs and AAA projectiles, which are unlikely to be encountered at depths greater than 1m bgl. However, due to the "J Curve" and the potential for structures to impede the penetration into the ground, HE bombs have been discovered at much shallower depths than the average.

## Risk Pathway

Given the types of UXO that might be present on-site, all types of aggressive intrusive engineering activities (i.e. investigative groundworks and construction methodologies) may generate a significant risk pathway. Whilst not all UXO encountered aggressively will initiate upon contact, such a discovery could lead to serious impact on the project especially in terms of critical injury to personnel, damage to equipment and project delay.

## Prospective Consequences

Consequences of UXO initiation include:

1. Fatally injure personnel;
2. Severe damage to plant and equipment;
3. Deliver blast and fragmentation damage to nearby buildings;
4. Rupture and damage underground utilities/services.

Consequences of UXO discovery include:

1. Delay to the project and blight;
2. Disruption to local community/infrastructure;
3. The expenditure of additional risk mitigation resources and EOD clearance;
4. Incurring additional time and cost.

# UXO RISK CALCULATION

## Site Activities

Although there is some variation in the probability of encountering and initiating items of UXO when conducting different types of intrusive activities, a number of investigative and construction methodologies have been described for analysis at this Study Site. The consequences of initiating UXO vary greatly, depending upon, *inter alia* the mass of HE in the UXO and how aggressively it might be encountered. For this reason, *6 Alpha* has conducted separate risk rating calculations for each investigative and construction methodology that might be employed.

## Risk Rating Calculation

*6 Alpha*'s Semi-Quantitative Risk Assessment assesses and rates the risks posed by the most probable threat items when conducting a number of different activities on the site. Risk Rating is determined by calculating the probability of encountering UXO and the consequences of initiating it.

| UXO Risk Calculation Table – All Areas | | | | |
|---|---|---|---|---|
| **Activity** | **Threat Item** | **Probability (SH+EM=P)** | **Consequence (D+PSR=C)** | **Risk Rating (PXC=RR)** |
| **Window Sampling** (to 6m bgl) | HE Bombs | 2+3=5 | 3+2=5 | 5x5=25 |
| | AAA Projectiles | 1+3=4 | 3+1=4 | 4x4=16 |
| | IBs | 1+3=4 | 3+1=4 | 4x4=16 |
| **Excavations** | HE Bombs | 2+2=4 | 3+3=6 | 4x6=24 |
| | AAA Projectiles | 1+2=3 | 3+1=4 | 3x4=12 |
| | IBs | 1+2=3 | 3+1=4 | 3x4=12 |
| **Trenching** | HE Bombs | 2+2=4 | 3+3=6 | 4x6=24 |
| | AAA Projectiles | 1+2=3 | 3+1=4 | 3x4=12 |
| | IBs | 1+2=3 | 3+1=4 | 3x4=12 |
| **Boreholes** (to 30m bgl) | HE Bombs | 2+3=5 | 3+2=5 | 5x5=25 |
| | AAA Projectiles | 1+3=4 | 3+1=4 | 4x4=16 |
| | IBs | 1+3=4 | 3+1=4 | 4x4=16 |
| **Piling** | HE Bombs | 2+3=5 | 3+2=5 | 5x5=25 |
| | AAA Projectiles | 1+3=4 | 3+1=4 | 4x4=16 |
| | IBs | 1+3=4 | 3+1=4 | 4x4=16 |
| Abbreviations – Site History (SH), Engineering Methodology (EM), Probability (P), Depth (D), Consequence (C), Proximity to Sensitive Receptors (PSR) and Risk Rating (RR). | | | | |

# STAGE FIVE – RECOMMENDED RISK MITIGATION MEASURES

## Do the ground conditions support a geophysical UXO survey?

**Non-Intrusive Methods of Mitigation** – Magnetometer results may be affected by ferro-magnetic contamination due to previous construction activities and made ground within the Study Site.

**Intrusive Methods of Mitigation** – Intrusive magnetometry may be effective on this Study Site, prior to boreholing and piling especially. However, any ferrous metal/red brick contamination in made ground/old foundations may affect the detection capability of the UXB survey equipment, as it passes through the contaminated layer especially. Nonetheless, beyond the contaminated strata such a survey should prove effective.

## Mitigation Measures to Reduce Risk to 'ALARP'

| Activity | Risk Mitigation Measures | Final Risk Rating |
|---|---|---|
| **All Activities in All Areas** | **1. Operational UXO Emergency Response Plan;** appropriate site management documentation should be held on-site to guide and plan for the actions which should be undertaken in the event of a suspected or real UXO discovery (this plan can be supplied by *6 Alpha*);<br>**2. UXO Safety & Awareness Briefings;** the briefings are essential when there is a possibility of explosive ordnance encounter and are a vital part of the general safety requirement. All personnel working on the site should receive a briefing on the identification of a UXB, what actions they should take to keep people and equipment away from such a hazard and to alert site management. Information concerning the nature of the UXB threat should be held in the site office and displayed for general information on notice boards, both for reference and as a reminder for ground workers. The safety awareness briefing is an essential part of the *Health & Safety Plan* for the site and helps to evidence conformity with the principles laid down in the *CDM* regulations 2015 (this brief can be delivered directly, or in some cases remotely, by *6 Alpha*). | **ALARP** |
| **Excavations and Trenching into Previously Undisturbed Ground** | **3. Non-intrusive UXO Survey and/or EOD Engineer in the Watching Brief Role;** Where 'open' intrusive works into previously undisturbed ground are proposed and where the extent is considered to be within the capabilities of non-intrusive UXO survey equipment and implementation of this is assessed as likely to prove effective, a non-intrusive geophysical UXO survey should be trialed and, if it proves successful, should be employed to survey site-wide, or in specific areas where 'open' intrusive works are to be implemented to identify for signs of sub-surface anomalies which may model as the target UXO in advance of said works. If the survey proves partially or wholly ineffective, an EOD Engineer should be present in the UXO Watching Brief Role to monitor ongoing 'open' intrusive works to identify any suspicious items that may be UXB or UXO related (this service can be provided by 6 Alpha). | |
| **Window Sampling, Piling and Boreholing into Previously Undisturbed Ground** | **3. Intrusive UXO Survey;** Where 'blind' intrusive works into previously undisturbed ground are proposed, an intrusive UXO survey (employing down-hole magnetometer or MagCone techniques) is strongly recommended. Such a survey should extend to the *assessed average bomb penetration depth* or to the maximum depth of the works, whichever is encountered first, or until geology is encountered through which it is assessed a UXB would not penetrate, to identify for signs of sub-surface anomalies which may model as the target UXO in advance of said works. (this service can be provided by *6 Alpha*). | |

This assessment has been conducted based on the information provided by the Client, should the proposed works change then *6 Alpha* should be re-engaged to refine this risk assessment

# Report Figures

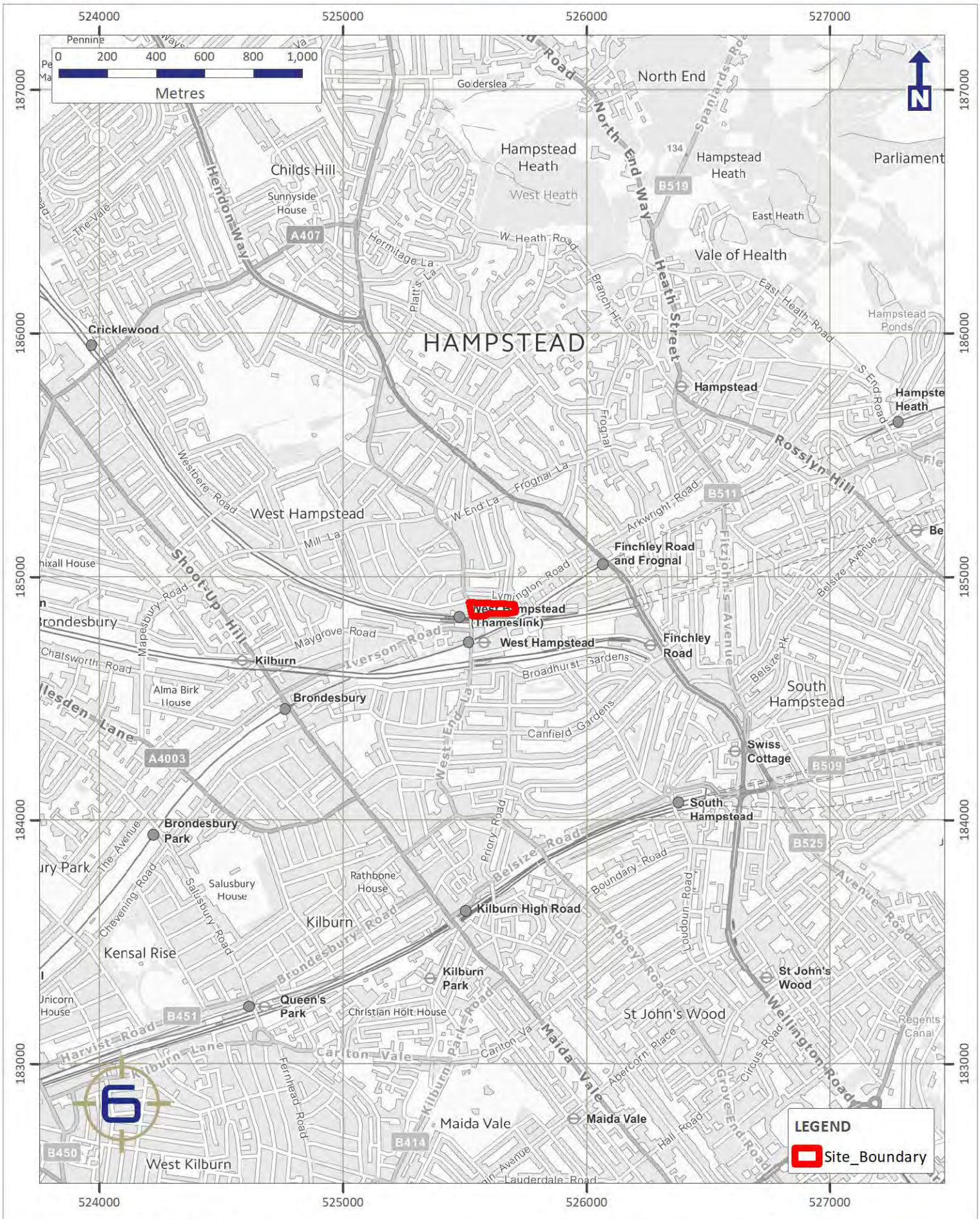
# Figure One - Study Site Location

# 156 WEST END LANE, WEST HAMPSTEAD, NW6 1SD

## Site Location

BRITISH NATIONAL GRID

BOMB SEARCH
WWW.6ALPHA.COM




| PROJECT NO. | FIGURE | DRAWN | CHECKED | DATE | | | |
|---|---|---|---|---|---|---|---|
| 7921 | 1 | CC | SB | 21 January 2020 | Contains Ordnance Survey data © Crown copyright and database right 2017 | Produced by and Copyright to 6 Alpha Associates Ltd. Users noting any errors please notify 6 Alpha. | alpha ASSOCIATES |

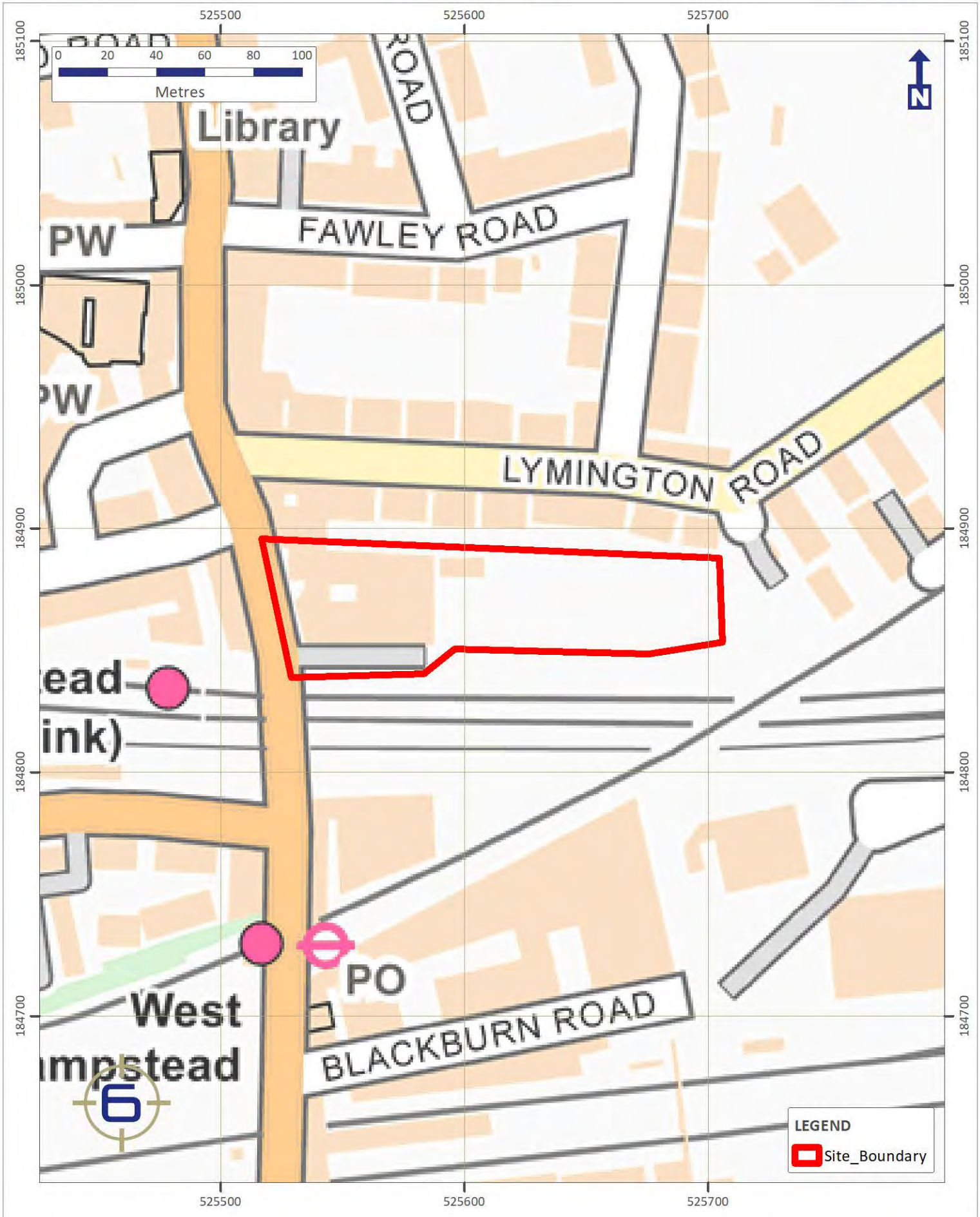
# Figure Two - Study Site Boundary

BRITISH NATIONAL GRID

# 156 WEST END LANE, WEST HAMPSTEAD, NW6 1SD

## Site Boundary

BOMB SEARCH
WWW.6ALPHA.COM




| PROJECT NO. | FIGURE | DRAWN | CHECKED | DATE | | | |
|---|---|---|---|---|---|---|---|
| 7921 | 2 | CC | SB | 21 January 2020 | Contains Ordnance Survey data © Crown copyright and database right 2017 | Produced by and Copyright to 6 Alpha Associates Ltd. Users noting any errors please notify 6 Alpha. | alpha ASSOCIATES |

# Figure Three - Aerial Photography (2019)


# 156 WEST END LANE, WEST HAMPSTEAD, NW6 1SD

## Aerial Photography (2019)

BOMB SEARCH
WWW.6ALPHA.COM

525500 525600 525700

185100 185000 184900 184800 184700

0 20 40 60 80 100
Metres

N

LEGEND
Site_Boundary

| PROJECT NO. | FIGURE | DRAWN | CHECKED | DATE | | |
|---|---|---|---|---|---|---|
| 7921 | 3 | CC | SB | 21 January 2020 | Map data: Google | Produced by and Copyright to 6 Alpha Associates Ltd. Users noting any errors please notify 6 Alpha. |

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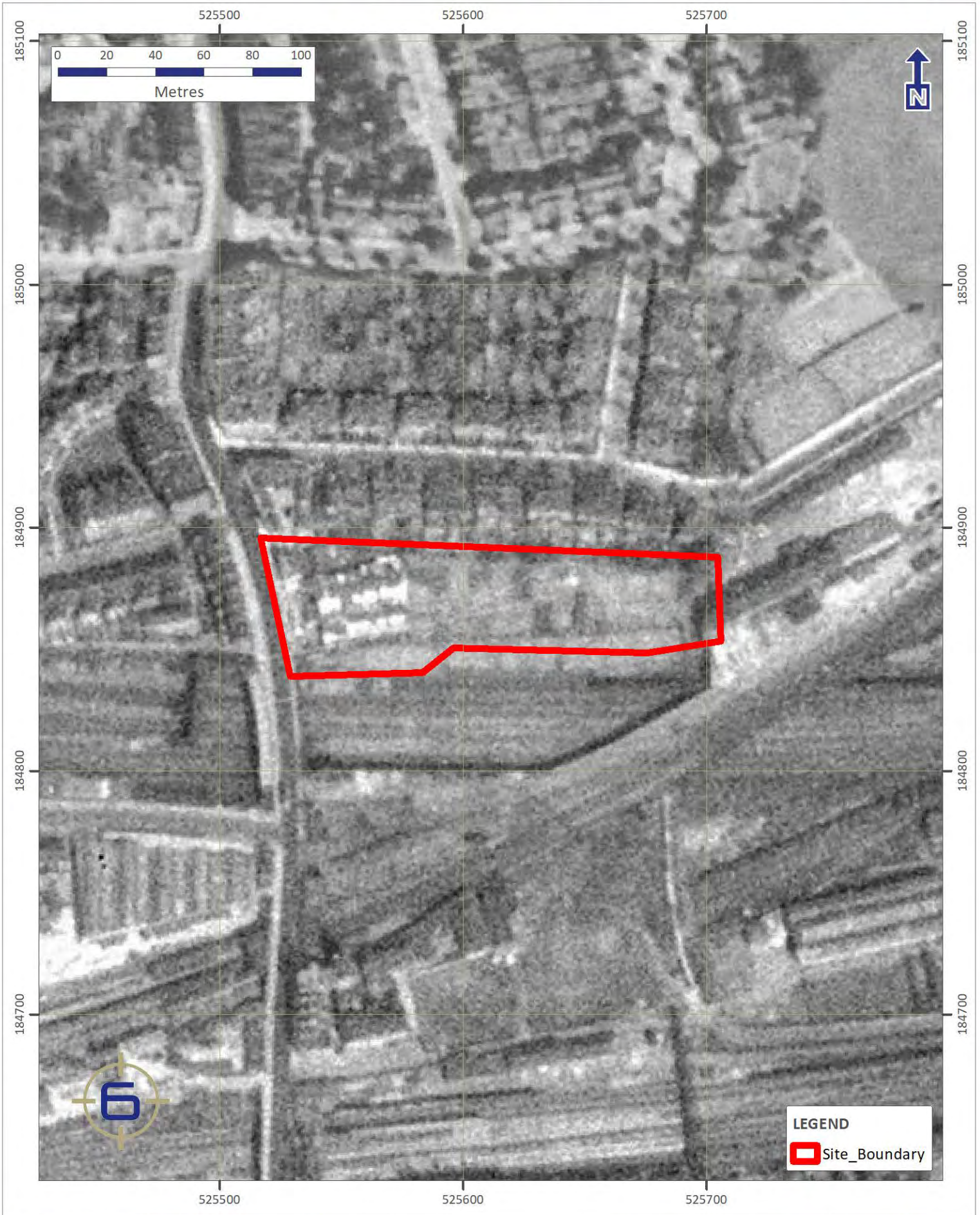
# Figure Four - Aerial Photography (1945)


# 156 WEST END LANE, WEST HAMPSTEAD, NW6 1SD

## Aerial Photography (1945)

BOMB SEARCH
WWW.6ALPHA.COM




| PROJECT NO. | FIGURE | DRAWN | CHECKED | DATE | | |
|---|---|---|---|---|---|---|
| 7921 | 4 | CC | SB | 21 January 2020 | Map data: Google, The GeoInformation Group | Produced by and Copyright to 6 Alpha Associates Ltd. Users noting any errors please notify 6 Alpha. |

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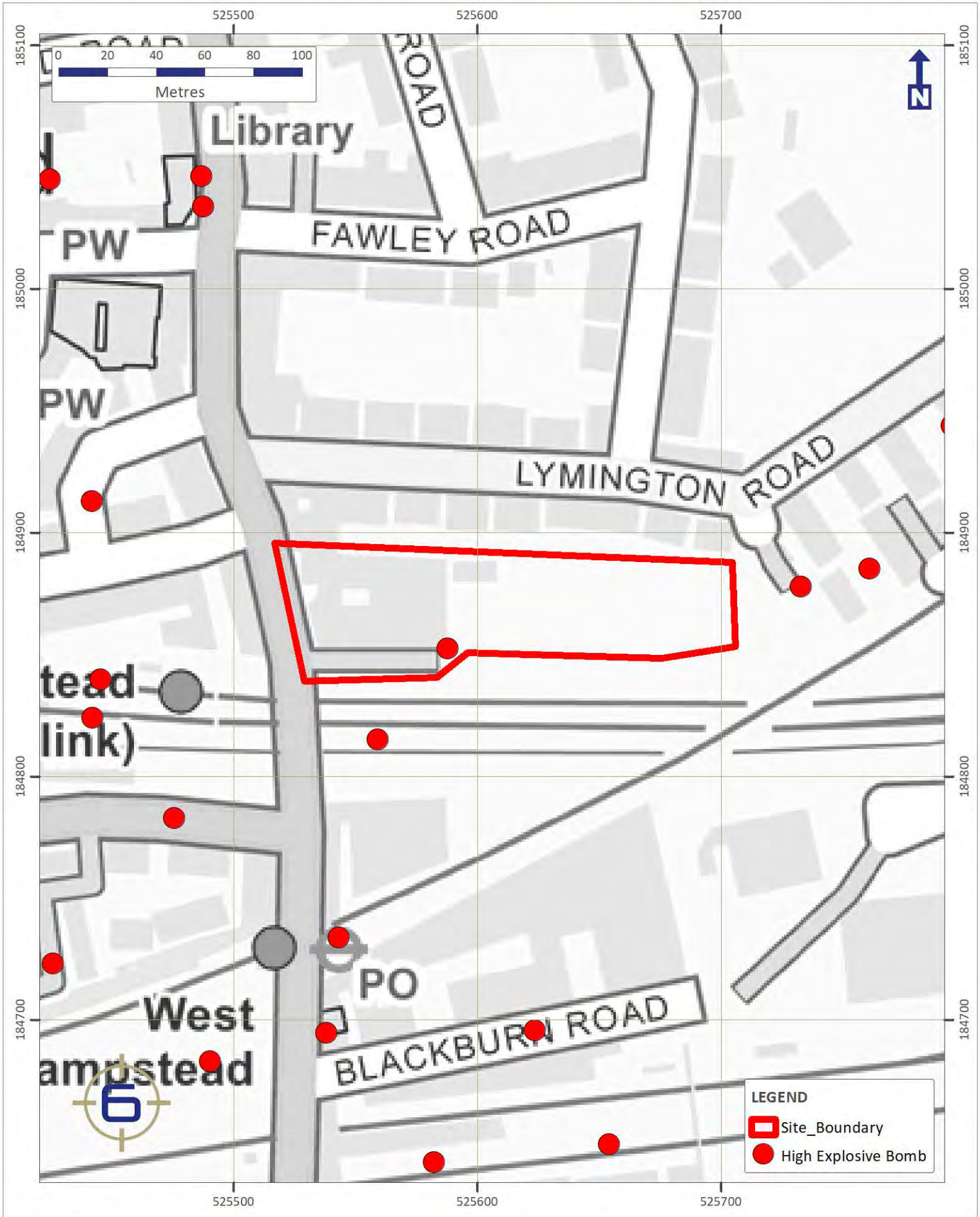
# Figure Five - WWII High Explosive Bomb Strikes

BRITISH NATIONAL GRID

# 156 WEST END LANE, WEST HAMPSTEAD, NW6 1SD

## WWII High Explosive Bomb Strikes

BOMB SEARCH
WWW.6ALPHA.COM




| PROJECT NO. | FIGURE | DRAWN | CHECKED | DATE | | | |
|---|---|---|---|---|---|---|---|
| 7921 | 5 | CC | SB | 21 January 2020 | Contains Ordnance Survey data © Crown copyright and database right 2017 | Produced by and Copyright to 6 Alpha Associates Ltd. Users noting any errors please notify 6 Alpha. | alpha ASSOCIATES |

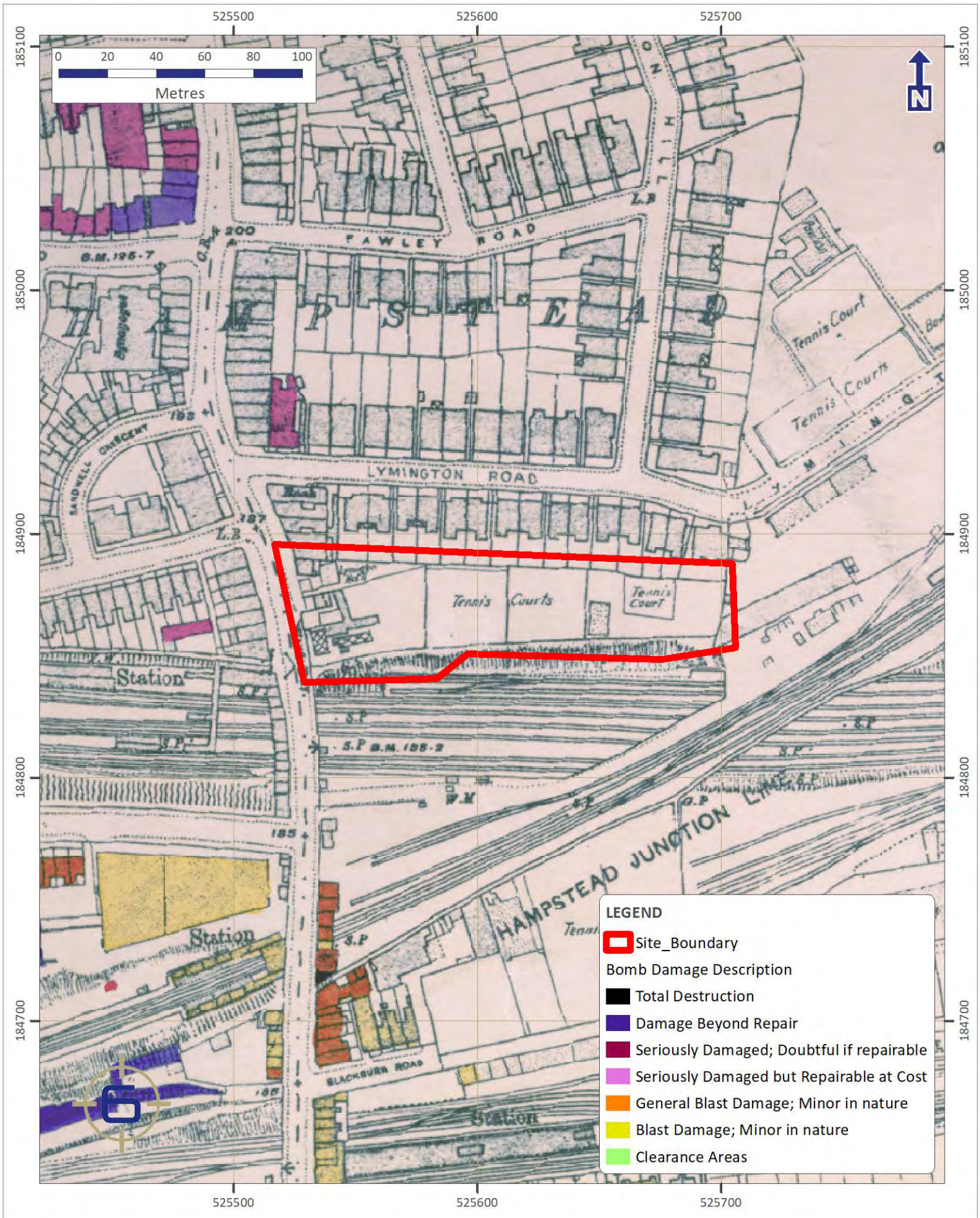
# Figure Six - London County Council WWII Bomb Damage Map

BRITISH NATIONAL GRID

# 156 WEST END LANE, WEST HAMPSTEAD, NW6 1SD

## London County Council WWII Bomb Damage Map

BOMB SEARCH
WWW.6ALPHA.COM




| PROJECT NO. | FIGURE | DRAWN | CHECKED | DATE | | | |
|---|---|---|---|---|---|---|---|
| 7921 | 6 | CC | SB | 21 January 2020 | Contains Ordnance Survey data © Crown copyright and database right 2017 | Produced by and Copyright to 6 Alpha Associates Ltd. Users noting any errors please notify 6 Alpha. | alpha ASSOCIATES |

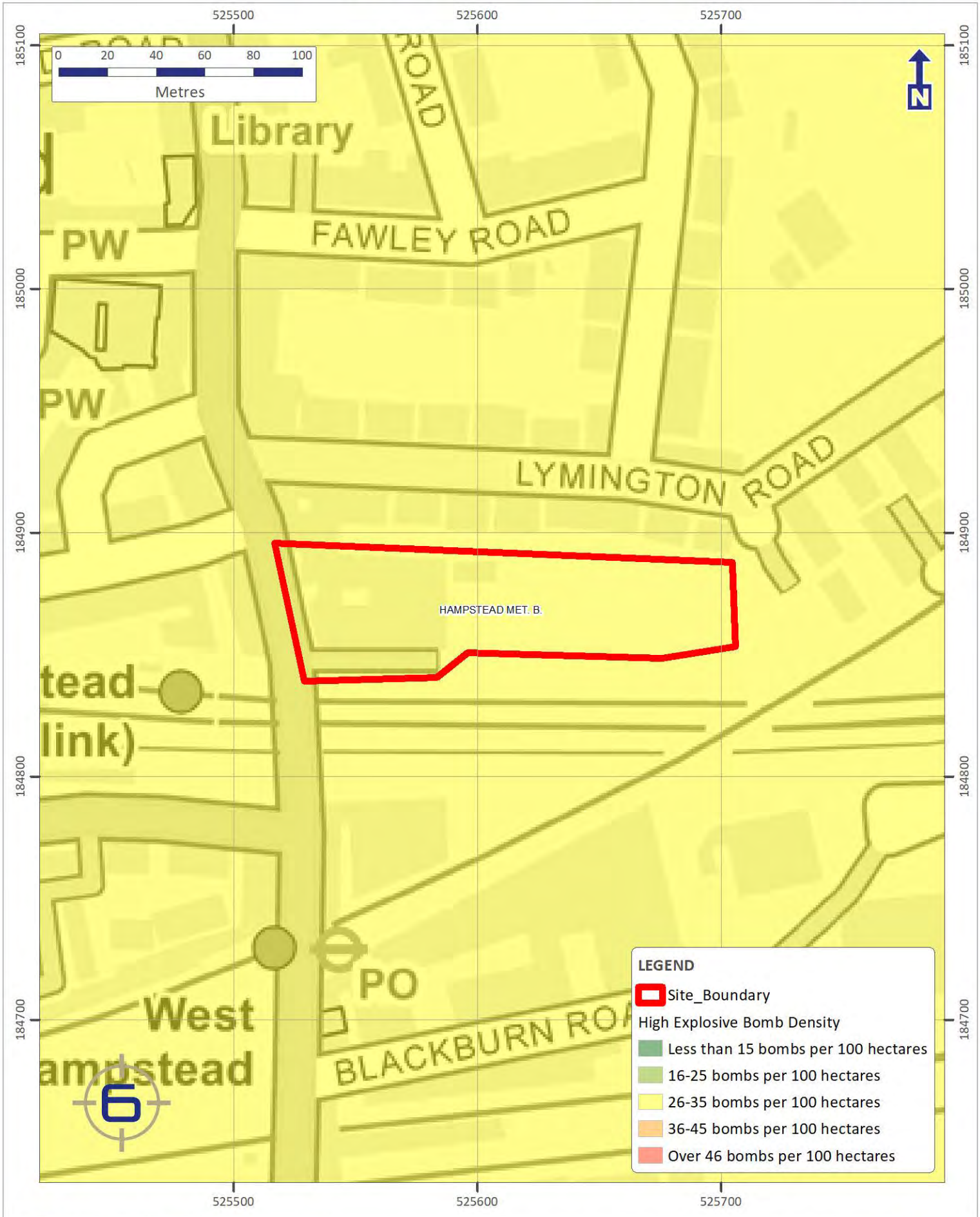
# Figure Seven - WWII High Explosive Bomb Density

BRITISH NATIONAL GRID

# 156 WEST END LANE, WEST HAMPSTEAD, NW6 1SD

## WWII High Explosive Bomb Density

BOMB SEARCH
WWW.6ALPHA.COM




| PROJECT NO. | FIGURE | DRAWN | CHECKED | DATE | | | |
|---|---|---|---|---|---|---|---|
| 7921 | 7 | CC | SB | 21 January 2020 | Contains Ordnance Survey data © Crown copyright and database right 2017 | Produced by and Copyright to 6 Alpha Associates Ltd. Users noting any errors please notify 6 Alpha. | alpha ASSOCIATES |

# APPENDIX C

*CGL Risk Assessment Methodology*

## CGL Risk Assessment Methodology

The following risk Assessment methodology is based on CIRIA C552 (2001) Contaminated Land Risk Assessment – A Guide to Good Practice[1], in order to quantify potential risk via risk estimation and risk evaluation, which can be adopted at the Phase I stage. This will then determine an overall risk category which can be used to identify likely actions. This methodology uses qualitative descriptors and therefore is a qualitative approach and is undertaken for each potential pollution linkage (source-pathway-receptor) identified for the site in accordance with Contaminated Land Reports 6[2] and 11[3].

The methodology requires the classification of:

- The magnitude of the consequence (severity) of a risk occurring, and
- The magnitude of the probability (likelihood) of a risk occurring.

The potential consequences of contamination risks occurring at this site are classified in accordance with Table 1 below, which is adapted from the CIRIA guidance[1].

***Table 1. Classifications of Consequence ratings***

| *Classification* | *Definition of Consequence* | *Examples* |
|---|---|---|
| **Severe** | Short-term (acute) risks to human health. | High concentration of cyanide on the surface of an informal recreation area |
| | Short-term (acute) risk of pollution of sensitive water resource or ecosystem. | Major spillage of contaminants from site into controlled waters |
| | Catastrophic damage to crops/buildings/property/infrastructure, including off-site soils. | Explosion causing building collapse |
| **Medium** | Long-term (chronic) risks to human health | Concentrations of a contaminant from site exceeding the generic or site specific assessment criteria |
| | Long-term (chronic) pollution of sensitive water resource | Leaching of contaminants from a site into a major or minor aquifer |
| | Significant change in an ecosystem/contamination of off-site soils | Death of a species within a designated nature reserve |
| **Mild** | Pollution of non-sensitive water resource | Pollution of a non-classified groundwater |
| | Significant damage to crops/ buildings/property/infrastructure | Damage to a building rendering it unsafe to occupy (e.g. foundation damage resulting in instability) |
| | Damage to an ecosystem or sensitive buildings/structures/services | |
| **Minor** | Easily preventable non-permanent health effects | Presence of contamination at concentrations which require the use of personal protective equipment during site work |
| | Harm, although not necessarily significant harm, which may result in financial loss or expenditure to resolve | Loss of plants in a landscaping scheme/discolouration of concrete |
| | Easily repairable effects of damage to buildings/structures/services | |

[1] CIRIA, (2001). *Contaminated Land Risk Assessment. A Guide to Good Practice*. CIRIA C552.
[2] M.J. Carter Associates, (1995*). Prioritisation and Categorisation Procedure for Sites Which May Be Contaminated*. Contaminated Land Report 6. Department of the Environment. C
[3] Environment Agency, (2004). *Model Procedures for the Management of Land Contamination.* Contaminated Land Report 11.

The potential probability of the risks being realised are classified in accordance with the ratings set out in Table 2 which are adapted from the CIRIA guidance[1]. It should be noted that where a pollutant linkage has not been identified the likelihood is considered to be zero.

***Table 2. Classifications of probability ratings***

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

In accordance with C552 the risk classification for each pollution linkage are classified in accordance with the matrix for consequence and probability set out in Table 3. The definitions for the risk classifications are presented in Table 4.

***Table 3. Risk classification matrix***

| | | *Consequence* | | | |
|---|---|---|---|---|---|
| | | ***Severe*** | ***Medium*** | ***Mild*** | ***Minor*** |
| **Probability** | **High likelihood** | Very High | High | Moderate | Moderate / Low |
| | **Likely** | High | Moderate | Moderate / Low | Low |
| | **Low likelihood** | Moderate | Moderate / Low | Low | Very Low |
| | **Unlikely** | Moderate / Low | Low | Very Low | Very Low |

***Table 4. Risk classification definitions***

| *Classification* | *Definition* |
|---|---|
| **Very High** | There is a high probability that severe harm could arise to a designated receptor from the identified hazard or there is evidence that severe harm is currently happening. This risk, if realised, is likely to result in substantial liability. Urgent investigation (if not already undertaken) and remediation are likely to be required. |
| **High** | Harm is likely to arise to a designated receptor from the identified hazard. Realisation of the risk is likely to result in substantial liability. Urgent investigation (if not already undertaken) and remediation are likely to be required. |
| **Moderate** | It is possible that harm could arise to a designated receptor from the identified hazard. However, it is either relatively unlikely that such harm would be severe or if any harm were to occur it is more likely that the harm would be relatively mild. Urgent investigation (if not already undertaken) is normally required to clarify the potential risk and to determine the potential liability. Some remedial works may be required in the longer term. |
| **Low** | It is possible that harm could arise to a designated receptor from the identified hazard, but it is considered likely that this harm, if realised, would at worse normally be mild. |
| **Very Low** | There is a low possibility that harm could arise to a designated receptor from the identified hazard. In the event of such harm being realised it is not likely to be severe. |

# APPENDIX D

*Phase 1 Exploratory Hole Logs*

# BOREHOLE LOG

| Project | | | | BOREHOLE No |
|---|---|---|---|---|
| 156 West End Lane, West Hampstead | | | | BH1 |
| Job No | Date | Ground Level (m) | Co-Ordinates (m) | |
| CG/38293 | 25-02-20<br>27-02-20 | 54.78 | E 525,602.7 N 184,869.1 | |
| Client | | | | Sheet |
| A2 Dominion | | | | 1 of 4 |

| SAMPLES & TESTS | | | Water | STRATA | | | | Instrument /Backfill |
|---|---|---|---|---|---|---|---|---|
| Depth (m) | Type No | Test Result | | Reduced Level | Legend | Depth (m) (Thick-ness) | DESCRIPTION | |
| | | | | 54.68 | | 0.10 | Concrete.<br>[MADE GROUND] | |
| 0.30 | B1 | | | | | (0.50) | | |
| 0.30 | ES1 | | | 54.18 | | 0.60 | Loose to dense dark brown and dark grey clayey gravelly fine to coarse sand. Gravel is angular to subrounded fine to coarse flint, sandstone and rare brick.<br>[MADE GROUND] | |
| 1.00 | B2 | | | | | | Loose to dense brown clayey gravelly fine to coarse sand. Gravel is angular to subrounded fine to coarse sandstone and brick.<br>[MADE GROUND] | |
| 1.00 | ES2 | | | | | | | |
| 1.20 | SPT | N26 | | | | (2.00) | | |
| 2.00 | B3 | | | | | | | |
| 2.00 | ES3 | | | | | | | |
| 2.20 | SPT | N36 | | 52.18 | | 2.60 | | |
| 2.60 | B4 | | | 51.98 | | 2.80 | Firm brown slightly sandy gravelly clay. Gravel is angular to subrounded fine to coarse brick fragments.<br>[MADE GROUND] | |
| 2.60 | ES4 | | | | | (0.40) | | |
| 3.00 | B5 | | | 51.58 | | 3.20 | Stiff brown mottled light bluish grey slightly gravelly clay. Gravel is angular to subrounded fine to coarse flint and rare brick.<br>[MADE GROUND] | |
| 3.00 | ES5 | | | | | | | |
| 3.20 | SPT | N13 | | | | | Firm becoming stiff brown locally mottled orangish brown and light bluish grey silty CLAY.<br>[LONDON CLAY FORMATION] | |
| 4.00 | D6 | | | | | | | |
| 4.20 | D7 | | | | | | | |
| 4.20 | SPT | N13 | | | | | | |
| 5.00 | ES6 | | | | | | | |
| 5.00 | B8 | | | | | | | |
| 5.20 | U9 | 22 blows | | | | | | |
| 5.65 | D10 | | | | | | | |
| 6.00 | D11 | | | | | | | |
| 6.50 | D12 | | | | | (6.90) | | |
| 6.50 | SPT | N19 | | | | | | |
| 7.50 | B13 | | | | | | | |

## Boring Progress and Water Observations

| Date | Comment | Strike Depth | Casing Depth | Casing Dia. mm | Standing Depth |
|---|---|---|---|---|---|
| | | | | | |

## General Remarks

METHOD: Hand dig to 1.2m.
CASING: Drilled in to 150mm. Casing to 6.0m.
GROUNDWATER: No Groundwater encountered.
CONTAMINATION: Significant visual or olfactory contamination was not encountered.
BACKFILL: On completion, a slotted standpipe (50mm) was installed to 4m to 1m response zone between 1.0 to 4.0m; plain standpipe was installed from ground level to 1.0m; bentonite seal 0.0 to 1.0m, concrete and flush cover at ground level.
REMARKS: Borehole terminated at 30.0mbgl as per client's requirements.

| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| Cable Percussion Rig | RM Foster Drilling | SWO | RJB |

# BOREHOLE LOG

| Project | | | | BOREHOLE No |
|---|---|---|---|---|
| 156 West End Lane, West Hampstead | | | | **BH1** |
| Job No | Date | Ground Level (m) | Co-Ordinates (m) | |
| CG/38293 | 25-02-20<br>27-02-20 | 54.78 | E 525,602.7 N 184,869.1 | |
| Client | | | | Sheet |
| A2 Dominion | | | | 2 of 4 |

| SAMPLES & TESTS | | | Water | STRATA | | | | |
|---|---|---|---|---|---|---|---|---|
| Depth (m) | Type No | Test Result | | Reduced Level | Legend | Depth (m) (Thick-ness) | DESCRIPTION | Instrument /Backfill |
| 8.00 | U14 | 35 blows | | | | | Firm becoming stiff brown locally mottled orangish brown and light bluish grey silty CLAY. [LONDON CLAY FORMATION] *(continued)* | |
| 8.45 | D15 | | | | | | | |
| 9.00 | D16 | | | | | | | |
| 9.50 | D17 | | | | | | | |
| 9.50 | SPT | N25 | | | | | | |
| 10.00 | B18 | | | 44.68 | | 10.10 | | |
| | | | | 44.38 | | 10.40 | Stiff brown mottled bluish grey slightly gravelly silty CLAY. Gravel is subangular to rounded fine to coarse claystone. [LONDON CLAY FORMATION] | |
| | | | | | | | Stiff bluish grey silty CLAY. [LONDON CLAY FORMATION] | |
| 11.00 | D19 | | | | | | | |
| 11.00 | U20 | 50 blows | | | | | | |
| 11.40 | D21 | | | | | | | |
| 12.00 | B22 | | | | | | | |
| 12.50 | D23 | | | | | | | |
| 12.50 | SPT | N27 | | | | | | |
| 13.50 | D24 | | | | | | | |
| 14.00 | U25 | 65 blows | | | | | | |
| 14.40 | D26 | | | | | | | |
| 15.00 | B27 | | | | | | | |
| 15.50 | D28 | | | | | | | |
| 15.50 | SPT | N34 | | | | | | |

## Boring Progress and Water Observations

| Date | Comment | Strike Depth | Casing Depth | Casing Dia. mm | Standing Depth |
|---|---|---|---|---|---|
| | | | | | |

## General Remarks

METHOD: Hand dig to 1.2m.
CASING: Drilled in to 150mm. Casing to 6.0m.
GROUNDWATER: No Groundwater encountered.
CONTAMINATION: Significant visual or olfactory contamination was not encountered.
BACKFILL: On completion, a slotted standpipe (50mm) was installed to 4m to 1m response zone between 1.0 to 4.0m; plain standpipe was installed from ground level to 1.0m; bentonite seal 0.0 to 1.0m, concrete and flush cover at ground level.
REMARKS: Borehole terminated at 30.0mbgl as per client's requirements.

| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| Cable Percussion Rig | RM Foster Drilling | SWO | RJB |

# BOREHOLE LOG

| Project | | | | BOREHOLE No |
|---|---|---|---|---|
| 156 West End Lane, West Hampstead | | | | **BH1** |
| Job No | Date | Ground Level (m) | Co-Ordinates (m) | |
| CG/38293 | 25-02-20<br>27-02-20 | 54.78 | E 525,602.7 N 184,869.1 | |
| Client | | | | Sheet |
| A2 Dominion | | | | 3 of 4 |

| SAMPLES & TESTS | | | Water | STRATA | | | | Instrument /Backfill |
|---|---|---|---|---|---|---|---|---|
| Depth (m) | Type No | Test Result | | Reduced Level | Legend | Depth (m) (Thick-ness) | DESCRIPTION | |
| | | | | | | | Stiff bluish grey silty CLAY.<br>[LONDON CLAY FORMATION] *(continued)* | |
| 16.50 | D29 | | | | | | | |
| 17.00 | U30 | 70 blows | | | | | | |
| 17.00 | B32 | | | | | | | |
| 17.35 | D31 | | | | | | | |
| 18.50 | D33 | | | | | | | |
| 18.50 | SPT | N39 | | | | | | |
| 19.50 | D34 | | | | | | | |
| 20.00 | U35 | 100 blows | | | | | | |
| 20.00 | B37 | | | | | (19.60) | | |
| 20.35 | D36 | | | | | | | |
| 21.00 | D38 | | | | | | | |
| 21.50 | D39 | | | | | | | |
| 21.50 | SPT | N49 | | | | | | |
| 22.00 | B40 | | | | | | | |
| 23.00 | U41 | 90 blows | | | | | | |
| 23.45 | D42 | | | | | | | |

## Boring Progress and Water Observations

| Date | Comment | Strike Depth | Casing Depth | Casing Dia. mm | Standing Depth |
|---|---|---|---|---|---|
| | | | | | |

## General Remarks

METHOD: Hand dig to 1.2m.
CASING: Drilled in to 150mm. Casing to 6.0m.
GROUNDWATER: No Groundwater encountered.
CONTAMINATION: Significant visual or olfactory contamination was not encountered.
BACKFILL: On completion, a slotted standpipe (50mm) was installed to 4m to 1m response zone between 1.0 to 4.0m; plain standpipe was installed from ground level to 1.0m; bentonite seal 0.0 to 1.0m, concrete and flush cover at ground level.
REMARKS: Borehole terminated at 30.0mbgl as per client's requirements.

| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| Cable Percussion Rig | RM Foster Drilling | SWO | RJB |

# BOREHOLE LOG

| Project | | | | BOREHOLE No |
|---|---|---|---|---|
| 156 West End Lane, West Hampstead | | | | BH1 |
| Job No | Date | Ground Level (m) | Co-Ordinates (m) | |
| CG/38293 | 25-02-20<br>27-02-20 | 54.78 | E 525,602.7 N 184,869.1 | |
| Client | | | | Sheet |
| A2 Dominion | | | | 4 of 4 |

| SAMPLES & TESTS | | | Water | STRATA | | | | Instrument /Backfill |
|---|---|---|---|---|---|---|---|---|
| Depth (m) | Type No | Test Result | | Reduced Level | Legend | Depth (m) (Thick-ness) | DESCRIPTION | |
| 24.00 | D43 | | | | | | Stiff bluish grey silty CLAY.<br>[LONDON CLAY FORMATION] *(continued)* | |
| 24.50 | D44 | | | | | | | |
| 24.50 | SPT | N46 | | | | | | |
| 25.00 | B45 | | | | | | | |
| 26.00 | U46 | 100 blows | | | | | | |
| 26.40 | D47 | | | | | | | |
| 27.00 | B48 | | | | | | | |
| 27.50 | D49 | | | | | | | |
| 27.50 | SPT | N50 | | | | | | |
| 28.50 | D50 | | | | | | | |
| 29.00 | U51 | 100 blows | | | | | | |
| 29.35 | D52 | | | | | | | |
| | | | | 24.78 | | 30.00 | | |
| 30.00 | B53 | | | | | | *(Borehole terminated at 30m)* | |
| 30.00 | D54 | | | | | | | |
| 30.00 | SPT | N36 | | | | | | |

## Boring Progress and Water Observations

| Date | Comment | Strike Depth | Casing Depth | Casing Dia. mm | Standing Depth |
|---|---|---|---|---|---|
| | | | | | |

## General Remarks

METHOD: Hand dig to 1.2m.
CASING: Drilled in to 150mm. Casing to 6.0m.
GROUNDWATER: No Groundwater encountered.
CONTAMINATION: Significant visual or olfactory contamination was not encountered.
BACKFILL: On completion, a slotted standpipe (50mm) was installed to 4m to 1m response zone between 1.0 to 4.0m; plain standpipe was installed from ground level to 1.0m; bentonite seal 0.0 to 1.0m, concrete and flush cover at ground level.
REMARKS: Borehole terminated at 30.0mbgl as per client's requirements.

| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| Cable Percussion Rig | RM Foster Drilling | SWO | RJB |

# BOREHOLE LOG

| Project | | | | BOREHOLE No |
|---|---|---|---|---|
| 156 West End Lane, West Hampstead | | | | BH2 |
| Job No | Date | Ground Level (m) | Co-Ordinates (m) | |
| CG/38293 | 28-02-20<br>02-03-20 | 53.00 | E 525,654.8 N 184,865.7 | |
| Client | | | | Sheet |
| A2 Dominion | | | | 1 of 4 |

| SAMPLES & TESTS | | | Water | STRATA | | | | Instrument /Backfill |
|---|---|---|---|---|---|---|---|---|
| Depth (m) | Type No | Test Result | | Reduced Level | Legend | Depth (m) (Thick-ness) | DESCRIPTION | |
| | | | | 52.90 | | 0.10 | Concrete. [MADE GROUND] | |
| | | | | 52.60 | | 0.40 | Dark brown and dark grey clayey gravelly fine to coarse sand. Gravel is angular to subrounded fine to coarse flint, sandstone and rare brick. [MADE GROUND] | |
| 0.80 | B1 | | | | | | | |
| 0.80 | ES1 | | | | | | Soft to firm dark brown and brown slightly sandy gravelly clay. Gravel is angular to subrounded fine to coarse flint, sandstone and brick. [MADE GROUND] | |
| 1.20 | SPT | N6 | | | | (1.80) | | |
| 2.00 | B2 | | | 50.80 | | 2.20 | | |
| 2.00 | ES2 | | | | | | Firm light brown with orange brown and occasional light grey mottling slightly gravelly silty CLAY. Gravel is fine to medium, rounded to subrounded flint. [Possible HEAD DEPOSITS] | |
| 2.20 | D3 | | | | | | | |
| 2.20 | SPT | N4 | | | | | | |
| 3.00 | ES3 | | | | | (1.80) | | |
| 3.00 | B4 | | | | | | | |
| 3.20 | SPT | N14 | | | | | | |
| 3.50 | B5 | | | | | | | |
| | | | | 49.00 | | 4.00 | | |
| 4.00 | B6 | | | | | | Firm to stiff orange brown gravelly silty CLAY. Gravel is fine to coarse, rounded and tabular flint. [Possible HEAD DEPOSITS] | |
| 4.20 | U7 | 25 blows | | | | | | |
| 4.65 | D8 | | | | | | | |
| 5.00 | D9 | | | | | (2.00) | | |
| 5.20 | D10 | | | | | | | |
| 5.20 | SPT | N16 | | | | | | |
| | | | | 47.00 | | 6.00 | | |
| 6.00 | ES4 | | | | | | Firm becoming stiff orange brown silty CLAY with very fine mica/selenite. [LONDON CLAY FORMATION] | |
| 6.00 | B11 | | | | | | 6.00 Possible very fine mica and/or selenite. | |
| 6.50 | U12 | 30 blows | | | | | | |
| 6.95 | D13 | | | | | | | |
| 7.00 | D14 | | | | | (2.50) | | |

## Boring Progress and Water Observations

| Date | Comment | Strike Depth | Casing Depth | Casing Dia. mm | Standing Depth |
|---|---|---|---|---|---|
| | | | | | |

## General Remarks

METHOD: Hand dig to 1.2m.
CASING: Drilled in to 150mm. Casing to 6.0m.
GROUNDWATER: No Groundwater encountered.
CONTAMINATION: Significant visual or olfactory contamination was not encountered.
BACKFILL: On completion, a slotted standpipe (50mm) was installed to 4m to 1m response zone between 1.0 to 4.0m; plain standpipe was installed from ground level to 1.0m; bentonite seal 0.0 to 1.0m, concrete and flush cover at ground level.
REMARKS: Borehole terminated at 30.0mbgl as per client's requirements.

| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| Cable Percussion Rig | RM Foster Drilling | JMW | RJB |

# BOREHOLE LOG

| Project | | | | BOREHOLE No |
|---|---|---|---|---|
| 156 West End Lane, West Hampstead | | | | BH2 |
| Job No | Date | Ground Level (m) | Co-Ordinates (m) | |
| CG/38293 | 28-02-20<br>02-03-20 | 53.00 | E 525,654.8 N 184,865.7 | |
| Client | | | | Sheet |
| A2 Dominion | | | | 2 of 4 |

| SAMPLES & TESTS | | | Water | STRATA | | | | Instrument /Backfill |
|---|---|---|---|---|---|---|---|---|
| Depth (m) | Type No | Test Result | | Reduced Level | Legend | Depth (m) (Thick-ness) | DESCRIPTION | |
| 8.00 | D15 | | | | | | Firm becoming stiff orange brown silty CLAY with very fine mica/selenite. [LONDON CLAY FORMATION] *(continued)* | |
| 8.00 | SPT | N21 | | 44.50 | | 8.50 | | |
| | | | | | | | Stiff brown grey silty CLAY with very fine selenite crystals. [LONDON CLAY FORMATION] | |
| 9.00 | B16 | | | | | | | |
| 9.50 | U17 | 35 blows | | | | | | |
| 9.95 | D18 | | | | | | | |
| 11.00 | B19 | | | | | | | |
| 11.00 | D20 | | | | | | | |
| 11.00 | SPT | N27 | | | | | | |
| 12.00 | D21 | | | | | | | |
| 12.50 | U22 | 80 blows | | | | | | |
| 12.85 | D23 | | | | | | | |
| 13.00 | B24 | | | | | | 13.00 Dark grey in colour. | |
| 14.00 | D25 | | | | | | | |
| 14.00 | SPT | N34 | | | | | | |
| 15.00 | D26 | | | | | | | |
| 15.50 | U27 | 58 blows | | | | | | |

## Boring Progress and Water Observations

| Date | Comment | Strike Depth | Casing Depth | Casing Dia. mm | Standing Depth |
|---|---|---|---|---|---|
| | | | | | |

## General Remarks

METHOD: Hand dig to 1.2m.
CASING: Drilled in to 150mm. Casing to 6.0m.
GROUNDWATER: No Groundwater encountered.
CONTAMINATION: Significant visual or olfactory contamination was not encountered.
BACKFILL: On completion, a slotted standpipe (50mm) was installed to 4m to 1m response zone between 1.0 to 4.0m; plain standpipe was installed from ground level to 1.0m; bentonite seal 0.0 to 1.0m, concrete and flush cover at ground level.
REMARKS: Borehole terminated at 30.0mbgl as per client's requirements.

| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| Cable Percussion Rig | RM Foster Drilling | JMW | RJB |

# BOREHOLE LOG

| Project | | | | BOREHOLE No |
|---|---|---|---|---|
| 156 West End Lane, West Hampstead | | | | BH2 |
| Job No | Date | Ground Level (m) | Co-Ordinates (m) | |
| CG/38293 | 28-02-20<br>02-03-20 | 53.00 | E 525,654.8 N 184,865.7 | |
| Client | | | | Sheet |
| A2 Dominion | | | | 3 of 4 |

| SAMPLES & TESTS | | | Water | STRATA | | | | Instrument /Backfill |
|---|---|---|---|---|---|---|---|---|
| Depth (m) | Type No | Test Result | | Reduced Level | Legend | Depth (m) (Thick-ness) | DESCRIPTION | |
| 15.95 | D28 | | | | | | Stiff brown grey silty CLAY with very fine selenite crystals. [LONDON CLAY FORMATION] *(continued)* | |
| 17.00 | B29 | | | | | | 17.00 Thin light grey silt partings and possible rare fine shell debris. | |
| 17.00 | D30 | | | | | | | |
| 17.00 | SPT | N33 | | | | | | |
| 18.00 | D31 | | | | | | | |
| 18.50 | U32 | 80 blows | | | | | | |
| 18.95 | D33 | | | | | | | |
| 19.00 | B34 | | | | | (21.50) | | |
| 20.00 | D35 | | | | | | | |
| 20.00 | SPT | N41 | | | | | | |
| 21.00 | B36 | | | | | | | |
| 21.50 | U37 | 90 blows | | | | | | |
| 21.90 | D38 | | | | | | | |
| 23.00 | B39 | | | | | | | |
| 23.00 | D40 | | | | | | | |
| 23.00 | SPT | N50 | | | | | | |

## Boring Progress and Water Observations

| Date | Comment | Strike Depth | Casing Depth | Casing Dia. mm | Standing Depth |
|---|---|---|---|---|---|
| | | | | | |

## General Remarks

METHOD: Hand dig to 1.2m.
CASING: Drilled in to 150mm. Casing to 6.0m.
GROUNDWATER: No Groundwater encountered.
CONTAMINATION: Significant visual or olfactory contamination was not encountered.
BACKFILL: On completion, a slotted standpipe (50mm) was installed to 4m to 1m response zone between 1.0 to 4.0m; plain standpipe was installed from ground level to 1.0m; bentonite seal 0.0 to 1.0m, concrete and flush cover at ground level.
REMARKS: Borehole terminated at 30.0mbgl as per client's requirements.

| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| Cable Percussion Rig | RM Foster Drilling | JMW | RJB |

# BOREHOLE LOG

| Project | | | | BOREHOLE No |
|---|---|---|---|---|
| 156 West End Lane, West Hampstead | | | | BH2 |
| Job No | Date | Ground Level (m) | Co-Ordinates (m) | |
| CG/38293 | 28-02-20<br>02-03-20 | 53.00 | E 525,654.8 N 184,865.7 | |
| Client | | | | Sheet |
| A2 Dominion | | | | 4 of 4 |

| SAMPLES & TESTS | | | Water | STRATA | | | | Instrument /Backfill |
|---|---|---|---|---|---|---|---|---|
| Depth (m) | Type No | Test Result | | Reduced Level | Legend | Depth (m) (Thick-ness) | DESCRIPTION | |
| 24.00 | D41 | | | | | | Stiff brown grey silty CLAY with very fine selenite crystals. [LONDON CLAY FORMATION] *(continued)* | |
| 24.50 | U42 | 100 blows | | | | | | |
| 24.85 | D43 | | | | | | | |
| 26.00 | B44 | | | | | | | |
| 26.00 | D45 | | | | | | | |
| 26.00 | SPT | N40 | | | | | | |
| 27.00 | D46 | | | | | | | |
| 27.50 | U47 | 100 blows | | | | | | |
| 27.85 | D48 | | | | | | 27.85 Very stiff with blocky fissuring. | |
| 28.50 | B49 | | | | | | | |
| 29.00 | D50 | | | | | | | |
| 29.00 | SPT | N50/ 297 mm | | | | | | |
| | | | | 23.00 | | 30.00 | | |
| 30.00 | D51 | | | | | | *(Borehole terminated at 30m)* | |
| 30.00 | D52 | | | | | | | |
| 30.00 | SPT | N49 | | | | | | |

## Boring Progress and Water Observations

| Date | Comment | Strike Depth | Casing Depth | Casing Dia. mm | Standing Depth |
|---|---|---|---|---|---|
| | | | | | |

## General Remarks

METHOD: Hand dig to 1.2m.
CASING: Drilled in to 150mm. Casing to 6.0m.
GROUNDWATER: No Groundwater encountered.
CONTAMINATION: Significant visual or olfactory contamination was not encountered.
BACKFILL: On completion, a slotted standpipe (50mm) was installed to 4m to 1m response zone between 1.0 to 4.0m; plain standpipe was installed from ground level to 1.0m; bentonite seal 0.0 to 1.0m, concrete and flush cover at ground level.
REMARKS: Borehole terminated at 30.0mbgl as per client's requirements.

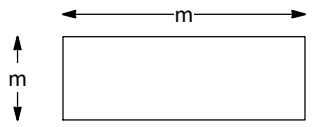
| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| Cable Percussion Rig | RM Foster Drilling | JMW | RJB |

# TRIAL PIT LOG

| Project | | | | TRIAL PIT No |
|---|---|---|---|---|
| 156 West End Lane, West Hampstead | | | | FIP1 |
| Job No | Date | Ground Level (m) | Co-Ordinates (m) | |
| CG/38293 | 15-01-20 | 54.62 | E 525,610.8 N 184,884.4 | |
| Client | | | | Sheet |
| A2 Dominion | | | | 1 of 1 |

| SAMPLES & TESTS | | | Water | STRATA | | | |
|---|---|---|---|---|---|---|---|
| Depth (m) | Type No | Test Result (N/kPa/ppm) | | Reduced Level | Legend | Depth (m) (Thick-ness) | DESCRIPTION |
| | | | | 54.37 | | (0.25) 0.25 | Reinforced Concrete [MADE GROUND] |
| | | | | | | (1.45) | Loose brown gravelly fine to coarse sand. Gravel is fine to coarse, rounded to subangular of flint, brick and concrete. Occasional cobbles of brick and metal fragments. [MADE GROUND] |
| | | | | 52.92 | | 1.70 | *(Pit terminated at 1.7m)* |

**Plan**




Stability:

**General Remarks**

1. Trial pit terminated at 1.7mbgl.
2. Water not encountered during excavation.
3. Backfilled with arisings upon completion.

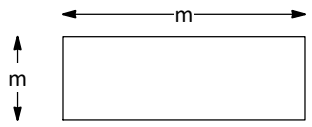
| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| | GEH Limited | NLC | RJB |

# TRIAL PIT LOG

| Project | | | | TRIAL PIT No |
|---|---|---|---|---|
| 156 West End Lane, West Hampstead | | | | FIP2 |
| Job No | Date | Ground Level (m) | Co-Ordinates (m) | |
| CG/38293 | 15-01-20 | 54.15 | E 525,625.4 N 184,883.7 | |
| Client | | | | Sheet |
| A2 Dominion | | | | 1 of 1 |

| SAMPLES & TESTS | | | Water | STRATA | | | |
|---|---|---|---|---|---|---|---|
| Depth (m) | Type No | Test Result (N/kPa/ppm) | | Reduced Level | Legend | Depth (m) (Thick-ness) | DESCRIPTION |
| | | | | 53.87 | | (0.28) 0.28 | Reinforced Concrete [MADE GROUND] |
| 0.50 | ES1 | | | 52.95 | | (0.92) 1.20 | Loose brown gravelly fine to coarse sand. Gravel is fine to coarse, rounded to subangular of flint, brick and concrete. Occasional cobbles of brick. [MADE GROUND] |
| | | | | 52.45 | | (0.50) 1.70 | Firm dark grey slightly sandy organic clay. Frequent rootlets and organic matter. [MADE GROUND] |
| | | | | | | | *(Pit terminated at 1.7m)* |

## Plan




Stability:

## General Remarks

1. Trial pit terminated at 1.7mbgl.
2. Water not encountered during excavation.
3. Backfilled with arisings upon completion.

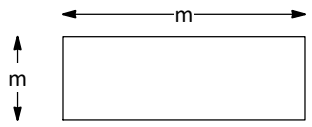
| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| | GEH Limited | NLC | RJB |

# TRIAL PIT LOG

| Project | | | | TRIAL PIT No |
|---|---|---|---|---|
| 156 West End Lane, West Hampstead | | | | FIP3 |
| Job No | Date | Ground Level (m) | Co-Ordinates (m) | |
| CG/38293 | 15-01-20 | 53.33 | E 525,648.3 N 184,883.3 | |
| Client | | | | Sheet |
| A2 Dominion | | | | 1 of 1 |

| SAMPLES & TESTS | | | Water | STRATA | | | |
|---|---|---|---|---|---|---|---|
| Depth (m) | Type No | Test Result (N/kPa/ppm) | | Reduced Level | Legend | Depth (m) (Thick-ness) | DESCRIPTION |
| | | | | 53.13 | | 0.20 | Reinforced Concrete<br>[MADE GROUND] |
| | | | | 52.88 | | (0.25)<br>0.45 | Firm orange gravelly sandy clay. Gravel is fine to coarse, rounded to subangular of flint and brick. Sand is fine to coarse.<br>[MADE GROUND] |
| | | | | 52.23 | | (0.65)<br>1.10 | Firm dark brown sandy gravelly clay. Sand is fine to coarse. Gravel is fine to coarse, rounded to subangular of flint, brick and concrete. Occasional cobbles of brick.<br>[MADE GROUND] |
| | | | | 51.73 | | (0.50)<br>1.60 | Firm dark grey mottled black organic clay. Occasional roots, organic matter and brick fragments. Organic odour<br>[MADE GROUND] |
| | | | | | | | *(Pit terminated at 1.6m)* |

## Plan




Stability:

## General Remarks

1. Trial pit terminated at 1.6mbgl.
2. Water not encountered during excavation.
3. Backfilled with arisings upon completion.

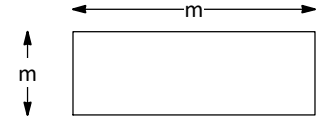
| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| | GEH Limited | NLC | RJB |

# TRIAL PIT LOG

| Project | | | | TRIAL PIT No |
|---|---|---|---|---|
| 156 West End Lane, West Hampstead | | | | FIP4 |
| Job No | Date | Ground Level (m) | Co-Ordinates (m) | |
| CG/38293 | 15-01-20 | 53.00 | E 525,662.6 N 184,880.4 | |
| Client | | | | Sheet |
| A2 Dominion | | | | 1 of 1 |

| SAMPLES & TESTS | | | Water | STRATA | | | |
|---|---|---|---|---|---|---|---|
| Depth (m) | Type No | Test Result (N/kPa/ppm) | | Reduced Level | Legend | Depth (m) (Thick-ness) | DESCRIPTION |
| | | | | 52.70 | | (0.30) 0.30 | Reinforced Concrete [MADE GROUND] |
| 0.40 | ES1 | | | 52.30 | | (0.40) 0.70 | Yellow clayey gravelly fine to coarse sand. Gravel is rounded to subangular of flint. [MADE GROUND] |
| 0.75<br>0.80 | ES3<br>ES2 | | | 51.90 | | (0.40) 1.10 | Firm brown gravelly sandy clay. Gravel is fine to medium, subrounded to angular of flint, concrete and brick. Sand is fine to coarse. [MADE GROUND]<br>0.75 Isolated pocket of medium subangular gravel of concrete in south east corner of pit. Strong hydrocarbon odour. |
| | | | | 51.65 | | (0.25) 1.35 | 0.75 - 1.10 In south of pit, ground conditions comprise reworked alluvium; Firm dark grey mottled black clay with occassional concrete fragments. |
| | | | | | | | Firm brown mottled grey clay. Occasional fine subangular gravel of brick. [MADE GROUND] |
| | | | | | | | *(Pit terminated at 1.35m)* |

## Plan




Stability:

## General Remarks

1. Trial pit terminated at 1.35mbgl.
2. Water encountered at 0.7mbgl.
3. Backfilled with arisings upon completion.

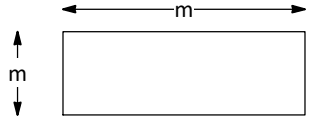
| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| | GEH Limited | NLC | RJB |

# TRIAL PIT LOG

| Project | | | | TRIAL PIT No |
|---|---|---|---|---|
| 156 West End Lane, West Hampstead | | | | FIP6 |
| Job No | Date | Ground Level (m) | Co-Ordinates (m) | |
| CG/38293 | 16-01-20 | 53.00 | E 525,666.5 N 184,878.9 | |
| Client | | | | Sheet |
| A2 Dominion | | | | 1 of 1 |

| SAMPLES & TESTS | | | Water | STRATA | | | |
|---|---|---|---|---|---|---|---|
| Depth (m) | Type No | Test Result (N/kPa/ppm) | | Reduced Level | Legend | Depth (m) (Thick-ness) | DESCRIPTION |
| | | | | 52.75 | | (0.25) 0.25 | Reinforced Concrete [MADE GROUND] |
| | | | | 52.25 | | (0.50) 0.75 | Yellow clayey gravelly fine to coarse sand. Gravel is rounded to subangular of flint. [MADE GROUND] |
| | | | | 51.45 | | (0.80) 1.55 | 0.70 - 1.25 In west of pit, ground conditions comprise reworked alluvium; Firm dark grey mottled black clay with occassional concrete fragments. Firm brown gravelly clay. Gravel is fine to medium, rounded to subangular of brick, concrete and flint. [MADE GROUND] |
| | | | | 51.10 | | (0.35) 1.90 | Firm brown mottled grey clay. Occasional fine subangular gravel of brick. [MADE GROUND] |
| | | | | | | | *(Pit terminated at 1.9m)* |

## Plan




Stability:

## General Remarks

1. Trial pit terminated at 1.9mbgl.
2. Water encountered at 0.75mbgl.
3. Backfilled with arisings upon completion.

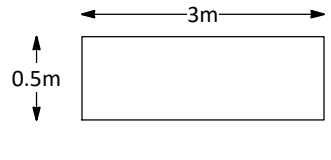
| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| | GEH Limited | NLC | RJB |

# TRIAL PIT LOG

| Project | | | | TRIAL PIT No |
|---|---|---|---|---|
| 156 West End Lane, West Hampstead | | | | **TP1** |
| Job No | Date | Ground Level (m) | Co-Ordinates (m) | |
| CG/38293 | 13-03-20 | 54.04 | E 525,622.8 N 184,854.6 | |
| Client | | | | Sheet |
| A2 Dominion | | | | 1 of 1 |

| SAMPLES & TESTS | | | Water | STRATA | | | |
|---|---|---|---|---|---|---|---|
| Depth (m) | Type No | Test Result (N/kPa/ppm) | | Reduced Level | Legend | Depth (m) (Thick-ness) | DESCRIPTION |
| | | | | 53.84 | | 0.20 | Reinforced concrete with 4mm diameter rebar over a plastic membrane. [MADE GROUND] |
| 0.50 | ES1 | | | 53.24 | | (0.60) 0.80 | Dark grey brown clayey sandy gravel with cobbles of brick. Sand is medium to coarse. Gravel is angular to subangular fine to coarse of brick, concrete, clinker and flint. [MADE GROUND] |
| 0.90 | ES2 | | | 52.74 | | (0.50) 1.30 | Light brown to orange brown slightly clayey sandy gravel. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of brick, concrete and flint. [MADE GROUND] |
| 1.40 | ES3 | | | | | | Orange brown gravelly fine to coarse sand with medium subrounded flint cobble content. Gravel is subangular fine to medium of flint. [MADE GROUND] |
| 1.90 | ES4 | | | 51.74 | | (1.00) 2.30 | |
| 2.70 | ES5 | | | 50.64 | | (1.10) 3.40 | Orange brown slightly clayey sandy subangular to subrounded fine to coarse flint gravel with low to medium rounded to subrounded flint cobble content. [MADE GROUND]<br>2.70 Becoming clayey. |
| | | | | | | | *(Pit terminated at 3.4m)* |

## Plan




Stability: Unstable

## General Remarks

METHOD: Machine excavated to 3.4m.
GROUNDWATER: No Groundwater encountered.
CONTAMINATION: Significant visual or olfactory contamination was not encountered.
BACKFILL: On completion, trial pit backfilled with arisings, compacted with JCB bucket and left flush.
REMARKS: Trial pit terminated at 3.4m due to side collaspe.

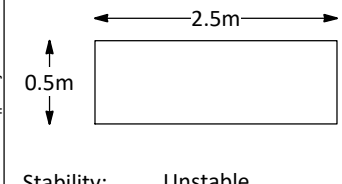
| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| JCB3CX | Kayleigh Plant Hire | GAT | RJB |

# TRIAL PIT LOG

| Project | | | | TRIAL PIT No |
|---|---|---|---|---|
| 156 West End Lane, West Hampstead | | | | **TP2** |
| Job No | Date | Ground Level (m) | Co-Ordinates (m) | |
| CG/38293 | 13-03-20 | 54.69 | E 525,602.6 N 184,854.9 | |
| Client | | | | Sheet |
| A2 Dominion | | | | 1 of 1 |

| SAMPLES & TESTS | | | Water | STRATA | | | |
|---|---|---|---|---|---|---|---|
| Depth (m) | Type No | Test Result (N/kPa/ppm) | | Reduced Level | Legend | Depth (m) (Thick-ness) | DESCRIPTION |
| | | | | 54.49 | | 0.20 | Reinforced concrete with 4mm diameter rebar over a plastic membrane. [MADE GROUND] |
| 0.30 | ES1 | | | 53.89 | | (0.60) 0.80 | Dark grey brown slightly clayey gravelly medium sand. Gravel is angular to subrounded fine to coarse of concrete, brick, flint and occasional clinker. [MADE GROUND] |
| 0.90 | ES2 | | | 53.59 | | (0.30) 1.10 | Light brown to orange brown slightly clayey gravelly medium to coarse sand. Gravel is subangular to subrounded flint and fine brick. [MADE GROUND] |
| 1.30 | ES3 | | | | | | Orange brown sand and gravel with low to medium subrounded to rounded flint cobble content. Sand is medium to coarse. Gravel is subrounded to subangular fine to coarse flint. [MADE GROUND] |
| 2.30 | ES4 | | | 51.89 | | (1.70) 2.80 | |
| | | | | | | | *(Pit terminated at 2.8m)* |

## Plan




Stability: Unstable

## General Remarks

METHOD: Machine excavated to 2.8m.
GROUNDWATER: No Groundwater encountered.
CONTAMINATION: Significant visual or olfactory contamination was not encountered.
BACKFILL: On completion, trial pit backfilled with arisings, compacted with JCB bucket and left flush.
REMARKS: Trial pit terminated at 2.8m due to side collaspe.

| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| JCB3CX | Kayleigh Plant Hire | GAT | RJB |

# WINDOW SAMPLE LOG

| Project | | | | HOLE No |
|---|---|---|---|---|
| 156 West End Lane, West Hampstead | | | | WS6 |
| Job No | Date | Ground Level (m) | Co-Ordinates (m) | |
| CG/38293 | 25-02-20<br>25-02-20 | 54.18 | E 525,622.6 N 184,867.6 | |
| Client | | | | Sheet |
| A2 Dominion | | | | 1 of 2 |

| SAMPLES & TESTS | | | Water | STRATA | | | | Instrument /Backfill |
|---|---|---|---|---|---|---|---|---|
| Depth (m) | Type No | Test Result (N/kPa/ppm) | | Reduced Level | Legend | Depth (m) (Thick-ness) | DESCRIPTION | |
| | | | | 54.08 | | 0.10 | Concrete.<br>[MADE GROUND] | |
| 0.30 | ES1 | | | 53.48 | | (0.60)<br>0.70 | Loose to dense brown and dark brown clayey very gravelly fine to coarse sand. Gravel is subangular to rounded fine to coarse flint.<br>[MADE GROUND] | |
| 0.80 | ES2 | | | 53.28 | | 0.90 | Dense brown, dark brown and reddish brown clayey very gravelly fine to coarse sand with a low subangular brick cobble content. Gravel is subangular to rounded fine to coarse flint. Rare plastic fragments.<br>[MADE GROUND] | |
| 1.10<br>1.20 | ES3<br>SPT | N30 | | 52.43 | | (0.85)<br>1.75 | Dense brown, dark brown and dark grey clayey very gravelly fine to coarse sand with a low subangular brick cobble content. Gravel is subangular to rounded fine to coarse flint. Frequent ashy material.<br>[MADE GROUND] | |
| 1.90<br>2.00 | ES4<br>SPT | N7 | | 51.98 | | (0.45)<br>2.20 | Firm locally soft dark bluish grey slightly gravelly silty clay. Gravel is angular to subrounded fine brick.<br>[MADE GROUND] | |
| 3.00 | SPT | N14 | | 50.78 | | (1.20)<br>3.40 | Firm brown, orangish brown and light bluish grey CLAY.<br>[LONDON CLAY FORMATION] | |
| 4.00 | SPT | N10 | | | | (3.05) | Firm becoming stiff brown mottled light bluish grey silty CLAY.<br>[LONDON CLAY FORMATION] | |

## Boring Progress and Water Observations

| Date | Strike depth | Casing depth | Comment | Time measured | Standing Depth |
|---|---|---|---|---|---|
| | | | | | |

## General Remarks

METHOD: Hand dig to 1.2m.
GROUNDWATER: No Groundwater encountered.
CONTAMINATION: Significant visual or olfactory contamination was not encountered.
BACKFILL: On completion, a slotted standpipe (50mm) was installed to 2.0mbgl to 0.5m response zone between 0.5 to 2.0mbgl.
REMARKS: Borehole terminated at 6.45mbgl due to density of the ground.

| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| Tracked Windowless Sample Rig | RGI Limited | SWO | RJB |

# WINDOW SAMPLE LOG

| Project | | | | HOLE No |
|---|---|---|---|---|
| 156 West End Lane, West Hampstead | | | | WS6 |
| Job No | Date | Ground Level (m) | Co-Ordinates (m) | |
| CG/38293 | 25-02-20<br>25-02-20 | 54.18 | E 525,622.6 N 184,867.6 | |
| Client | | | | Sheet |
| A2 Dominion | | | | 2 of 2 |

| SAMPLES & TESTS | | | Water | STRATA | | | | Instrument /Backfill |
|---|---|---|---|---|---|---|---|---|
| Depth (m) | Type No | Test Result (N/kPa/ppm) | | Reduced Level | Legend | Depth (m) (Thick-ness) | DESCRIPTION | |
| 5.00 | SPT | N11 | | | | | Firm becoming stiff brown mottled light bluish grey silty CLAY. [LONDON CLAY FORMATION] *(continued)* | |
| 6.00 | SPT | N19 | | 47.73 | | 6.45 | | |
| | | | | | | | *(Window sample terminated at 6.45m)* | |

## Boring Progress and Water Observations

| Date | Strike depth | Casing depth | Comment | Time measured | Standing Depth |
|---|---|---|---|---|---|
| | | | | | |

## General Remarks

METHOD: Hand dig to 1.2m.
GROUNDWATER: No Groundwater encountered.
CONTAMINATION: Significant visual or olfactory contamination was not encountered.
BACKFILL: On completion, a slotted standpipe (50mm) was installed to 2.0mbgl to 0.5m response zone between 0.5 to 2.0mbgl.
REMARKS: Borehole terminated at 6.45mbgl due to density of the ground.

| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| Tracked Windowless Sample Rig | RGI Limited | SWO | RJB |

# WINDOW SAMPLE LOG

| Project | | | | HOLE No |
|---|---|---|---|---|
| 156 West End Lane, West Hampstead | | | | WS7 |
| Job No | Date | Ground Level (m) | Co-Ordinates (m) | |
| CG/38293 | 26-02-20<br>26-02-20 | 53.07 | E 525,652.5 N 184,856.0 | |
| Client | | | | Sheet |
| A2 Dominion | | | | 1 of 2 |

| SAMPLES & TESTS | | | Water | STRATA | | | | Instrument /Backfill |
|---|---|---|---|---|---|---|---|---|
| Depth (m) | Type No | Test Result (N/kPa/ppm) | | Reduced Level | Legend | Depth (m) (Thick-ness) | DESCRIPTION | |
| | | | | 52.97 | | 0.10 | Concrete.<br>[MADE GROUND] | |
| | | | | 52.67 | | (0.30)<br>0.40 | Loose to dense dark brown and dark grey clayey gravelly fine to coarse sand. Gravel is angular to subrounded fine to coarse flint, sandstone and rare brick.<br>[MADE GROUND] | |
| | | | | 52.47 | | 0.60 | | |
| 0.60 | ES1 | | | | | | Loose to dense brown clayey gravelly fine to coarse sand. Gravel is angular to subrounded fine to coarse sandstone and brick.<br>[MADE GROUND] | |
| 1.00 | SPT | N19 | | 51.87 | | (0.60)<br>1.20 | Dense brown, dark brown and dark grey clayey very gravelly fine to coarse sand with a low subangular brick cobble content. Gravel is subangular to rounded fine to coarse flint.<br>[MADE GROUND] | |
| 1.30 | ES2 | | | | | | Dense brown and orangish brown slightly sandy gravelly clay. Gravel is angular to subrounded fine to coarse flint and sandstone.<br>[MADE GROUND] | |
| | | | | 51.07 | | (0.80)<br>2.00 | | |
| 2.00-3.00 | B1 | | | | | | Dense orangish brown and brown clayey gravelly fine to coarse sand. Gravel is angular to subrounded fine to coarse flint and rare sandstone.<br>[MADE GROUND] | |
| 2.00 | SPT | N8 | | | | | | |
| 3.00 | SPT | N9 | | | | (2.00) | | |
| | | | | 49.07 | | 4.00 | | |
| 4.00 | SPT | N4 | | | | | Firm becoming stiff brown mottled light bluish grey silty CLAY.<br>[LONDON CLAY FORMATION] | |
| 4.50 | D2 | | | | | | | |

## Boring Progress and Water Observations

| Date | Strike depth | Casing depth | Comment | Time measured | Standing Depth |
|---|---|---|---|---|---|
| | | | | | |

## General Remarks

METHOD: Hand dig to 1.2m.
GROUNDWATER: No Groundwater encountered.
CONTAMINATION: Significant visual or olfactory contamination was not encountered.
BACKFILL: On completion, a slotted standpipe (50mm) was installed to 4.0mbgl to 2.0m response zone between 4.0mbgl to 2.0mbgl.
REMARKS: Borehole terminated at 6.45mbgl due to density of the ground.

| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| Tracked Windowless Sample Rig | RGI Limited | SWO | RJB |

# WINDOW SAMPLE LOG

| Project | | | | HOLE No |
|---|---|---|---|---|
| 156 West End Lane, West Hampstead | | | | WS7 |
| Job No | Date | Ground Level (m) | Co-Ordinates (m) | |
| CG/38293 | 26-02-20<br>26-02-20 | 53.07 | E 525,652.5 N 184,856.0 | |
| Client | | | | Sheet |
| A2 Dominion | | | | 2 of 2 |

| SAMPLES & TESTS | | | Water | STRATA | | | | Instrument /Backfill |
|---|---|---|---|---|---|---|---|---|
| Depth (m) | Type No | Test Result (N/kPa/ppm) | | Reduced Level | Legend | Depth (m) (Thick-ness) | DESCRIPTION | |
| 5.00 | SPT | N8 | | | | (2.45) | Firm becoming stiff brown mottled light bluish grey silty CLAY. [LONDON CLAY FORMATION] *(continued)* | |
| 5.50 | D3 | | | | | | | |
| 6.00 | SPT | N14 | | | | | | |
| | | | | 46.62 | | 6.45 | | |
| | | | | | | | *(Window sample terminated at 6.45m)* | |

## Boring Progress and Water Observations

| Date | Strike depth | Casing depth | Comment | Time measured | Standing Depth |
|---|---|---|---|---|---|
| | | | | | |

## General Remarks

METHOD: Hand dig to 1.2m.
GROUNDWATER: No Groundwater encountered.
CONTAMINATION: Significant visual or olfactory contamination was not encountered.
BACKFILL: On completion, a slotted standpipe (50mm) was installed to 4.0mbgl to 2.0m response zone between 4.0mbgl to 2.0mbgl.
REMARKS: Borehole terminated at 6.45mbgl due to density of the ground.

| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| Tracked Windowless Sample Rig | RGI Limited | SWO | RJB |

# APPENDIX E

*Phase 2 Exploratory Hole Logs*

# BOREHOLE LOG

| Project | | | | BOREHOLE No |
|---|---|---|---|---|
| 156 West End Lane, West Hampstead | | | | BH03 |
| Job No | Date | Ground Level (m) | Co-Ordinates (m) | |
| CG/38293 | 16-07-20<br>21-07-20 | 55.30 | E 525,538.3 N 184,860.1 | |
| Client | | | | Sheet |
| A2 Dominion | | | | 1 of 4 |

| SAMPLES & TESTS | | | Water | STRATA | | | | Instrument /Backfill |
|---|---|---|---|---|---|---|---|---|
| Depth (m) | Type No | Test Result | | Reduced Level | Legend | Depth (m) (Thick-ness) | DESCRIPTION | |
| | | | | 54.95 | | 0.35 | Reinforced concrete.<br>[MADE GROUND] | |
| 0.50 | B | | | | | | Brown silty sandy gravel. Gravel is fine to coarse rounded to angular of flint and brick. Sand is fine to coarse.<br>[MADE GROUND] | |
| 0.50 | D | | | | | (0.85) | | |
| 0.80 | B | | | | | | | |
| 0.80 | D | | | | | | | |
| 0.80 | ES | | | 54.10 | | 1.20 | | |
| | | | | | | | Firm brownish grey sandy silty CLAY. Sand is fine to coarse.<br>[MADE GROUND] | |
| 1.50 | D | | | | | | | |
| 1.50 | SPT | N9 | | | | | | |
| 2.00 | B | | | | | (1.70) | | |
| 2.00 | D | | | | | | | |
| 2.00 | ES | | | | | | | |
| 2.30 | B | | | | | | | |
| 2.30 | D | | | | | | | |
| 2.50 | D | | | 52.40 | | 2.90 | | |
| 2.50 | SPT | N30 | | | | | Medium dense grey sandy gravel. Gravel if fine to coarse rounded of flint. Sand is medium to coarse.<br>[MADE GROUND] | |
| 3.00 | B | | | | | (1.00) | | |
| 3.50 | SPT | N25 | | 51.40 | | 3.90 | | |
| 3.90 | D | | | | | | Firm becoming stiff orangish brown mottled bluish grey silty CLAY with rare selenite crystals.<br>[WEATHERED LONDON CLAY] | |
| 4.50 | D | | | | | | | |
| 4.50-4.95 | U | | | | | | | |
| 4.95 | B | | | | | | | |
| 4.95 | D | | | | | | | |
| 5.50 | B | | | | | | | |
| 5.50 | D | | | | | (3.80) | | |
| 6.00 | SPTLS | | | | | | | |
| 6.00 | SPT | N21 | | | | | | |
| 7.00 | D | | | | | | | |
| 7.50-7.95 | U | | | 47.60 | | 7.70 | | |
| | | | | | | | Very stiff bluish grey silty CLAY with rare selenite crystals.<br>[LONDON CLAY FORMATION] | |

## Boring Progress and Water Observations

| Date | Comment | Strike Depth | Casing Depth | Casing Dia. mm | Standing Depth |
|---|---|---|---|---|---|
| | | | | | |

## General Remarks

1. Borehole terminated at target depth.
2. D = Disturbed sample, B = Bulk sample, U = Undisturbed open drive sample, N = Standard Penetration Test 'N' value.
3. Installation details; 0.0-2.0mbgl: plain pipe with bentonite backfill; 2.0-4.0mbgl: slotted pipe with gravel backfill; 4.0-6.0mbgl: bentonite backfill; 6.0-30.0mbgl backfilled with soil arisings. Gas tap, bung and flush cover installed.
4. No groundwater strikes observed.
5. No visual or olfactory indicators of contamination observed.

| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| Cut-down CP rig | RM Foster Drilling | RSW | ABA |

# BOREHOLE LOG

| Project | | | | BOREHOLE No |
|---|---|---|---|---|
| 156 West End Lane, West Hampstead | | | | BH03 |
| Job No | Date | Ground Level (m) | Co-Ordinates (m) | |
| CG/38293 | 16-07-20<br>21-07-20 | 55.30 | E 525,538.3 N 184,860.1 | |
| Client | | | | Sheet |
| A2 Dominion | | | | 2 of 4 |

| SAMPLES & TESTS | | | Water | STRATA | | | | Instrument /Backfill |
|---|---|---|---|---|---|---|---|---|
| Depth (m) | Type No | Test Result | | Reduced Level | Legend | Depth (m) (Thick-ness) | DESCRIPTION | |
| 7.95 | D | | | | | | Very stiff bluish grey silty CLAY with rare selenite crystals. [LONDON CLAY FORMATION] *(continued)* | |
| 8.50 | B | | | | | | | |
| 8.50 | D | | | | | | | |
| 9.00 | SPTLS | | | | | | | |
| 9.00 | SPT | N44 | | | | | | |
| 10.00 | D | | | | | | | |
| 10.50 | U | | | | | | | |
| 10.85 | D | | | | | | | |
| 11.50 | B | | | | | | | |
| 11.50 | D | | | | | | | |
| 12.00 | SPTLS | | | | | | | |
| 12.00 | SPT | N30 | | | | | | |
| 13.00 | D | | | | | | | |
| 13.50-13.95 | U | | | | | | | |
| 13.95 | D | | | | | | | |
| 14.50 | B | | | | | | | |
| 14.50 | D | | | | | | | |
| 15.00 | SPTLS | | | | | | | |
| 15.00 | SPT | N30 | | | | | | |

## Boring Progress and Water Observations

| Date | Comment | Strike Depth | Casing Depth | Casing Dia. mm | Standing Depth |
|---|---|---|---|---|---|
| | | | | | |

## General Remarks

1. Borehole terminated at target depth.
2. D = Disturbed sample, B = Bulk sample, U = Undisturbed open drive sample, N = Standard Penetration Test 'N' value.
3. Installation details; 0.0-2.0mbgl: plain pipe with bentonite backfill; 2.0-4.0mbgl: slotted pipe with gravel backfill; 4.0-6.0mbgl: bentonite backfill; 6.0-30.0mbgl backfilled with soil arisings. Gas tap, bung and flush cover installed.
4. No groundwater strikes observed.
5. No visual or olfactory indicators of contamination observed.

| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| Cut-down CP rig | RM Foster Drilling | RSW | ABA |

# BOREHOLE LOG

| Project | | | | BOREHOLE No |
|---|---|---|---|---|
| 156 West End Lane, West Hampstead | | | | BH03 |
| Job No | Date | Ground Level (m) | Co-Ordinates (m) | |
| CG/38293 | 16-07-20<br>21-07-20 | 55.30 | E 525,538.3 N 184,860.1 | |
| Client | | | | Sheet |
| A2 Dominion | | | | 3 of 4 |

| SAMPLES & TESTS | | | Water | STRATA | | | | Instrument /Backfill |
|---|---|---|---|---|---|---|---|---|
| Depth (m) | Type No | Test Result | | Reduced Level | Legend | Depth (m) (Thick-ness) | DESCRIPTION | |
| 16.00 | D | | | | | | Very stiff bluish grey silty CLAY with rare selenite crystals. [LONDON CLAY FORMATION] *(continued)* | |
| 16.50 | U | | | | | | | |
| 16.95 | D | | | | | | | |
| 17.50 | B | | | | | | | |
| 17.50 | D | | | | | | | |
| 18.00 | SPTLS | | | | | | | |
| 18.00 | SPT | N24 | | | | (22.30) | | |
| 19.00 | D | | | | | | | |
| 19.50-19.90 | U | | | | | | | |
| 19.90 | B | | | | | | | |
| 19.90 | D | | | | | | | |
| 20.50 | D | | | | | | | |
| 21.00 | SPTLS | | | | | | | |
| 21.00 | SPT | N41 | | | | | 21.40 - 21.80 Band of claystone. | |
| 22.00 | D | | | | | | | |
| 22.50 | U | | | | | | | |
| 22.95 | B | | | | | | | |
| 22.95 | D | | | | | | | |
| 23.50 | D | | | | | | | |

## Boring Progress and Water Observations

| Date | Comment | Strike Depth | Casing Depth | Casing Dia. mm | Standing Depth |
|---|---|---|---|---|---|
| | | | | | |

## General Remarks

1. Borehole terminated at target depth.
2. D = Disturbed sample, B = Bulk sample, U = Undisturbed open drive sample, N = Standard Penetration Test 'N' value.
3. Installation details; 0.0-2.0mbgl: plain pipe with bentonite backfill; 2.0-4.0mbgl: slotted pipe with gravel backfill; 4.0-6.0mbgl: bentonite backfill; 6.0-30.0mbgl backfilled with soil arisings. Gas tap, bung and flush cover installed.
4. No groundwater strikes observed.
5. No visual or olfactory indicators of contamination observed.

| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| Cut-down CP rig | RM Foster Drilling | RSW | ABA |

# BOREHOLE LOG

| Project | | | | BOREHOLE No |
|---|---|---|---|---|
| 156 West End Lane, West Hampstead | | | | BH03 |
| Job No | Date | Ground Level (m) | Co-Ordinates (m) | |
| CG/38293 | 16-07-20<br>21-07-20 | 55.30 | E 525,538.3 N 184,860.1 | |
| Client | | | | Sheet |
| A2 Dominion | | | | 4 of 4 |

| SAMPLES & TESTS | | | Water | STRATA | | | | Instrument /Backfill |
|---|---|---|---|---|---|---|---|---|
| Depth (m) | Type No | Test Result | | Reduced Level | Legend | Depth (m) (Thick-ness) | DESCRIPTION | |
| 24.00<br>24.00 | SPTLS<br>SPT | N41 | | | | | Very stiff bluish grey silty CLAY with rare selenite crystals. [LONDON CLAY FORMATION] *(continued)* | |
| 25.00 | D | | | | | | | |
| 26.00 | D | | | | | | | |
| 27.00<br>27.00 | SPTLS<br>SPT | N52 | | | | | | |
| 28.00 | D | | | | | | | |
| 29.00 | D | | | | | | | |
| | | | | 25.30 | | 30.00 | | |
| 30.00<br>30.00 | SPTLS<br>SPT | N51 | | | | | *(Borehole terminated at 30m)* | |

## Boring Progress and Water Observations

| Date | Comment | Strike Depth | Casing Depth | Casing Dia. mm | Standing Depth |
|---|---|---|---|---|---|
| | | | | | |

## General Remarks

1. Borehole terminated at target depth.
2. D = Disturbed sample, B = Bulk sample, U = Undisturbed open drive sample, N = Standard Penetration Test 'N' value.
3. Installation details; 0.0-2.0mbgl: plain pipe with bentonite backfill; 2.0-4.0mbgl: slotted pipe with gravel backfill; 4.0-6.0mbgl: bentonite backfill; 6.0-30.0mbgl backfilled with soil arisings. Gas tap, bung and flush cover installed.
4. No groundwater strikes observed.
5. No visual or olfactory indicators of contamination observed.

| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| Cut-down CP rig | RM Foster Drilling | RSW | ABA |

# WINDOW SAMPLE LOG

| Project | | | | HOLE No |
|---|---|---|---|---|
| 156 West End Lane, West Hampstead | | | | **WS201** |
| Job No | Date | Ground Level (m) | Co-Ordinates (m) | |
| CG/38293 | 16-07-20<br>16-07-20 | 55.30 | E 525,564.7 N 184,856.7 | |
| Client | | | | Sheet |
| A2 Dominion | | | | 1 of 1 |

| SAMPLES & TESTS | | | Water | STRATA | | | | Instrument /Backfill |
|---|---|---|---|---|---|---|---|---|
| Depth (m) | Type No | Test Result (N/kPa/ppm) | | Reduced Level | Legend | Depth (m) (Thick-ness) | DESCRIPTION | |
| | | | | 55.05 | | 0.25 | Reinforced concrete.<br>[MADE GROUND] | |
| 0.30 | ES | | | | | (0.55) | Brown clayey silty sandy gravel. Gravel is fine to coarse angular of flint and occasional brick. Sand is fine to medium.<br>[MADE GROUND] | |
| | | | | 54.50 | | 0.80 | | |
| 1.50 | ES | | | | | (2.80) | Yellowish brown silty sandy gravel. Gravel is fine to coarse angular flint and occasional brick. Sand is medium to coarse.<br>[MADE GROUND]<br>1.80 - 1.90 Angular grey ballast.<br>2.20 - 2.40 Gravelly SAND.<br>2.80 - 3.20 Gravelly SAND. | |
| 3.50 | ES | | | 51.70 | | 3.60 | | |
| | | | | 51.50 | | 3.80 | Orangish brown and greyish brown speckled white clayey sandy gravel. Gravel is fine to coarse tabular of flint. Sand is fine to medium.<br>[MADE GROUND] | |
| | | | | | | (0.65) | Yellowish brown silty sandy gravel. Gravel is fine to coarse angular of flint and occasional brick. Sand is medium to coarse.<br>[MADE GROUND] | |
| | | | | 50.85 | | 4.45 | | |
| | | | | | | (0.55) | Firm brown mottled bluish grey silty CLAY with rare selenite crystals.<br>[WEATHERED LONDON CLAY] | |
| | | | | 50.30 | | 5.00 | | |
| | | | | | | | *(Window sample terminated at 5m)* | |

## Boring Progress and Water Observations

| Date | Strike depth | Casing depth | Comment | Time measured | Standing Depth |
|---|---|---|---|---|---|
| | | | | | |

## General Remarks

1. Borehole terminated at target depth within natural stratum within natural stratum.
2. Installation details; 0.0-1.0mbgl: plain pipe with bentonite backfill; 1.0-4.0mbgl: slotted pipe with gravel backfill; 4.0-5.0mbgl: bentonite backfill. Gas tap, bung and flush cover installed.
3. No groundwater strikes observed.
4. No visual or olfactory indicators of contamination observed.

| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| WS rig | Topdrill | RSW | ABA |

# WINDOW SAMPLE LOG

| Project | | | | HOLE No |
|---|---|---|---|---|
| 156 West End Lane, West Hampstead | | | | **WS202** |
| Job No | Date | Ground Level (m) | Co-Ordinates (m) | |
| CG/38293 | 16-07-20<br>16-07-20 | 55.30 | E 525,581.0 N 184,856.6 | |
| Client | | | | Sheet |
| A2 Dominion | | | | 1 of 1 |

| SAMPLES & TESTS | | | Water | STRATA | | | | |
|---|---|---|---|---|---|---|---|---|
| Depth (m) | Type No | Test Result (N/kPa/ppm) | | Reduced Level | Legend | Depth (m) (Thick-ness) | DESCRIPTION | Instrument /Backfill |
| | | | | 55.05 | | 0.25 | Reinforced concrete.<br>[MADE GROUND] | |
| 0.30 | ES | | | | | (1.25) | Compact brown silty sandy gravel. Gravel is subrounded brick and rounded to tabular of flint.<br>[MADE GROUND] | |
| | | | | 53.80 | | 1.50 | | |
| 1.70 | ES | | | 53.40 | | (0.40)<br>1.90 | Yellowish brown streaked dark brown slightly sandy clayey GRAVEL. Gravel is fine to coarse of brick and flint. Sand is medium to coarse.<br>[MADE GROUND] | |
| | | | | 52.40 | | (1.00)<br>2.90 | Yellowish brown slightly silty sandy GRAVEL. Gravel is fine to coarse rounded to tabular of flint. Sand is medium to coarse.<br>[MADE GROUND]<br>2.20 Becoming clayey. | |
| | | | | 52.20 | | 3.10 | Yellowish brown gravelly sand. Sand is medium to coarse. Gravel is fine to coarse rounded to tabular of flint.<br>[MADE GROUND] | |
| 3.80 | ES | | | 50.80 | | (1.40)<br>4.50 | Yellowish brown clayey sandy gravel. Gravel is fine to coarse rounded to tabular of flint. Sand is medium to coarse.<br>[MADE GROUND] | |
| 4.50 | ES | | | 50.30 | | (0.50)<br>5.00 | Firm brown mottled light bluish grey silty CLAY with rare selenite crystals.<br>[WEATHERED LONDON CLAY] | |
| | | | | | | | *(Window sample terminated at 5m)* | |

## Boring Progress and Water Observations

| Date | Strike depth | Casing depth | Comment | Time measured | Standing Depth |
|---|---|---|---|---|---|
| | | | | | |

## General Remarks

1. Borehole terminated at target depth.
2. Borehole backfilled with arisings upon completion.
3. No groundwater strikes observed.
4. No visual or olfactory indicators of contamination observed.

| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| WS rig | Topdrill | RSW | ABA |

# WINDOW SAMPLE LOG

| Project | | | | HOLE No |
|---|---|---|---|---|
| 156 West End Lane, West Hampstead | | | | **WS203** |
| Job No | Date | Ground Level (m) | Co-Ordinates (m) | |
| CG/38293 | 17-07-20<br>17-07-20 | 55.30 | E 525,583.7 N 184,879.2 | |
| Client | | | | Sheet |
| A2 Dominion | | | | 1 of 1 |

| SAMPLES & TESTS | | | Water | STRATA | | | | Instrument /Backfill |
|---|---|---|---|---|---|---|---|---|
| Depth (m) | Type No | Test Result (N/kPa/ppm) | | Reduced Level | Legend | Depth (m) (Thick-ness) | DESCRIPTION | |
| | | | | 55.04 | | 0.26 | Reinforced concrete.<br>[MADE GROUND] | |
| 0.30 | ES | | | | | (0.84) | Orange brown slightly silty gravelly SAND. Gravel is fine to medium rounded to tabular of flint. Sand is medium to coarse.<br>[MADE GROUND] | |
| | | | | 54.20 | | 1.10 | | |
| | | | | 53.70 | | (0.50) 1.60 | Yellowish brown speckled white gravelly sand. Sand is medium to coarse. Gravel is fine to medium rounded of flint.<br>[MADE GROUND] | |
| 1.50 | ES | | | | | (1.05) | Dark yellowish brown sandy gravel. Gravel is fine to medium rounded of flint. Sand is fine to medium.<br>[MADE GROUND]<br>2.30 Becoming slightly sandy. | |
| | | | | 52.65 | | 2.65 | | |
| 2.70 | ES | | | 52.45 | | 2.85 | Black medium to coarse SAND with high cobble content. Cobbles are angular yellow and red of brick.<br>[MADE GROUND] | |
| 3.00 | ES | | | | | (2.15) | Orange brown mottled light bluish grey silty CLAY with few selenite crystals.<br>[WEATHERED LONDON CLAY] | |
| | | | | 50.30 | | 5.00 | | |
| | | | | | | | *(Window sample terminated at 5m)* | |

## Boring Progress and Water Observations

| Date | Strike depth | Casing depth | Comment | Time measured | Standing Depth |
|---|---|---|---|---|---|
| | | | | | |

## General Remarks

1. Borehole terminated at target depth within natural stratum.
2. Installation details; 0.0-1.0mbgl: plain pipe with bentonite backfill; 1.0-3.0mbgl: slotted pipe with gravel backfill; 3.0-5.0mbgl: bentonite backfill. Gas tap, bung and flush cover installed.
3. No groundwater strikes observed.
4. Slight hydrocarbon odour observed between 2.65 to 2.85m. No other visual or olfactory indicators of contamination observed.

| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| WS rig | Topdrill | RSW | ABA |

# WINDOW SAMPLE LOG

| Project | | | | HOLE No |
|---|---|---|---|---|
| 156 West End Lane, West Hampstead | | | | **WS204** |
| Job No | Date | Ground Level (m) | Co-Ordinates (m) | |
| CG/38293 | 17-07-20<br>17-07-20 | 55.30 | E 525,563.9 N 184,875.3 | |
| Client | | | | Sheet |
| A2 Dominion | | | | 1 of 1 |

| SAMPLES & TESTS | | | Water | STRATA | | | | |
|---|---|---|---|---|---|---|---|---|
| Depth (m) | Type No | Test Result (N/kPa/ppm) | | Reduced Level | Legend | Depth (m) (Thick-ness) | DESCRIPTION | Instrument /Backfill |
| | | | | 55.05 | | 0.25 | Reinforced concrete.<br>[MADE GROUND] | |
| 0.30 | ES | | | | | (0.65) | Orange brown silty gravelly SAND. Sand if fine to medium. Gravel is fine to coarse rounded of flint and brick.<br>[MADE GROUND] | |
| | | | | 54.40 | | 0.90 | 0.80 - 0.90 Red brick. | |
| | | | | 54.20 | | 1.10 | Greenish grey mottled black sandy silty CLAY. Sand is fine.<br>[MADE GROUND] | |
| | | | | 54.10 | | 1.20 | | |
| 1.20 | ES | | | 53.90 | | 1.40 | Black coarse SAND with high cobble content. Sand is coarse. Cobbles are angular yellow and red of brick.<br>[MADE GROUND] | |
| | | | | | | (0.50) | Soft to firm black mottled greenish grey slightly gravelly clayey SILT. Gravel is fine to medium angular red of brick.<br>[MADE GROUND] | |
| | | | | 53.40 | | 1.90 | | |
| 1.90 | ES | | | 53.30 | | 2.00 | Soft to firm greenish grey mottled orange brown silty CLAY.<br>[MADE GROUND] | |
| | | | | | | | Soft to firm black mottled grey clayey SILT.<br>[MADE GROUND] | |
| 2.40 | ES | | | | | | Orangish brown mottled light bluish grey silty CLAY with few selenite crystals.<br>[WEATHERED LONDON CLAY] | |
| | | | | | | (3.00) | | |
| | | | | 50.30 | | 5.00 | | |
| | | | | | | | *(Window sample terminated at 5m)* | |

## Boring Progress and Water Observations

| Date | Strike depth | Casing depth | Comment | Time measured | Standing Depth |
|---|---|---|---|---|---|
| | | | | | |

## General Remarks

1. Borehole terminated at target depth within natural stratum.
2. Borehole backfilled with arisings upon completion.
3. No groundwater strikes observed.
4. Slight hydrocarbon odour observed between 1.10 to 1.20m and 1.90 to 2.0m. No other visual or olfactory indicators of contamination observed.

| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| WS rig | Topdrill | RSW | ABA |

# APPENDIX F

*Groundwater and Ground Gas Monitoring Records*

# GAS & GROUNDWATER MONITORING RECORD SHEET

| JOB DETAILS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Site: | West End Lane | | | | | Job No: | CG/38293a | | |
| Client: | A2 Dominion | | | | | Engineer: | RSW | | |
| **Well No.** | **Time (s)** | **Flow (l/hr)** | **dA (PA)** | **$O_2$ (% vol. in air)** | **$CO_2$ (% vol. in air)** | **$CH_4$ (% vol. in air)** | **PID (ppm)** | **Depth to Groundwater (mbgl)** | **Depth to base (mbgl)** |
| BH03 (28/7/20) | No gas monitoring undertaken | | | | | | | Dry | 4.00 |
| WS201 (28/7/20) | | | | | | | | Dry | 4.00 |
| WS203 (28/7/20) | | | | | | | | 2.10 | 3.00 |
| BH03 (6/8/20) | | | | | | | | Dry | 4.00 |
| WS201 (6/8/20) | | | | | | | | Dry | 4.00 |
| WS203 (6/8/20) | | | | | | | | 2.08 | 3.00 |
| BH03 (24/8/20) | 0 | <0.1 | <0.1 | 18.7 | 0.9 | -0.1 | 0.9 | 3.82 | 4.00 |
| | 15 | <0.1 | <0.1 | 19.3 | 0.9 | -0.1 | 0.9 | | |
| | 30 | <0.1 | <0.1 | 19.3 | 1.0 | -0.1 | 0.9 | | |
| | 60 | <0.1 | <0.1 | 19.3 | 1.0 | -0.1 | 0.9 | | |
| | 90 | <0.1 | <0.1 | 19.3 | 1.0 | -0.1 | 0.9 | | |
| | 120 | <0.1 | <0.1 | 19.3 | 1.0 | -0.1 | 0.9 | | |
| | 180 | <0.1 | <0.1 | 19.3 | 1.0 | -0.1 | 0.9 | | |
| | 240 | <0.1 | <0.1 | 19.3 | 1.0 | -0.1 | 0.9 | | |
| | 300 | <0.1 | <0.1 | 19.3 | 1.0 | -0.1 | 0.9 | | |
| | 360 | <0.1 | <0.1 | 19.3 | 1.0 | -0.1 | 0.9 | | |
| WS201 (24/8/20) | 0 | <0.1 | <0.1 | 19.9 | 0.0 | -0.1 | 0.9 | Dry | 4.00 |
| | 15 | <0.1 | <0.1 | 20.0 | 0.6 | -0.1 | 0.9 | | |
| | 30 | <0.1 | <0.1 | 18.9 | 0.7 | -0.1 | 0.9 | | |
| | 60 | <0.1 | <0.1 | 18.9 | 0.8 | -0.1 | 0.9 | | |
| | 90 | <0.1 | <0.1 | 18.9 | 0.8 | -0.1 | 0.9 | | |
| | 120 | <0.1 | <0.1 | 18.9 | 0.8 | -0.1 | 0.9 | | |
| | 180 | <0.1 | <0.1 | 18.9 | 0.8 | -0.1 | 0.9 | | |
| | 240 | <0.1 | <0.1 | 18.9 | 0.8 | -0.1 | 0.9 | | |
| | 300 | <0.1 | <0.1 | 18.9 | 0.8 | -0.1 | 0.9 | | |
| | 360 | <0.1 | <0.1 | 18.9 | 0.8 | -0.1 | 0.9 | | |
| WS203 (24/8/20) | 0 | <0.1 | <0.1 | 19.0 | 0.7 | -0.1 | 0.9 | 2.03 | 3.00 |
| | 15 | <0.1 | <0.1 | 18.7 | 0.9 | -0.1 | 0.9 | | |
| | 30 | <0.1 | <0.1 | 18.6 | 0.9 | -0.1 | 0.9 | | |
| | 60 | <0.1 | <0.1 | 18.5 | 0.9 | -0.1 | 0.9 | | |
| | 90 | <0.1 | <0.1 | 18.5 | 0.9 | -0.1 | 0.9 | | |
| | 120 | <0.1 | <0.1 | 18.5 | 0.9 | -0.1 | 0.9 | | |
| | 180 | <0.1 | <0.1 | 18.5 | 0.9 | -0.1 | 0.9 | | |
| | 240 | <0.1 | <0.1 | 18.5 | 0.9 | -0.1 | 0.9 | | |
| | 300 | <0.1 | <0.1 | 18.5 | 0.9 | -0.1 | 0.9 | | |
| | 360 | <0.1 | <0.1 | 18.5 | 0.9 | -0.1 | 0.9 | | |
| BH03 (10/9/20) | 0 | <0.1 | <0.1 | 20.0 | 0.3 | -0.1 | 0.9 | Dry | 4.00 |
| | 15 | <0.1 | <0.1 | 19.3 | 1.0 | -0.1 | 0.9 | | |
| | 30 | <0.1 | <0.1 | 18.8 | 1.1 | -0.1 | 0.9 | | |
| | 60 | <0.1 | <0.1 | 18.7 | 1.1 | -0.1 | 0.9 | | |
| | 90 | <0.1 | <0.1 | 18.7 | 1.1 | -0.1 | 0.9 | | |
| | 120 | <0.1 | <0.1 | 18.7 | 1.1 | -0.1 | 0.9 | | |
| | 180 | <0.1 | <0.1 | 18.7 | 1.1 | -0.1 | 0.9 | | |
| | 240 | <0.1 | <0.1 | 18.7 | 1.1 | -0.1 | 0.9 | | |
| | 300 | <0.1 | <0.1 | 18.7 | 1.1 | -0.1 | 0.9 | | |
| | 360 | <0.1 | <0.1 | 18.7 | 1.1 | -0.1 | 0.9 | | |
| WS201 | Destroyed by demolition works | | | | | | | | |
| WS203 | | | | | | | | | |

Notes:

*The measurement of hydrogen sulphide and hydrocarbon free product is undertaken on a site specific basis, if deemed necessary.*

** With reference to the Weather Underground rolling weather archive for Cambridge weather station.*

*NR= Not recorded*

# APPENDIX G

*Chemical Laboratory Test Results*

**Ric Wilkinson**
Card Geotechnics Ltd
4 Godalming Business Centre
Woolsack Way
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Surrey
GU7 1XW

**t:** 01483 310600
**f:** 01483 527285
**e:** RicW@cgl-uk.com

i2 Analytical Ltd.
7 Woodshots Meadow,
Croxley Green
Business Park,
Watford,
Herts,
WD18 8YS

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**e:** reception@i2analytical.com

# Analytical Report Number : 20-21301

Replaces Analytical Report Number: 20-21301, issue no. 1

Client references/information amended.

| | | | |
|---|---|---|---|
| **Project / Site name:** | 156 West End Lane, West Hampstead | **Samples received on:** | 24/07/2020 |
| **Your job number:** | CG-38293A | **Samples instructed on/ Analysis started on:** | 24/07/2020 |
| **Your order number:** | POP005191 | **Analysis completed by:** | 04/08/2020 |
| **Report Issue Number:** | 2 | **Report issued on:** | 04/09/2020 |
| **Samples Analysed:** | 10 soil samples | | |

**Signed:**

Zina Abdul Razzak
Senior Quality Specialist
**For & on behalf of i2 Analytical Ltd.**

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils - 4 weeks from reporting
leachates - 2 weeks from reporting
waters - 2 weeks from reporting
asbestos - 6 months from reporting

Excel copies of reports are only valid when accompanied by this PDF certificate.

Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement.
Application of uncertainty of measurement would provide a range within which the true result lies.
An estimate of measurement uncertainty can be provided on request.

**Analytical Report Number: 20-21301**
**Project / Site name: 156 West End Lane, West Hampstead**
**Your Order No: POP005191**

| Lab Sample Number | | | | 1572758 | 1572759 | 1572760 | 1572761 |
|---|---|---|---|---|---|---|---|
| **Sample Reference** | | | | WS201 | WS201 | WS202 | WS203 |
| **Sample Number** | | | | None Supplied | None Supplied | None Supplied | None Supplied |
| **Depth (m)** | | | | 0.30-0.60 | 1.50-2.00 | 0.30-0.70 | 0.30-0.60 |
| **Date Sampled** | | | | 17/07/2020 | 17/07/2020 | 17/07/2020 | 17/07/2020 |
| **Time Taken** | | | | None Supplied | None Supplied | None Supplied | None Supplied |
| **Analytical Parameter (Soil Analysis)** | **Units** | **Limit of detection** | **Accreditation Status** | | | | |
| Stone Content | % | 0.1 | NONE | < 0.1 | - | < 0.1 | < 0.1 |
| Moisture Content | % | N/A | NONE | 3.8 | - | 6.4 | 7.3 |
| Total mass of sample received | kg | 0.001 | NONE | 1.2 | - | 0.96 | 1.1 |
| Asbestos in Soil | Type | N/A | ISO 17025 | Not-detected | Not-detected | Not-detected | Not-detected |
| **General Inorganics** | | | | | | | |
| pH - Automated | pH Units | N/A | MCERTS | 10.1 | - | 9.7 | 10.5 |
| Total Cyanide | mg/kg | 1 | MCERTS | < 1 | - | < 1 | < 1 |
| Total Sulphate as SO4 | mg/kg | 50 | MCERTS | 800 | - | 3000 | 710 |
| Organic Matter | % | 0.1 | MCERTS | 1.7 | - | 1.1 | 0.4 |
| **Total Phenols** | | | | | | | |
| Total Phenols (monohydric) | mg/kg | 1 | MCERTS | < 1.0 | - | < 1.0 | < 1.0 |
| **Speciated PAHs** | | | | | | | |
| Naphthalene | mg/kg | 0.05 | MCERTS | < 0.05 | - | < 0.05 | < 0.05 |
| Acenaphthylene | mg/kg | 0.05 | MCERTS | < 0.05 | - | < 0.05 | < 0.05 |
| Acenaphthene | mg/kg | 0.05 | MCERTS | < 0.05 | - | < 0.05 | < 0.05 |
| Fluorene | mg/kg | 0.05 | MCERTS | < 0.05 | - | < 0.05 | < 0.05 |
| Phenanthrene | mg/kg | 0.05 | MCERTS | < 0.05 | - | 0.98 | < 0.05 |
| Anthracene | mg/kg | 0.05 | MCERTS | < 0.05 | - | 0.32 | < 0.05 |
| Fluoranthene | mg/kg | 0.05 | MCERTS | < 0.05 | - | 1.8 | < 0.05 |
| Pyrene | mg/kg | 0.05 | MCERTS | < 0.05 | - | 2 | < 0.05 |
| Benzo(a)anthracene | mg/kg | 0.05 | MCERTS | < 0.05 | - | 1.7 | < 0.05 |
| Chrysene | mg/kg | 0.05 | MCERTS | < 0.05 | - | 1.3 | < 0.05 |
| Benzo(b)fluoranthene | mg/kg | 0.05 | MCERTS | < 0.05 | - | 1.5 | < 0.05 |
| Benzo(k)fluoranthene | mg/kg | 0.05 | MCERTS | < 0.05 | - | 1.7 | < 0.05 |
| Benzo(a)pyrene | mg/kg | 0.05 | MCERTS | < 0.05 | - | 2 | < 0.05 |
| Indeno(1,2,3-cd)pyrene | mg/kg | 0.05 | MCERTS | < 0.05 | - | 1.1 | < 0.05 |
| Dibenz(a,h)anthracene | mg/kg | 0.05 | MCERTS | < 0.05 | - | 0.42 | < 0.05 |
| Benzo(ghi)perylene | mg/kg | 0.05 | MCERTS | < 0.05 | - | 1.4 | < 0.05 |
| Coronene | mg/kg | 0.05 | NONE | < 0.05 | - | < 0.05 | < 0.05 |
| **Total PAH** | | | | | | | |
| Total WAC-17 PAHs | mg/kg | 0.85 | NONE | < 0.85 | - | 16.3 | < 0.85 |
| **Heavy Metals / Metalloids** | | | | | | | |
| Antimony (aqua regia extractable) | mg/kg | 1 | ISO 17025 | 5.3 | - | 9.4 | 1.6 |
| Arsenic (aqua regia extractable) | mg/kg | 1 | MCERTS | 15 | - | 23 | 18 |
| Barium (aqua regia extractable) | mg/kg | 1 | MCERTS | 50 | - | 190 | 54 |
| Beryllium (aqua regia extractable) | mg/kg | 0.06 | MCERTS | 0.67 | - | 0.87 | 0.65 |
| Boron (water soluble) | mg/kg | 0.2 | MCERTS | 1.4 | - | 2.2 | 1.2 |
| Cadmium (aqua regia extractable) | mg/kg | 0.2 | MCERTS | 0.2 | - | < 0.2 | < 0.2 |
| Chromium (hexavalent) | mg/kg | 1.2 | MCERTS | < 1.2 | - | < 1.2 | < 1.2 |
| Chromium (III) | mg/kg | 1 | NONE | 24 | - | 180 | 29 |
| Chromium (aqua regia extractable) | mg/kg | 1 | MCERTS | 24 | - | 180 | 29 |
| Copper (aqua regia extractable) | mg/kg | 1 | MCERTS | 14 | - | 26 | 12 |
| Lead (aqua regia extractable) | mg/kg | 1 | MCERTS | 22 | - | 290 | 33 |
| Mercury (aqua regia extractable) | mg/kg | 0.3 | MCERTS | < 0.3 | - | < 0.3 | < 0.3 |
| Nickel (aqua regia extractable) | mg/kg | 1 | MCERTS | 24 | - | 87 | 24 |

**Analytical Report Number: 20-21301**
**Project / Site name: 156 West End Lane, West Hampstead**
**Your Order No: POP005191**

| Lab Sample Number | | | | 1572758 | 1572759 | 1572760 | 1572761 |
|---|---|---|---|---|---|---|---|
| Sample Reference | | | | WS201 | WS201 | WS202 | WS203 |
| Sample Number | | | | None Supplied | None Supplied | None Supplied | None Supplied |
| Depth (m) | | | | 0.30-0.60 | 1.50-2.00 | 0.30-0.70 | 0.30-0.60 |
| Date Sampled | | | | 17/07/2020 | 17/07/2020 | 17/07/2020 | 17/07/2020 |
| Time Taken | | | | None Supplied | None Supplied | None Supplied | None Supplied |
| **Analytical Parameter (Soil Analysis)** | **Units** | **Limit of detection** | **Accreditation Status** | | | | |
| Selenium (aqua regia extractable) | mg/kg | 1 | MCERTS | < 1.0 | - | < 1.0 | < 1.0 |
| Vanadium (aqua regia extractable) | mg/kg | 1 | MCERTS | 34 | - | 46 | 37 |
| Zinc (aqua regia extractable) | mg/kg | 1 | MCERTS | 54 | - | 120 | 57 |

**Monoaromatics & Oxygenates**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Benzene | µg/kg | 1 | MCERTS | < 1.0 | - | < 1.0 | < 1.0 |
| Toluene | µg/kg | 1 | MCERTS | < 1.0 | - | < 1.0 | < 1.0 |
| Ethylbenzene | µg/kg | 1 | MCERTS | < 1.0 | - | < 1.0 | < 1.0 |
| p & m-xylene | µg/kg | 1 | MCERTS | < 1.0 | - | < 1.0 | < 1.0 |
| o-xylene | µg/kg | 1 | MCERTS | < 1.0 | - | < 1.0 | < 1.0 |
| MTBE (Methyl Tertiary Butyl Ether) | µg/kg | 1 | MCERTS | < 1.0 | - | < 1.0 | < 1.0 |

**Petroleum Hydrocarbons**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TPH-CWG - Aliphatic >EC5 - EC6 | mg/kg | 0.001 | MCERTS | < 0.001 | - | < 0.001 | < 0.001 |
| TPH-CWG - Aliphatic >EC6 - EC8 | mg/kg | 0.001 | MCERTS | < 0.001 | - | < 0.001 | < 0.001 |
| TPH-CWG - Aliphatic >EC8 - EC10 | mg/kg | 0.001 | MCERTS | < 0.001 | - | < 0.001 | < 0.001 |
| TPH-CWG - Aliphatic >EC10 - EC12 | mg/kg | 1 | MCERTS | < 1.0 | - | < 1.0 | < 1.0 |
| TPH-CWG - Aliphatic >EC12 - EC16 | mg/kg | 2 | MCERTS | < 2.0 | - | < 2.0 | < 2.0 |
| TPH-CWG - Aliphatic >EC16 - EC21 | mg/kg | 8 | MCERTS | < 8.0 | - | < 8.0 | < 8.0 |
| TPH-CWG - Aliphatic >EC21 - EC35 | mg/kg | 8 | MCERTS | < 8.0 | - | < 8.0 | < 8.0 |
| TPH-CWG - Aliphatic (EC5 - EC35) | mg/kg | 10 | MCERTS | < 10 | - | < 10 | < 10 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TPH-CWG - Aromatic >EC5 - EC7 | mg/kg | 0.001 | MCERTS | < 0.001 | - | < 0.001 | < 0.001 |
| TPH-CWG - Aromatic >EC7 - EC8 | mg/kg | 0.001 | MCERTS | < 0.001 | - | < 0.001 | < 0.001 |
| TPH-CWG - Aromatic >EC8 - EC10 | mg/kg | 0.001 | MCERTS | < 0.001 | - | < 0.001 | < 0.001 |
| TPH-CWG - Aromatic >EC10 - EC12 | mg/kg | 1 | MCERTS | < 1.0 | - | < 1.0 | < 1.0 |
| TPH-CWG - Aromatic >EC12 - EC16 | mg/kg | 2 | MCERTS | < 2.0 | - | 9 | < 2.0 |
| TPH-CWG - Aromatic >EC16 - EC21 | mg/kg | 10 | MCERTS | < 10 | - | 14 | < 10 |
| TPH-CWG - Aromatic >EC21 - EC35 | mg/kg | 10 | MCERTS | < 10 | - | 44 | < 10 |
| TPH-CWG - Aromatic (EC5 - EC35) | mg/kg | 10 | MCERTS | < 10 | - | 67 | < 10 |

U/S = Unsuitable Sample  I/S = Insufficient Sample

**Analytical Report Number: 20-21301**
**Project / Site name: 156 West End Lane, West Hampstead**
**Your Order No: POP005191**

| Lab Sample Number | | | | 1572762 | 1572763 | 1572764 | 1572765 |
|---|---|---|---|---|---|---|---|
| Sample Reference | | | | WS203 | WS203 | WS204 | WS204 |
| Sample Number | | | | None Supplied | None Supplied | None Supplied | None Supplied |
| Depth (m) | | | | 1.50 | 3.00 | 0.30-0.60 | 1.20 |
| Date Sampled | | | | 17/07/2020 | 17/07/2020 | 17/07/2020 | 17/07/2020 |
| Time Taken | | | | None Supplied | None Supplied | None Supplied | None Supplied |
| **Analytical Parameter (Soil Analysis)** | **Units** | **Limit of detection** | **Accreditation Status** | | | | |
| Stone Content | % | 0.1 | NONE | < 0.1 | < 0.1 | - | < 0.1 |
| Moisture Content | % | N/A | NONE | 4.6 | 12 | - | 17 |
| Total mass of sample received | kg | 0.001 | NONE | 0.96 | 0.93 | - | 0.83 |
| Asbestos in Soil | Type | N/A | ISO 17025 | Not-detected | - | Not-detected | - |
| **General Inorganics** | | | | | | | |
| pH - Automated | pH Units | N/A | MCERTS | 9.8 | 8.4 | - | 7.7 |
| Total Cyanide | mg/kg | 1 | MCERTS | < 1 | < 1 | - | < 1 |
| Total Sulphate as SO4 | mg/kg | 50 | MCERTS | 1200 | 360 | - | 770 |
| Organic Matter | % | 0.1 | MCERTS | 0.5 | 0.6 | - | 4.9 |
| **Total Phenols** | | | | | | | |
| Total Phenols (monohydric) | mg/kg | 1 | MCERTS | < 1.0 | < 1.0 | - | < 1.0 |
| **Speciated PAHs** | | | | | | | |
| Naphthalene | mg/kg | 0.05 | MCERTS | < 0.05 | < 0.05 | - | < 0.05 |
| Acenaphthylene | mg/kg | 0.05 | MCERTS | < 0.05 | < 0.05 | - | < 0.05 |
| Acenaphthene | mg/kg | 0.05 | MCERTS | < 0.05 | < 0.05 | - | < 0.05 |
| Fluorene | mg/kg | 0.05 | MCERTS | < 0.05 | < 0.05 | - | < 0.05 |
| Phenanthrene | mg/kg | 0.05 | MCERTS | 0.26 | < 0.05 | - | 2.1 |
| Anthracene | mg/kg | 0.05 | MCERTS | < 0.05 | < 0.05 | - | 0.7 |
| Fluoranthene | mg/kg | 0.05 | MCERTS | 0.81 | < 0.05 | - | 4.9 |
| Pyrene | mg/kg | 0.05 | MCERTS | 0.83 | < 0.05 | - | 4.5 |
| Benzo(a)anthracene | mg/kg | 0.05 | MCERTS | 0.29 | < 0.05 | - | 3 |
| Chrysene | mg/kg | 0.05 | MCERTS | 0.32 | < 0.05 | - | 2.3 |
| Benzo(b)fluoranthene | mg/kg | 0.05 | MCERTS | 0.27 | < 0.05 | - | 2.1 |
| Benzo(k)fluoranthene | mg/kg | 0.05 | MCERTS | 0.13 | < 0.05 | - | 1.9 |
| Benzo(a)pyrene | mg/kg | 0.05 | MCERTS | < 0.05 | < 0.05 | - | 2.2 |
| Indeno(1,2,3-cd)pyrene | mg/kg | 0.05 | MCERTS | < 0.05 | < 0.05 | - | 0.99 |
| Dibenz(a,h)anthracene | mg/kg | 0.05 | MCERTS | < 0.05 | < 0.05 | - | 0.4 |
| Benzo(ghi)perylene | mg/kg | 0.05 | MCERTS | < 0.05 | < 0.05 | - | 1 |
| Coronene | mg/kg | 0.05 | NONE | < 0.05 | < 0.05 | - | < 0.05 |
| **Total PAH** | | | | | | | |
| Total WAC-17 PAHs | mg/kg | 0.85 | NONE | 2.91 | < 0.85 | - | 25.9 |
| **Heavy Metals / Metalloids** | | | | | | | |
| Antimony (aqua regia extractable) | mg/kg | 1 | ISO 17025 | 1.6 | 1.9 | - | 2.1 |
| Arsenic (aqua regia extractable) | mg/kg | 1 | MCERTS | 11 | 13 | - | 13 |
| Barium (aqua regia extractable) | mg/kg | 1 | MCERTS | 54 | 35 | - | 94 |
| Beryllium (aqua regia extractable) | mg/kg | 0.06 | MCERTS | 0.71 | 1.2 | - | 0.94 |
| Boron (water soluble) | mg/kg | 0.2 | MCERTS | 2.1 | 1.6 | - | 5.5 |
| Cadmium (aqua regia extractable) | mg/kg | 0.2 | MCERTS | < 0.2 | < 0.2 | - | < 0.2 |
| Chromium (hexavalent) | mg/kg | 1.2 | MCERTS | < 1.2 | < 1.2 | - | < 1.2 |
| Chromium (III) | mg/kg | 1 | NONE | 26 | 52 | - | 31 |
| Chromium (aqua regia extractable) | mg/kg | 1 | MCERTS | 26 | 52 | - | 31 |
| Copper (aqua regia extractable) | mg/kg | 1 | MCERTS | 12 | 20 | - | 48 |
| Lead (aqua regia extractable) | mg/kg | 1 | MCERTS | 52 | 21 | - | 240 |
| Mercury (aqua regia extractable) | mg/kg | 0.3 | MCERTS | < 0.3 | < 0.3 | - | 0.9 |
| Nickel (aqua regia extractable) | mg/kg | 1 | MCERTS | 20 | 37 | - | 17 |

**Analytical Report Number: 20-21301**
**Project / Site name: 156 West End Lane, West Hampstead**
**Your Order No: POP005191**

| Lab Sample Number | | | | 1572762 | 1572763 | 1572764 | 1572765 |
|---|---|---|---|---|---|---|---|
| **Sample Reference** | | | | WS203 | WS203 | WS204 | WS204 |
| **Sample Number** | | | | None Supplied | None Supplied | None Supplied | None Supplied |
| **Depth (m)** | | | | 1.50 | 3.00 | 0.30-0.60 | 1.20 |
| **Date Sampled** | | | | 17/07/2020 | 17/07/2020 | 17/07/2020 | 17/07/2020 |
| **Time Taken** | | | | None Supplied | None Supplied | None Supplied | None Supplied |
| **Analytical Parameter (Soil Analysis)** | **Units** | **Limit of detection** | **Accreditation Status** | | | | |
| Selenium (aqua regia extractable) | mg/kg | 1 | MCERTS | < 1.0 | < 1.0 | - | < 1.0 |
| Vanadium (aqua regia extractable) | mg/kg | 1 | MCERTS | 31 | 74 | - | 57 |
| Zinc (aqua regia extractable) | mg/kg | 1 | MCERTS | 46 | 64 | - | 88 |
| **Monoaromatics & Oxygenates** | | | | | | | |
| Benzene | µg/kg | 1 | MCERTS | < 1.0 | < 1.0 | - | < 1.0 |
| Toluene | µg/kg | 1 | MCERTS | < 1.0 | < 1.0 | - | < 1.0 |
| Ethylbenzene | µg/kg | 1 | MCERTS | < 1.0 | < 1.0 | - | < 1.0 |
| p & m-xylene | µg/kg | 1 | MCERTS | < 1.0 | < 1.0 | - | < 1.0 |
| o-xylene | µg/kg | 1 | MCERTS | < 1.0 | < 1.0 | - | < 1.0 |
| MTBE (Methyl Tertiary Butyl Ether) | µg/kg | 1 | MCERTS | < 1.0 | < 1.0 | - | < 1.0 |
| **Petroleum Hydrocarbons** | | | | | | | |
| TPH-CWG - Aliphatic >EC5 - EC6 | mg/kg | 0.001 | MCERTS | < 0.001 | < 0.001 | - | < 0.001 |
| TPH-CWG - Aliphatic >EC6 - EC8 | mg/kg | 0.001 | MCERTS | < 0.001 | < 0.001 | - | < 0.001 |
| TPH-CWG - Aliphatic >EC8 - EC10 | mg/kg | 0.001 | MCERTS | < 0.001 | < 0.001 | - | < 0.001 |
| TPH-CWG - Aliphatic >EC10 - EC12 | mg/kg | 1 | MCERTS | 1.2 | < 1.0 | - | < 1.0 |
| TPH-CWG - Aliphatic >EC12 - EC16 | mg/kg | 2 | MCERTS | 24 | < 2.0 | - | < 2.0 |
| TPH-CWG - Aliphatic >EC16 - EC21 | mg/kg | 8 | MCERTS | 52 | < 8.0 | - | < 8.0 |
| TPH-CWG - Aliphatic >EC21 - EC35 | mg/kg | 8 | MCERTS | 32 | < 8.0 | - | < 8.0 |
| TPH-CWG - Aliphatic (EC5 - EC35) | mg/kg | 10 | MCERTS | 110 | < 10 | - | < 10 |
| TPH-CWG - Aromatic >EC5 - EC7 | mg/kg | 0.001 | MCERTS | < 0.001 | < 0.001 | - | < 0.001 |
| TPH-CWG - Aromatic >EC7 - EC8 | mg/kg | 0.001 | MCERTS | < 0.001 | < 0.001 | - | < 0.001 |
| TPH-CWG - Aromatic >EC8 - EC10 | mg/kg | 0.001 | MCERTS | < 0.001 | < 0.001 | - | < 0.001 |
| TPH-CWG - Aromatic >EC10 - EC12 | mg/kg | 1 | MCERTS | < 1.0 | < 1.0 | - | < 1.0 |
| TPH-CWG - Aromatic >EC12 - EC16 | mg/kg | 2 | MCERTS | 13 | < 2.0 | - | < 2.0 |
| TPH-CWG - Aromatic >EC16 - EC21 | mg/kg | 10 | MCERTS | 26 | < 10 | - | 22 |
| TPH-CWG - Aromatic >EC21 - EC35 | mg/kg | 10 | MCERTS | < 10 | < 10 | - | 38 |
| TPH-CWG - Aromatic (EC5 - EC35) | mg/kg | 10 | MCERTS | 46 | < 10 | - | 60 |

U/S = Unsuitable Sample  I/S = Insufficient Sample

**Analytical Report Number: 20-21301**
**Project / Site name: 156 West End Lane, West Hampstead**
**Your Order No: POP005191**

| Lab Sample Number | | | | 1572766 | 1572767 |
|---|---|---|---|---|---|
| **Sample Reference** | | | | WS204 | BH03 |
| **Sample Number** | | | | None Supplied | None Supplied |
| **Depth (m)** | | | | 2.40 | 0.80 |
| **Date Sampled** | | | | 17/07/2020 | 17/07/2020 |
| **Time Taken** | | | | None Supplied | None Supplied |
| **Analytical Parameter (Soil Analysis)** | **Units** | **Limit of detection** | **Accreditation Status** | | |
| Stone Content | % | 0.1 | NONE | < 0.1 | < 0.1 |
| Moisture Content | % | N/A | NONE | 13 | 5.8 |
| Total mass of sample received | kg | 0.001 | NONE | 1 | 0.91 |
| Asbestos in Soil | Type | N/A | ISO 17025 | - | Not-detected |
| **General Inorganics** | | | | | |
| pH - Automated | pH Units | N/A | MCERTS | 8.4 | 9.7 |
| Total Cyanide | mg/kg | 1 | MCERTS | < 1 | < 1 |
| Total Sulphate as SO4 | mg/kg | 50 | MCERTS | 350 | 960 |
| Organic Matter | % | 0.1 | MCERTS | 0.4 | 0.6 |
| **Total Phenols** | | | | | |
| Total Phenols (monohydric) | mg/kg | 1 | MCERTS | < 1.0 | < 1.0 |
| **Speciated PAHs** | | | | | |
| Naphthalene | mg/kg | 0.05 | MCERTS | < 0.05 | < 0.05 |
| Acenaphthylene | mg/kg | 0.05 | MCERTS | < 0.05 | < 0.05 |
| Acenaphthene | mg/kg | 0.05 | MCERTS | < 0.05 | 0.25 |
| Fluorene | mg/kg | 0.05 | MCERTS | < 0.05 | < 0.05 |
| Phenanthrene | mg/kg | 0.05 | MCERTS | < 0.05 | 1.6 |
| Anthracene | mg/kg | 0.05 | MCERTS | < 0.05 | 0.4 |
| Fluoranthene | mg/kg | 0.05 | MCERTS | < 0.05 | 2.6 |
| Pyrene | mg/kg | 0.05 | MCERTS | < 0.05 | 2.5 |
| Benzo(a)anthracene | mg/kg | 0.05 | MCERTS | < 0.05 | 1.6 |
| Chrysene | mg/kg | 0.05 | MCERTS | < 0.05 | 1.2 |
| Benzo(b)fluoranthene | mg/kg | 0.05 | MCERTS | < 0.05 | 1.9 |
| Benzo(k)fluoranthene | mg/kg | 0.05 | MCERTS | < 0.05 | 1.4 |
| Benzo(a)pyrene | mg/kg | 0.05 | MCERTS | < 0.05 | 1.5 |
| Indeno(1,2,3-cd)pyrene | mg/kg | 0.05 | MCERTS | < 0.05 | 0.78 |
| Dibenz(a,h)anthracene | mg/kg | 0.05 | MCERTS | < 0.05 | 0.22 |
| Benzo(ghi)perylene | mg/kg | 0.05 | MCERTS | < 0.05 | 0.81 |
| Coronene | mg/kg | 0.05 | NONE | < 0.05 | < 0.05 |
| **Total PAH** | | | | | |
| Total WAC-17 PAHs | mg/kg | 0.85 | NONE | < 0.85 | 16.8 |
| **Heavy Metals / Metalloids** | | | | | |
| Antimony (aqua regia extractable) | mg/kg | 1 | ISO 17025 | 1.7 | 2.4 |
| Arsenic (aqua regia extractable) | mg/kg | 1 | MCERTS | 12 | 23 |
| Barium (aqua regia extractable) | mg/kg | 1 | MCERTS | 40 | 84 |
| Beryllium (aqua regia extractable) | mg/kg | 0.06 | MCERTS | 1.1 | 0.87 |
| Boron (water soluble) | mg/kg | 0.2 | MCERTS | 1.2 | 1.5 |
| Cadmium (aqua regia extractable) | mg/kg | 0.2 | MCERTS | < 0.2 | < 0.2 |
| Chromium (hexavalent) | mg/kg | 1.2 | MCERTS | < 1.2 | < 1.2 |
| Chromium (III) | mg/kg | 1 | NONE | 47 | 27 |
| Chromium (aqua regia extractable) | mg/kg | 1 | MCERTS | 47 | 27 |
| Copper (aqua regia extractable) | mg/kg | 1 | MCERTS | 20 | 19 |
| Lead (aqua regia extractable) | mg/kg | 1 | MCERTS | 14 | 72 |
| Mercury (aqua regia extractable) | mg/kg | 0.3 | MCERTS | < 0.3 | < 0.3 |
| Nickel (aqua regia extractable) | mg/kg | 1 | MCERTS | 36 | 36 |

**Analytical Report Number: 20-21301**
**Project / Site name: 156 West End Lane, West Hampstead**
**Your Order No: POP005191**

| Lab Sample Number | | | | 1572766 | 1572767 |
|---|---|---|---|---|---|
| **Sample Reference** | | | | WS204 | BH03 |
| **Sample Number** | | | | None Supplied | None Supplied |
| **Depth (m)** | | | | 2.40 | 0.80 |
| **Date Sampled** | | | | 17/07/2020 | 17/07/2020 |
| **Time Taken** | | | | None Supplied | None Supplied |
| **Analytical Parameter (Soil Analysis)** | **Units** | **Limit of detection** | **Accreditation Status** | | |
| Selenium (aqua regia extractable) | mg/kg | 1 | MCERTS | < 1.0 | < 1.0 |
| Vanadium (aqua regia extractable) | mg/kg | 1 | MCERTS | 68 | 41 |
| Zinc (aqua regia extractable) | mg/kg | 1 | MCERTS | 61 | 86 |

**Monoaromatics & Oxygenates**

| | | | | | |
|---|---|---|---|---|---|
| Benzene | µg/kg | 1 | MCERTS | < 1.0 | < 1.0 |
| Toluene | µg/kg | 1 | MCERTS | < 1.0 | < 1.0 |
| Ethylbenzene | µg/kg | 1 | MCERTS | < 1.0 | < 1.0 |
| p & m-xylene | µg/kg | 1 | MCERTS | < 1.0 | < 1.0 |
| o-xylene | µg/kg | 1 | MCERTS | < 1.0 | < 1.0 |
| MTBE (Methyl Tertiary Butyl Ether) | µg/kg | 1 | MCERTS | < 1.0 | < 1.0 |

**Petroleum Hydrocarbons**

| | | | | | |
|---|---|---|---|---|---|
| TPH-CWG - Aliphatic >EC5 - EC6 | mg/kg | 0.001 | MCERTS | < 0.001 | < 0.001 |
| TPH-CWG - Aliphatic >EC6 - EC8 | mg/kg | 0.001 | MCERTS | < 0.001 | < 0.001 |
| TPH-CWG - Aliphatic >EC8 - EC10 | mg/kg | 0.001 | MCERTS | < 0.001 | < 0.001 |
| TPH-CWG - Aliphatic >EC10 - EC12 | mg/kg | 1 | MCERTS | < 1.0 | < 1.0 |
| TPH-CWG - Aliphatic >EC12 - EC16 | mg/kg | 2 | MCERTS | < 2.0 | < 2.0 |
| TPH-CWG - Aliphatic >EC16 - EC21 | mg/kg | 8 | MCERTS | < 8.0 | < 8.0 |
| TPH-CWG - Aliphatic >EC21 - EC35 | mg/kg | 8 | MCERTS | < 8.0 | < 8.0 |
| TPH-CWG - Aliphatic (EC5 - EC35) | mg/kg | 10 | MCERTS | < 10 | < 10 |

| | | | | | |
|---|---|---|---|---|---|
| TPH-CWG - Aromatic >EC5 - EC7 | mg/kg | 0.001 | MCERTS | < 0.001 | < 0.001 |
| TPH-CWG - Aromatic >EC7 - EC8 | mg/kg | 0.001 | MCERTS | < 0.001 | < 0.001 |
| TPH-CWG - Aromatic >EC8 - EC10 | mg/kg | 0.001 | MCERTS | < 0.001 | < 0.001 |
| TPH-CWG - Aromatic >EC10 - EC12 | mg/kg | 1 | MCERTS | < 1.0 | < 1.0 |
| TPH-CWG - Aromatic >EC12 - EC16 | mg/kg | 2 | MCERTS | < 2.0 | < 2.0 |
| TPH-CWG - Aromatic >EC16 - EC21 | mg/kg | 10 | MCERTS | < 10 | 10 |
| TPH-CWG - Aromatic >EC21 - EC35 | mg/kg | 10 | MCERTS | < 10 | 13 |
| TPH-CWG - Aromatic (EC5 - EC35) | mg/kg | 10 | MCERTS | < 10 | 24 |

U/S = Unsuitable Sample  I/S = Insufficient Sample

**Analytical Report Number : 20-21301**
**Project / Site name: 156 West End Lane, West Hampstead**

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

| Lab Sample Number | Sample Reference | Sample Number | Depth (m) | Sample Description * |
|---|---|---|---|---|
| 1572758 | WS201 | None Supplied | 0.30-0.60 | Light brown sand with gravel. |
| 1572760 | WS202 | None Supplied | 0.30-0.70 | Light brown sand with gravel. |
| 1572761 | WS203 | None Supplied | 0.30-0.60 | Light brown sand with gravel. |
| 1572762 | WS203 | None Supplied | 1.5 | Light brown sand with gravel. |
| 1572763 | WS203 | None Supplied | 3 | Brown clay with gravel. |
| 1572765 | WS204 | None Supplied | 1.2 | Grey clay and sand with gravel. |
| 1572766 | WS204 | None Supplied | 2.4 | Brown clay with gravel. |
| 1572767 | BH03 | None Supplied | 0.8 | Light brown gravel.** |

** NON MCERTS MATRIX

**Analytical Report Number : 20-21301**
**Project / Site name: 156 West End Lane, West Hampstead**

**Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)**

| Analytical Test Name | Analytical Method Description | Analytical Method Reference | Method number | Wet / Dry Analysis | Accreditation Status |
|---|---|---|---|---|---|
| Metals in soil by ICP-OES | Determination of metals in soil by aqua-regia digestion followed by ICP-OES. | In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil. | L038-PL | D | MCERTS |
| Asbestos identification in soil | Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques. | In house method based on HSG 248 | A001-PL | D | ISO 17025 |
| Boron, water soluble, in soil | Determination of water soluble boron in soil by hot water extract followed by ICP-OES. | In-house method based on Second Site Properties version 3 | L038-PL | D | MCERTS |
| Hexavalent chromium in soil (Lower Level) | Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry. | In-house method | L080-PL | W | MCERTS |
| Moisture Content | Moisture content, determined gravimetrically. (30 oC) | In house method. | L019-UK/PL | W | NONE |
| Monohydric phenols in soil | Determination of phenols in soil by extraction with sodium hydroxide followed by distillation followed by colorimetry. | In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar) | L080-PL | W | MCERTS |
| Organic matter (Automated) in soil | Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate. | In house method. | L009-PL | D | MCERTS |
| Speciated WAC-17 PAHs in soil | Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards. | In-house method based on USEPA 8270. MCERTS accredited except Coronene. | L064-PL | D | NONE |
| pH in soil (automated) | Determination of pH in soil by addition of water followed by automated electrometric measurement. | In house method. | L099-PL | D | MCERTS |
| Total sulphate (as SO4 in soil) | Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES. | In house method. | L038-PL | D | MCERTS |
| Total cyanide in soil | Determination of total cyanide by distillation followed by colorimetry. | In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar) | L080-PL | W | MCERTS |
| BTEX and MTBE in soil (Monoaromatics) | Determination of BTEX in soil by headspace GC-MS. | In-house method based on USEPA8260 | L073B-PL | W | MCERTS |
| Cr (III) in soil | In-house method by calculation from total Cr and Cr VI. | In-house method by calculation | L080-PL | W | NONE |
| TPHCWG (Soil) | Determination of hexane extractable hydrocarbons in soil by GC-MS/GC-FID. | In-house method with silica gel split/clean up. | L088/76-PL | W | MCERTS |

**For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.**
**For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.**
**Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.**

**Analytical Report Number : 20-21301**
**Project / Site name: 156 West End Lane, West Hampstead**

| Sample ID | Other ID | Sample Type | Lab Sample Number | Sample Deviation | Test Name | Test Ref | Test Deviation |
|---|---|---|---|---|---|---|---|
| BH03 | None Supplied | S | 1572767 | c | Total cyanide in soil | L080-PL | c |
| WS201 | None Supplied | S | 1572758 | c | Total cyanide in soil | L080-PL | c |
| WS202 | None Supplied | S | 1572760 | c | Total cyanide in soil | L080-PL | c |
| WS203 | None Supplied | S | 1572761 | c | Total cyanide in soil | L080-PL | c |
| WS203 | None Supplied | S | 1572762 | c | Total cyanide in soil | L080-PL | c |
| WS203 | None Supplied | S | 1572763 | c | Total cyanide in soil | L080-PL | c |
| WS204 | None Supplied | S | 1572765 | c | Total cyanide in soil | L080-PL | c |
| WS204 | None Supplied | S | 1572766 | c | Total cyanide in soil | L080-PL | c |

# APPENDIX H

*Geotechnical Laboratory Test Results*

**Ric Wilkinson**
Card Geotechnics Ltd
4 Godalming Business Centre
Woolsack Way
Godalming
Surrey
GU7 1XW

**t:** 01483 310600
**f:** 01483 527285
**e:** RicW@cgl-uk.com

i2 Analytical Ltd.
7 Woodshots Meadow,
Croxley Green
Business Park,
Watford,
Herts,
WD18 8YS

**t:** 01923 225404
**f:** 01923 237404
**e:** reception@i2analytical.com

# Analytical Report Number : 20-21725

| | | | |
|---|---|---|---|
| **Project / Site name:** | 156 West End Lane, West Hampstead | **Samples received on:** | 21/07/2020 |
| **Your job number:** | CG-38293A | **Sample instructed/ Analysis started on:** | 27/07/2020 |
| **Your order number:** | POP005917 | **Analysis completed by:** | 07/08/2020 |
| **Report Issue Number:** | 1 | **Report issued on:** | 10/08/2020 |
| **Samples Analysed:** | 6 soil samples | | |

**Signed:**

Joanna Wawrzeczko
Technical Reviewer (Reporting Team)

**For & on behalf of i2 Analytical Ltd.**

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

| | |
|---|---|
| soils | - 4 weeks from reporting |
| leachates | - 2 weeks from reporting |
| waters | - 2 weeks from reporting |
| asbestos | - 6 months from reporting |

Excel copies of reports are only valid when accompanied by this PDF certificate.

Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement. Application of uncertainty of measurement would provide a range within which the true result lies. An estimate of measurement uncertainty can be provided on request.

**Analytical Report Number: 20-21725**

**Project / Site name: 156 West End Lane, West Hampstead**
**Your Order No: POP005917**

| Lab Sample Number | | | | 1575244 | 1575245 | 1575246 | 1575247 | 1575248 |
|---|---|---|---|---|---|---|---|---|
| **Sample Reference** | | | | BH03 | BH03 | BH03 | BH03 | BH03 |
| **Sample Number** | | | | None Supplied | None Supplied | None Supplied | None Supplied | None Supplied |
| **Depth (m)** | | | | 0.5 | 2.0 | 4.95 | 8.5 | 14.5 |
| **Date Sampled** | | | | Deviating | Deviating | Deviating | Deviating | Deviating |
| **Time Taken** | | | | None Supplied | None Supplied | None Supplied | None Supplied | None Supplied |
| **Analytical Parameter (Soil Analysis)** | **Units** | **Limit of detection** | **Accreditation Status** | | | | | |
| Stone Content | % | 0.1 | NONE | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 |
| Moisture Content | % | N/A | NONE | 3.6 | 17 | 18 | 18 | 17 |
| Total mass of sample received | kg | 0.001 | NONE | 2.0 | 1.8 | 2.0 | 2.0 | 2.0 |
| **General Inorganics** | | | | | | | | |
| pH - Automated | pH Units | N/A | MCERTS | 10.8 | 7.8 | 7.8 | 8.0 | 8.4 |
| Total Sulphate as $SO_4$ | mg/kg | 50 | MCERTS | - | - | 10000 | 1500 | 1000* |
| Water Soluble Sulphate (Soil Equivalent) | g/kg | 0.0025 | MCERTS | 0.30 | 3.4 | - | - | - |
| Water Soluble Sulphate as $SO_4$ 16hr extraction (2:1) | mg/kg | 2.5 | MCERTS | 300 | 3400 | - | - | - |
| Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent) | g/l | 0.00125 | MCERTS | 0.15 | 1.7 | 3.9 | 1.5 | 0.99* |
| Total Sulphur | mg/kg | 50 | MCERTS | - | - | 6300 | 1200 | 4400 |

* Despite repeating Total Sulphate and Water Soluble Sulphate analysis, the results remain contradictory.

**Analytical Report Number: 20-21725**

**Project / Site name: 156 West End Lane, West Hampstead**
**Your Order No: POP005917**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Lab Sample Number** | | | | 1575249 | | | | |
| **Sample Reference** | | | | BH03 | | | | |
| **Sample Number** | | | | None Supplied | | | | |
| **Depth (m)** | | | | 19.9 | | | | |
| **Date Sampled** | | | | Deviating | | | | |
| **Time Taken** | | | | None Supplied | | | | |
| **Analytical Parameter (Soil Analysis)** | **Units** | **Limit of detection** | **Accreditation Status** | | | | | |
| Stone Content | % | 0.1 | NONE | < 0.1 | | | | |
| Moisture Content | % | N/A | NONE | 16 | | | | |
| Total mass of sample received | kg | 0.001 | NONE | 2.0 | | | | |
| **General Inorganics** | | | | | | | | |
| pH - Automated | pH Units | N/A | MCERTS | 8.6 | | | | |
| Total Sulphate as $SO_4$ | mg/kg | 50 | MCERTS | 850* | | | | |
| Water Soluble Sulphate (Soil Equivalent) | g/kg | 0.0025 | MCERTS | - | | | | |
| Water Soluble Sulphate as $SO_4$ 16hr extraction (2:1) | mg/kg | 2.5 | MCERTS | - | | | | |
| Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent) | g/l | 0.00125 | MCERTS | 0.83* | | | | |
| Total Sulphur | mg/kg | 50 | MCERTS | 4800 | | | | |

* Despite repeating Total Sulphate and Water Soluble Sulphate analysis, the results remain contradictory.

**Analytical Report Number : 20-21725**

**Project / Site name: 156 West End Lane, West Hampstead**

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

| Lab Sample Number | Sample Reference | Sample Number | Depth (m) | Sample Description * |
|---|---|---|---|---|
| 1575244 | BH03 | None Supplied | 0.5 | Brown sand with rubble and gravel |
| 1575245 | BH03 | None Supplied | 2.0 | Brown clay with brick. |
| 1575246 | BH03 | None Supplied | 4.95 | Brown clay. |
| 1575247 | BH03 | None Supplied | 8.5 | Brown clay. |
| 1575248 | BH03 | None Supplied | 14.5 | Brown clay. |
| 1575249 | BH03 | None Supplied | 19.9 | Brown clay. |

**Analytical Report Number : 20-21725**

**Project / Site name: 156 West End Lane, West Hampstead**

**Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)**

| Analytical Test Name | Analytical Method Description | Analytical Method Reference | Method number | Wet / Dry Analysis | Accreditation Status |
|---|---|---|---|---|---|
| Moisture Content | Moisture content, determined gravimetrically. (30 oC) | In house method. | L019-UK/PL | W | NONE |
| pH in soil (automated) | Determination of pH in soil by addition of water followed by automated electrometric measurement. | In house method. | L099-PL | D | MCERTS |
| Stones content of soil | Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight. | In-house method based on British Standard Methods and MCERTS requirements. | L019-UK/PL | D | NONE |
| Sulphate, water soluble, in soil (16hr extraction) | Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent). | In house method. | L038-PL | D | MCERTS |
| Total sulphate (as SO4 in soil) | Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES. | In house method. | L038-PL | D | MCERTS |
| Total Sulphur in soil | Determination of total sulphur in soil by extraction with aqua-regia, potassium bromide/bromate followed by ICP-OES. | In house method. | L038-PL | D | MCERTS |

**For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.**
**For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.**
**Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.**

| Sample ID | Other_ID | Sample Type | Job | Sample Number | Sample Deviation Code | test_name | test_ref | Test Deviation code |
|---|---|---|---|---|---|---|---|---|
| BH03 | | S | 20-21725 | 1575244 | a | | | |
| BH03 | | S | 20-21725 | 1575245 | a | | | |
| BH03 | | S | 20-21725 | 1575246 | a | | | |
| BH03 | | S | 20-21725 | 1575247 | a | | | |
| BH03 | | S | 20-21725 | 1575248 | a | | | |
| BH03 | | S | 20-21725 | 1575249 | a | | | |



Key: a - No sampling date b - Incorrect container
c - Holding time d - Headspace e - Temperature

# TEST CERTIFICATE

## Liquid and Plastic Limits

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

UKAS TESTING 4041

Environmental Science

Tested in Accordance with: BS 1377-2: 1990: Clause 4.3 and 5

| | | | |
|---|---|---|---|
| Client: | Card Geotechnics Ltd | Client Reference: | CG-38293A |
| Client Address: | 4 Godalming Business Centre, Woolsack Way, Godalming, Surrey, GU7 1XW | Job Number: | 20-21719 |
| | | Date Sampled: | Not Given |
| | | Date Received: | 21/07/2020 |
| Contact: | Ric Wilkinson | Date Tested: | 07/08/2020 |
| Site Address: | 156 West End Lane, West Hampstead | Sampled By: | Not Given |

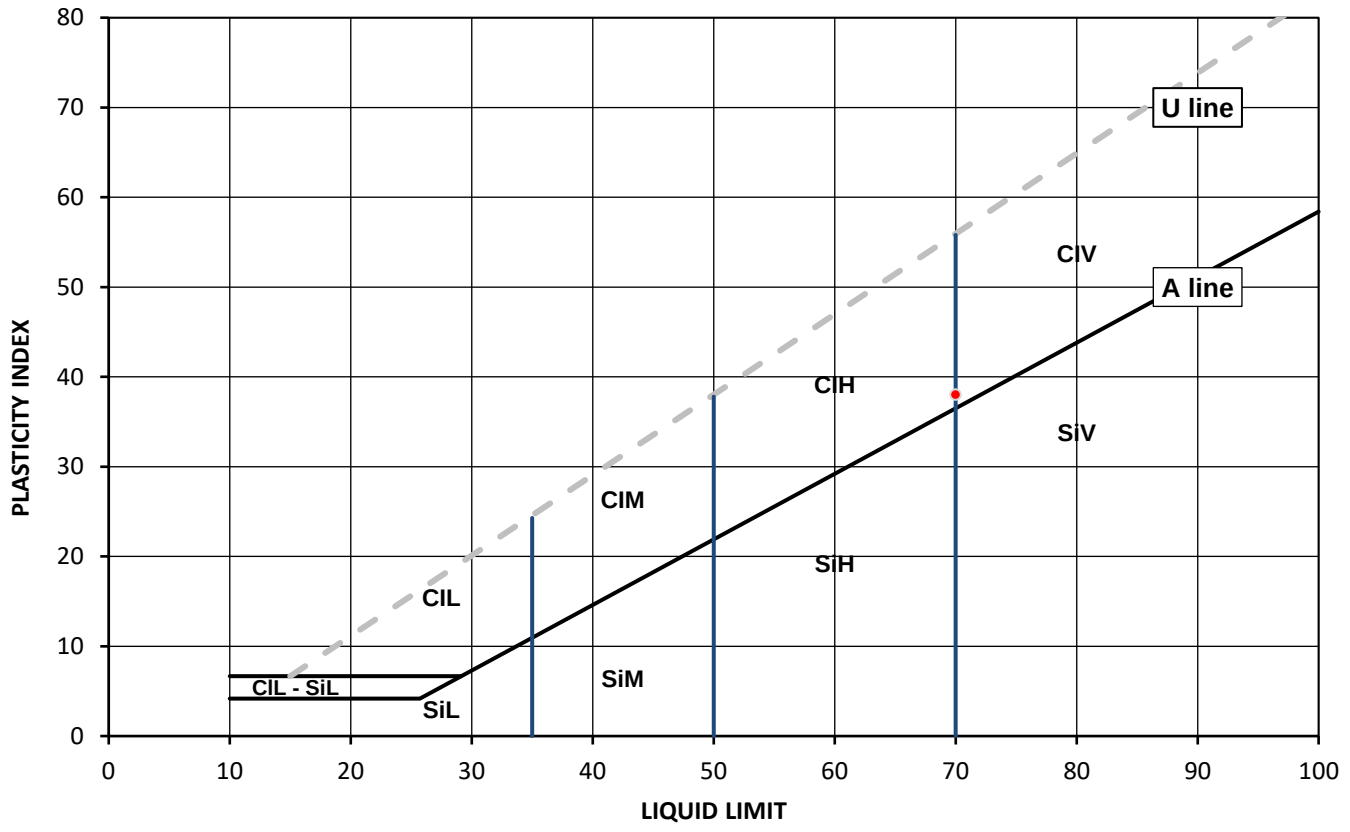
*Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland*

**Test Results:**

| | | | |
|---|---|---|---|
| Laboratory Reference: | 1575203 | Depth Top [m]: | 5.50 |
| Hole No.: | BH03 | Depth Base [m]: | Not Given |
| Sample Reference: | Not Given | Sample Type: | B |
| Soil Description: | Brown CLAY | | |

Sample Preparation: Tested in natural condition

| As Received Moisture Content [ W ] % | Liquid Limit [ WL ] % | Plastic Limit [ Wp ] % | Plasticity Index [ Ip ] % | % Passing 425µm BS Test Sieve |
|---|---|---|---|---|
| 32 | 70 | 32 | 38 | 100 |




Legend, based on BS EN ISO 14688 2:2018 Geotechnical investigation and testing – Identification and classification of soil

| | | Plasticity | | Liquid Limit |
|---|---|---|---|---|
| Cl | Clay | L | Low | below 35 |
| Si | Silt | M | Medium | 35 to 50 |
| | | H | High | 50 to 70 |
| | | V | Very high | exceeding 70 |
| | | O | Organic | append to classification for organic material ( eg ClHO ) |

Note: Moisture Content by BS 1377-2: 1990: Clause 3.2

Remarks:



**Signed:**

Aleksandra Jurochnik
PL Technical Reviewer
**for and on behalf of i2 Analytical Ltd**



**Date Reported:** 10/08/2020

**GF 236.10**

# TEST CERTIFICATE

## Liquid and Plastic Limits

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

UKAS TESTING 4041

Environmental Science

Tested in Accordance with: BS 1377-2: 1990: Clause 4.3 and 5

| | | | |
|---|---|---|---|
| Client: | Card Geotechnics Ltd | Client Reference: | CG-38293A |
| Client Address: | 4 Godalming Business Centre, Woolsack Way, Godalming, Surrey, GU7 1XW | Job Number: | 20-21719 |
| | | Date Sampled: | Not Given |
| | | Date Received: | 21/07/2020 |
| Contact: | Ric Wilkinson | Date Tested: | 07/08/2020 |
| Site Address: | 156 West End Lane, West Hampstead | Sampled By: | Not Given |

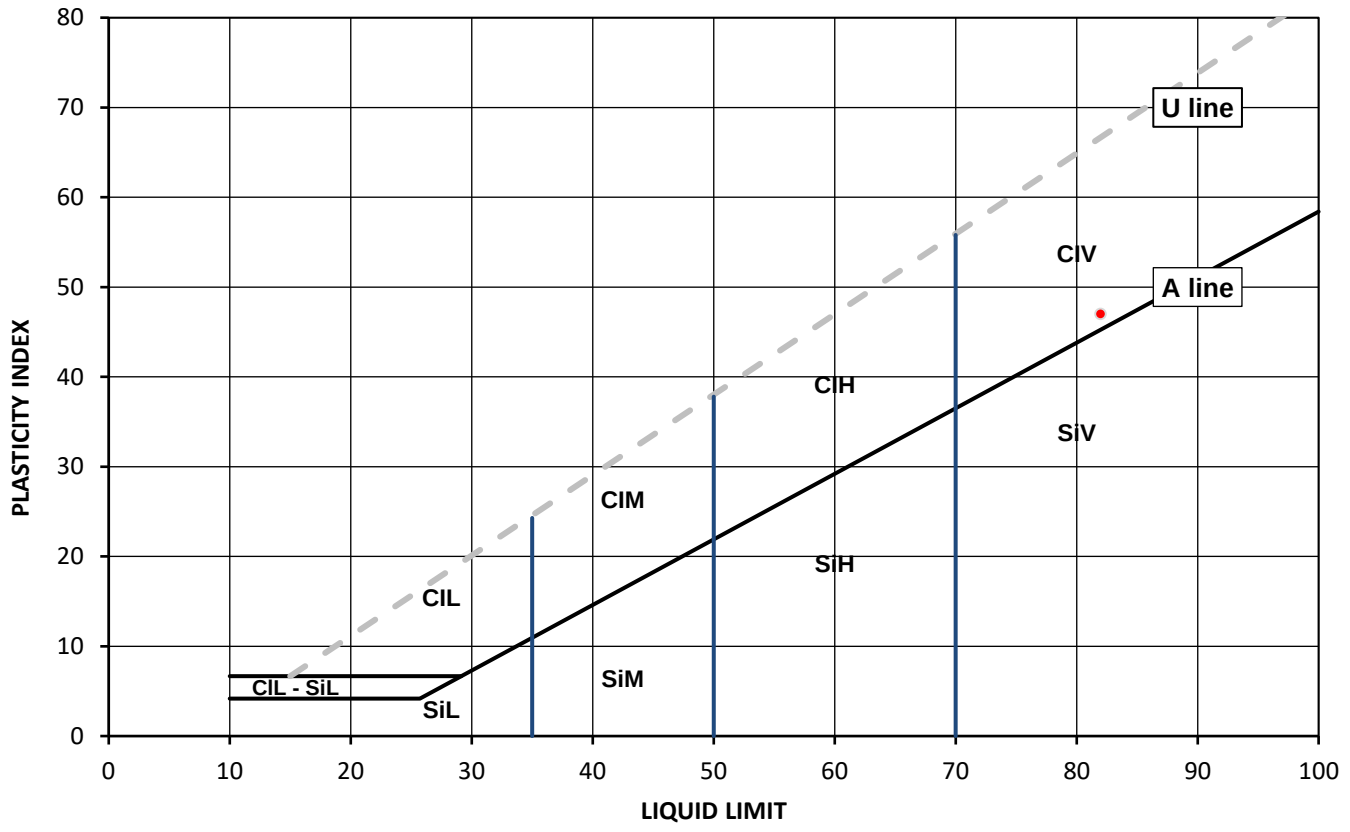
*Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland*

**Test Results:**

| | | | |
|---|---|---|---|
| Laboratory Reference: | 1575205 | Depth Top [m]: | 11.50 |
| Hole No.: | BH03 | Depth Base [m]: | Not Given |
| Sample Reference: | Not Given | Sample Type: | B |
| Soil Description: | Brown CLAY | | |

Sample Preparation: Tested in natural condition

| As Received Moisture Content [ W ] % | Liquid Limit [ WL ] % | Plastic Limit [ Wp ] % | Plasticity Index [ Ip ] % | % Passing 425µm BS Test Sieve |
|---|---|---|---|---|
| 31 | 82 | 35 | 47 | 100 |




Legend, based on BS EN ISO 14688 2:2018 Geotechnical investigation and testing – Identification and classification of soil

| | | Plasticity | | Liquid Limit |
|---|---|---|---|---|
| Cl | Clay | L | Low | below 35 |
| Si | Silt | M | Medium | 35 to 50 |
| | | H | High | 50 to 70 |
| | | V | Very high | exceeding 70 |
| | | O | Organic | append to classification for organic material ( eg ClHO ) |

Note: Moisture Content by BS 1377-2: 1990: Clause 3.2

Remarks:



**Signed:**

Aleksandra Jurochnik
PL Technical Reviewer
**for and on behalf of i2 Analytical Ltd**



**Date Reported:** 10/08/2020

**GF 236.10**

# TEST CERTIFICATE

## Liquid and Plastic Limits

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

UKAS TESTING 4041

Environmental Science

Tested in Accordance with: BS 1377-2: 1990: Clause 4.3 and 5

| | | | |
|---|---|---|---|
| Client: | Card Geotechnics Ltd | Client Reference: | CG-38293A |
| Client Address: | 4 Godalming Business Centre, Woolsack Way, Godalming, Surrey, GU7 1XW | Job Number: | 20-21719 |
| | | Date Sampled: | Not Given |
| | | Date Received: | 21/07/2020 |
| Contact: | Ric Wilkinson | Date Tested: | 07/08/2020 |
| Site Address: | 156 West End Lane, West Hampstead | Sampled By: | Not Given |

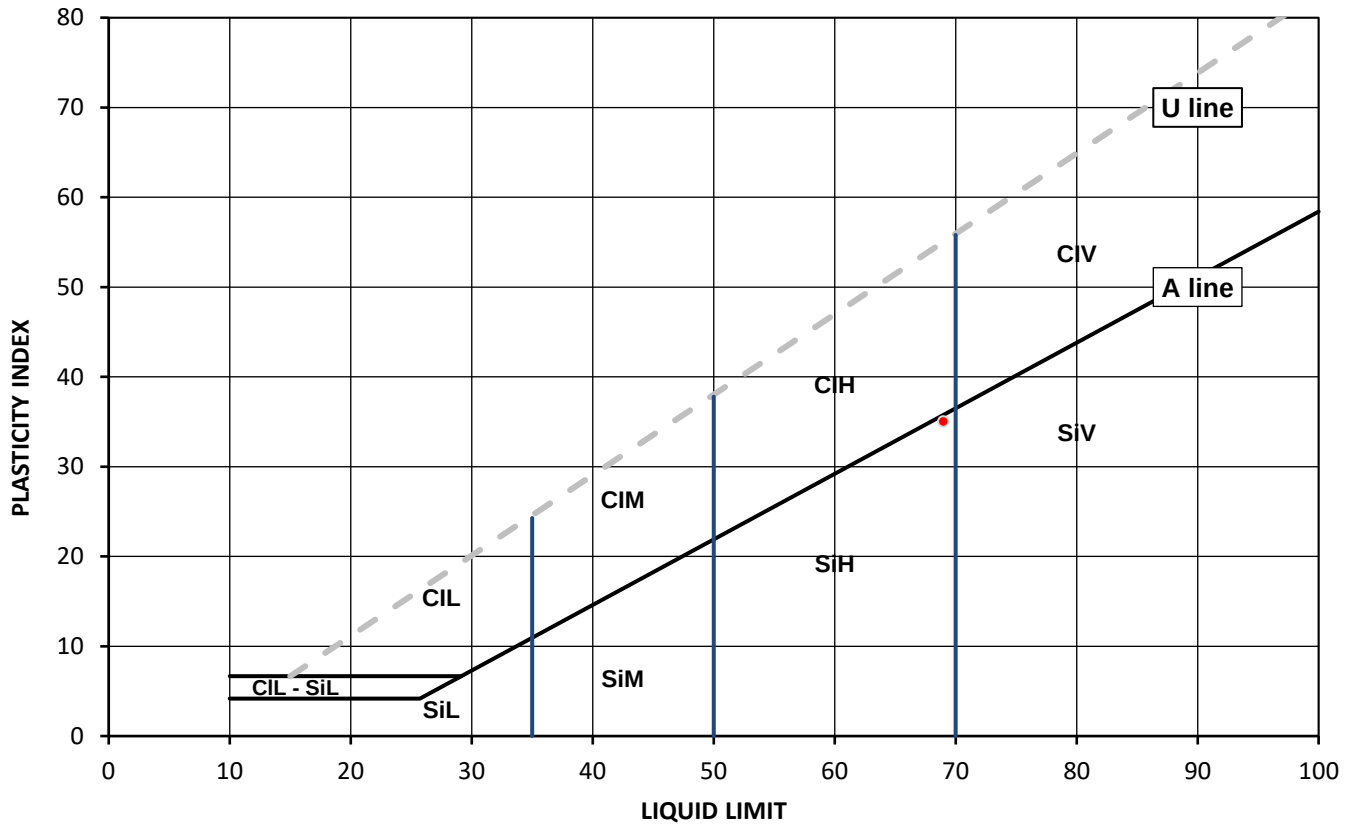
*Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland*

**Test Results:**

| | | | |
|---|---|---|---|
| Laboratory Reference: | 1575207 | Depth Top [m]: | 17.50 |
| Hole No.: | BH03 | Depth Base [m]: | Not Given |
| Sample Reference: | Not Given | Sample Type: | B |
| Soil Description: | Brown CLAY | | |

Sample Preparation: Tested in natural condition

| As Received Moisture Content [ W ] % | Liquid Limit [ WL ] % | Plastic Limit [ Wp ] % | Plasticity Index [ Ip ] % | % Passing 425µm BS Test Sieve |
|---|---|---|---|---|
| 29 | 69 | 34 | 35 | 100 |




Legend, based on BS EN ISO 14688 2:2018 Geotechnical investigation and testing – Identification and classification of soil

| | | Plasticity | | Liquid Limit |
|---|---|---|---|---|
| Cl | Clay | L | Low | below 35 |
| Si | Silt | M | Medium | 35 to 50 |
| | | H | High | 50 to 70 |
| | | V | Very high | exceeding 70 |
| | | O | Organic | append to classification for organic material ( eg ClHO ) |

Note: Moisture Content by BS 1377-2: 1990: Clause 3.2

Remarks:



**Signed:**

Aleksandra Jurochnik
PL Technical Reviewer
**for and on behalf of i2 Analytical Ltd**



**Date Reported:** 10/08/2020

**GF 236.10**

# TEST CERTIFICATE

## Liquid and Plastic Limits

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

UKAS TESTING 4041

Environmental Science

Tested in Accordance with: BS 1377-2: 1990: Clause 4.3 and 5

| | | | |
|---|---|---|---|
| Client: | Card Geotechnics Ltd | Client Reference: | CG-38293A |
| Client Address: | 4 Godalming Business Centre, Woolsack Way, Godalming, Surrey, GU7 1XW | Job Number: | 20-21719 |
| | | Date Sampled: | Not Given |
| | | Date Received: | 21/07/2020 |
| Contact: | Ric Wilkinson | Date Tested: | 07/08/2020 |
| Site Address: | 156 West End Lane, West Hampstead | Sampled By: | Not Given |

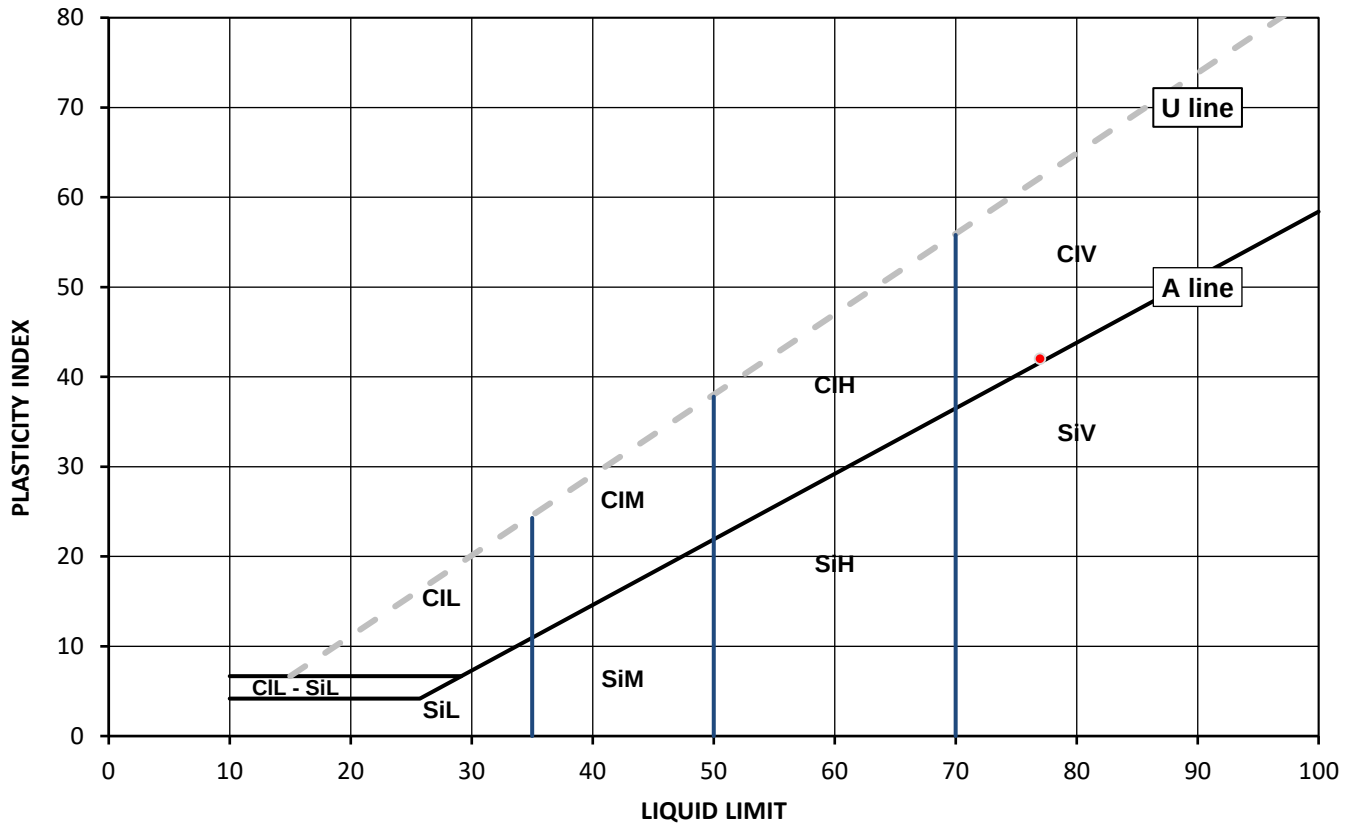
*Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland*

**Test Results:**

| | | | |
|---|---|---|---|
| Laboratory Reference: | 1575209 | Depth Top [m]: | 22.95 |
| Hole No.: | BH03 | Depth Base [m]: | Not Given |
| Sample Reference: | Not Given | Sample Type: | B |
| Soil Description: | Dark brown CLAY | | |

Sample Preparation: Tested in natural condition

| As Received Moisture Content [ W ] % | Liquid Limit [ WL ] % | Plastic Limit [ Wp ] % | Plasticity Index [ Ip ] % | % Passing 425µm BS Test Sieve |
|---|---|---|---|---|
| 24 | 77 | 35 | 42 | 100 |




Legend, based on BS EN ISO 14688 2:2018 Geotechnical investigation and testing – Identification and classification of soil

| | | Plasticity | | Liquid Limit |
|---|---|---|---|---|
| Cl | Clay | L | Low | below 35 |
| Si | Silt | M | Medium | 35 to 50 |
| | | H | High | 50 to 70 |
| | | V | Very high | exceeding 70 |
| | | O | Organic | append to classification for organic material ( eg ClHO ) |

Note: Moisture Content by BS 1377-2: 1990: Clause 3.2

Remarks:



**Signed:**

Aleksandra Jurochnik
PL Technical Reviewer
**for and on behalf of i2 Analytical Ltd**



**Date Reported:** 10/08/2020

**GF 236.10**

# SUMMARY REPORT

## Summary of Classification Test Results

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

Tested in Accordance with:

Moisture Content by BS 1377-2: 1990: Clause 3.2; Water Content by BS EN 17892-1: 2014; Atterberg by BS 1377-2: 1990: Clause 4.3 (4 Point Test), Clause 4.4 (1 Point Test) and 5; PD by BS 1377-2: 1990: Clause 8.2

Client: Card Geotechnics Ltd

Client Address: 4 Godalming Business Centre, Woolsack Way, Godalming, Surrey,, GU7 1XW

Contact: Ric Wilkinson

Site Address: 156 West End Lane, West Hampstead

Client Reference: CG-38293A
Job Number: 20-21719
Date Sampled: Not Given
Date Received: 21/07/2020
Date Tested: 07/08/2020
Sampled By: Not Given

*Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland*

**Test results**

| Laboratory Reference | Hole No. | Sample | | | | Description | Remarks | Moisture Content [ W ] | Water Content [ W ] | Atterberg | | | | Density | | | Total Porosity# | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Reference | Depth Top m | Depth Base m | Type | | | % | % | % Passing 425um % | WL % | Wp % | Ip % | bulk Mg/m3 | dry Mg/m3 | PD Mg/m3 | % | | |
| 1575203 | BH03 | Not Given | 5.50 | Not Given | B | Brown CLAY | Atterberg 4 Point | 32 | | 100 | 70 | 32 | 38 | | | | | | |
| 1575205 | BH03 | Not Given | 11.50 | Not Given | B | Brown CLAY | Atterberg 4 Point | 31 | | 100 | 82 | 35 | 47 | | | | | | |
| 1575207 | BH03 | Not Given | 17.50 | Not Given | B | Brown CLAY | Atterberg 4 Point | 29 | | 100 | 69 | 34 | 35 | | | | | | |
| 1575209 | BH03 | Not Given | 22.95 | Not Given | B | Dark brown CLAY | Atterberg 4 Point | 24 | | 100 | 77 | 35 | 42 | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |

Note: # Non accredited; NP - Non plastic

Comments:



**Signed:**

Aleksandra Jurochnik
PL Technical Reviewer
**for and on behalf of i2 Analytical Ltd**



**Date Reported:** 10/08/2020

**GF 238.12**

# TEST CERTIFICATE

## Particle Size Distribution

Tested in Accordance with: BS 1377-2: 1990

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

UKAS TESTING 4041

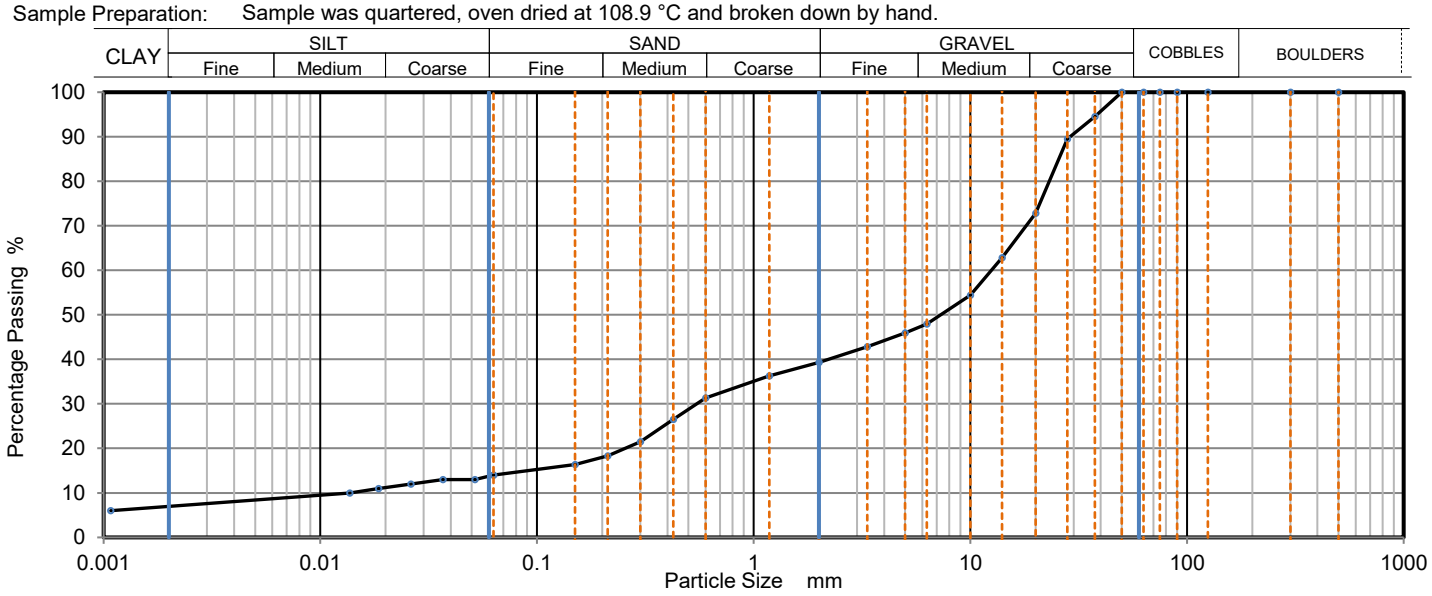
Environmental Science

| | | | |
|---|---|---|---|
| Client: | Card Geotechnics Ltd | Client Reference: | CG-38293A |
| Client Address: | 4 Godalming Business Centre, Woolsack Way, Godalming, Surrey, GU7 1XW | Job Number: | 20-21719 |
| | | Date Sampled: | Not Given |
| | | Date Received: | 21/07/2020 |
| Contact: | Ric Wilkinson | Date Tested: | 07/08/2020 |
| Site Address: | 156 West End Lane, West Hampstead | Sampled By: | Not Given |

*Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland*

**Test Results:**

| | | | |
|---|---|---|---|
| Laboratory Reference: | 1575200 | Depth Top [m]: | 0.80 |
| Hole No.: | BH03 | Depth Base [m]: | Not Given |
| Sample Reference: | Not Given | Sample Type: | B |
| Sample Description: | Brown clayey sandy silty GRAVEL | | |
| Sample Preparation: | Sample was quartered, oven dried at 108.9 °C and broken down by hand. | | |




| Sieving | | Sedimentation | |
|---|---|---|---|
| Particle Size mm | % Passing | Particle Size mm | % Passing |
| 500 | 100 | 0.0630 | 14 |
| 300 | 100 | 0.0516 | 13 |
| 125 | 100 | 0.0367 | 13 |
| 90 | 100 | 0.0261 | 12 |
| 75 | 100 | 0.0186 | 11 |
| 63 | 100 | 0.0137 | 10 |
| 50 | 100 | 0.0011 | 6 |
| 37.5 | 95 | | |
| 28 | 90 | | |
| 20 | 73 | | |
| 14 | 63 | | |
| 10 | 54 | | |
| 6.3 | 48 | | |
| 5 | 46 | | |
| 3.35 | 43 | | |
| 2 | 39 | Particle density | (assumed) |
| 1.18 | 36 | 2.65 | Mg/m3 |
| 0.6 | 31 | | |
| 0.425 | 27 | | |
| 0.3 | 22 | | |
| 0.212 | 18 | | |
| 0.15 | 16 | | |
| 0.063 | 14 | | |

| Sample Proportions | % dry mass |
|---|---|
| Very coarse | 0.00 |
| Gravel | 60.70 |
| Sand | 25.30 |
| Silt | 7.00 |
| Clay | 7.00 |

| Grading Analysis | | |
|---|---|---|
| D100 | mm | 50 |
| D60 | mm | 12.5 |
| D30 | mm | 0.545 |
| D10 | mm | 0.0114 |
| Uniformity Coefficient | | 1100 |
| Curvature Coefficient | | 2.1 |

Note: Tested in Accordance with BS1377:Part 2:1990, clauses 9.2 and 9.5

Remarks: The material submitted - fails to meet the minimum mass requirements as stated in BS1377 Part 2 Table 3



**Signed:**

Aleksandra Jurochnik
PL Technical Reviewer
**for and on behalf of i2 Analytical Ltd**



**Date Reported:** 10/08/2020

**GF 100.18**

# TEST CERTIFICATE

## Particle Size Distribution

Tested in Accordance with: BS 1377-2: 1990

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

UKAS TESTING 4041

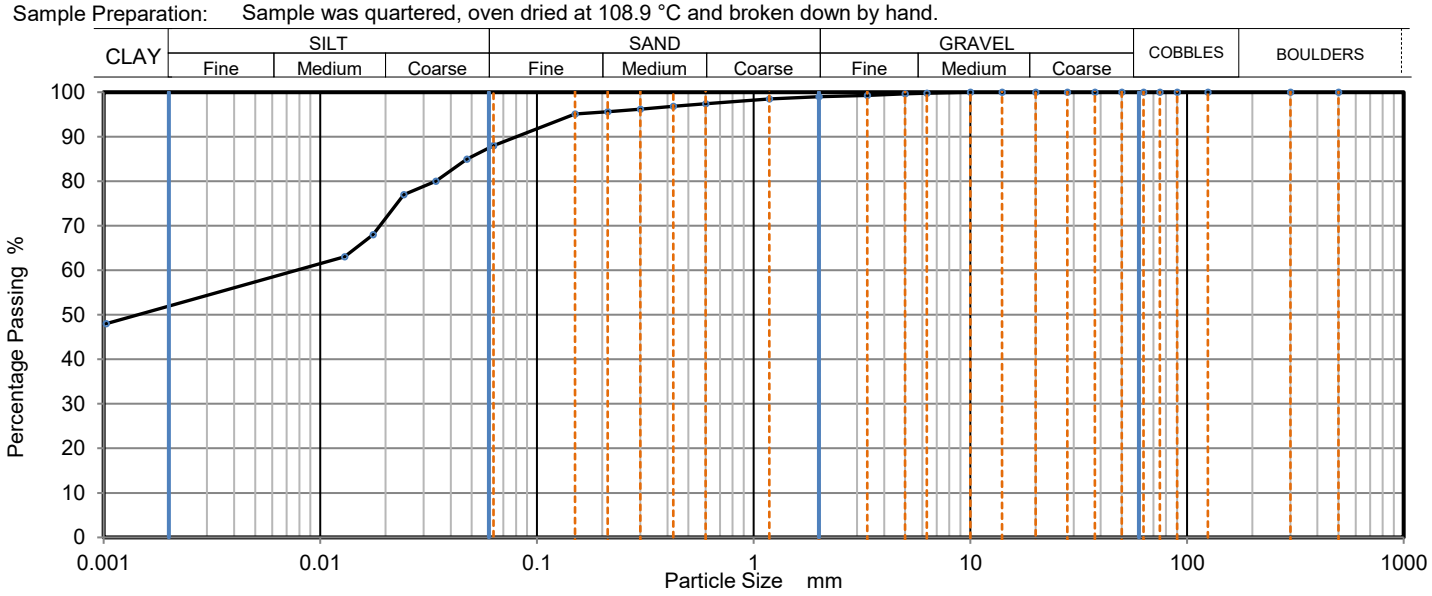
Environmental Science

| | | | |
|---|---|---|---|
| Client: | Card Geotechnics Ltd | Client Reference: | CG-38293A |
| Client Address: | 4 Godalming Business Centre, Woolsack Way, Godalming, Surrey, GU7 1XW | Job Number: | 20-21719 |
| | | Date Sampled: | Not Given |
| | | Date Received: | 21/07/2020 |
| Contact: | Ric Wilkinson | Date Tested: | 07/08/2020 |
| Site Address: | 156 West End Lane, West Hampstead | Sampled By: | Not Given |

*Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland*

**Test Results:**

| | | | |
|---|---|---|---|
| Laboratory Reference: | 1575201 | Depth Top [m]: | 2.30 |
| Hole No.: | BH03 | Depth Base [m]: | Not Given |
| Sample Reference: | Not Given | Sample Type: | B |
| Sample Description: | Brown sandy very silty CLAY | | |
| Sample Preparation: | Sample was quartered, oven dried at 108.9 °C and broken down by hand. | | |




| Sieving | | Sedimentation | |
|---|---|---|---|
| Particle Size mm | % Passing | Particle Size mm | % Passing |
| 500 | 100 | 0.0630 | 88 |
| 300 | 100 | 0.0475 | 85 |
| 125 | 100 | 0.0341 | 80 |
| 90 | 100 | 0.0243 | 77 |
| 75 | 100 | 0.0175 | 68 |
| 63 | 100 | 0.0130 | 63 |
| 50 | 100 | 0.0010 | 48 |
| 37.5 | 100 | | |
| 28 | 100 | | |
| 20 | 100 | | |
| 14 | 100 | | |
| 10 | 100 | | |
| 6.3 | 100 | | |
| 5 | 100 | | |
| 3.35 | 99 | | |
| 2 | 99 | Particle density | (assumed) |
| 1.18 | 99 | 2.65 | Mg/m3 |
| 0.6 | 97 | | |
| 0.425 | 97 | | |
| 0.3 | 96 | | |
| 0.212 | 96 | | |
| 0.15 | 95 | | |
| 0.063 | 88 | | |

| Sample Proportions | % dry mass |
|---|---|
| Very coarse | 0.00 |
| Gravel | 1.00 |
| Sand | 10.60 |
| Silt | 36.20 |
| Clay | 52.20 |

| Grading Analysis | | |
|---|---|---|
| D100 | mm | 10 |
| D60 | mm | 0.00806 |
| D30 | mm | |
| D10 | mm | |
| Uniformity Coefficient | | |
| Curvature Coefficient | | |

Note: Tested in Accordance with BS1377:Part 2:1990, clauses 9.2 and 9.5

Remarks:



**Signed:**

Aleksandra Jurochnik
PL Technical Reviewer
**for and on behalf of i2 Analytical Ltd**



**Date Reported:** 10/08/2020

**GF 100.18**

# TEST CERTIFICATE

**Unconsolidated Undrained**

**Triaxial Compression**

Tested in Accordance with:
BS 1377-7: 1990: Clause 8

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

UKAS TESTING 4041

Environmental Science

| | | | |
|---|---|---|---|
| Client: | Card Geotechnics Ltd | Client Reference: | CG-38293A |
| Client Address: | 4 Godalming Business Centre, Woolsack Way, Godalming, Surrey, GU7 1XW | Job Number: | 20-21719 |
| | | Date Sampled: | Not Given |
| | | Date Received: | 21/07/2020 |
| Contact: | Ric Wilkinson | Date Tested: | 08/08/2020 |
| Site Address: | 156 West End Lane, West Hampstead | Sampled By: | Not Given |

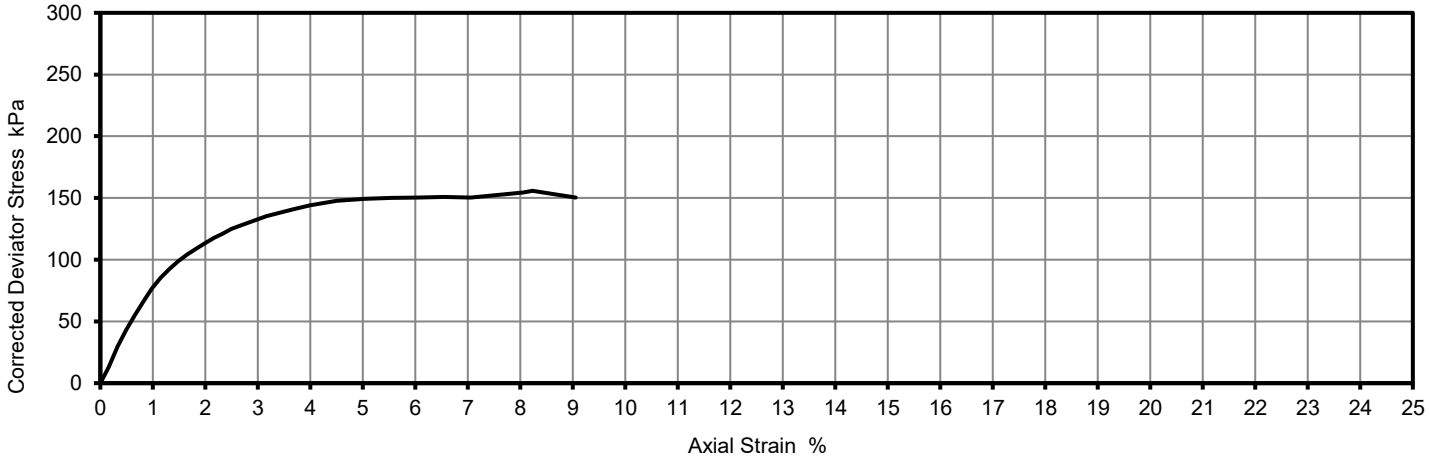
*Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland*

**Test Results:**

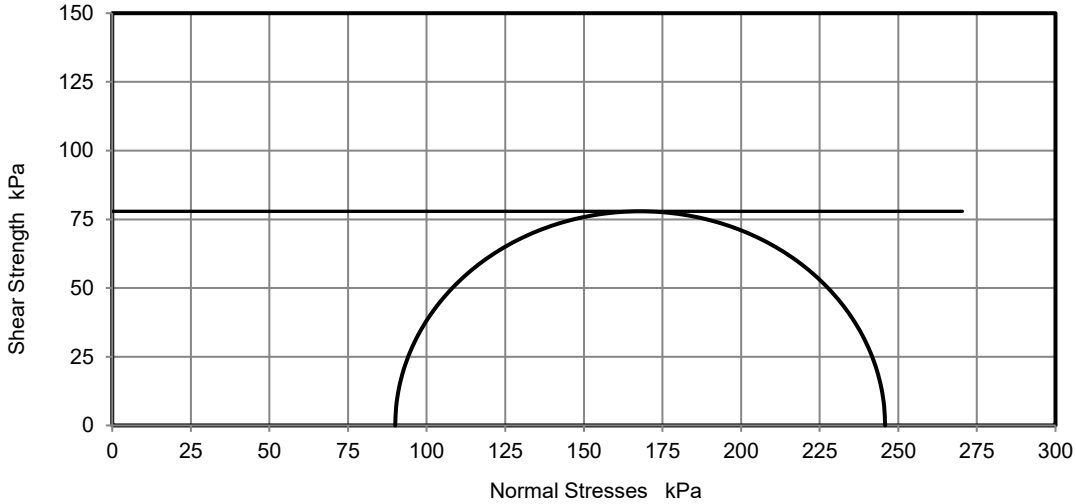
| | | | |
|---|---|---|---|
| Laboratory Reference: | 1575202 | Depth Top [m]: | 4.50 |
| Hole No.: | BH03 | Depth Base [m]: | 4.95 |
| Sample Reference: | Not Given | Sample Type: | U |
| Sample Description: | Brown to grey CLAY | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Test Number | 1 | | Rate of Strain | 2.00 | %/min | |
| Length | 199.44 | mm | Cell Pressure | 90 | kPa | |
| Diameter | 103.12 | mm | Axial Strain at failure | 8.2 | % | |
| Bulk Density | 1.94 | Mg/m3 | Deviator Stress, ( σ1 - σ3 )f | 156 | kPa | |
| Moisture Content | 33 | % | Undrained Shear Strength, cu | 78 | kPa | ½( σ1 - σ3 )f |
| Dry Density | 1.46 | Mg/m3 | Mode of Failure | Brittle | | |
| Membrane Correction | 0.55 | kPa | Membrane thickness | 0.29 | mm | |

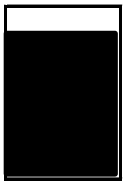
**Deviator Stress v Axial Strain**




**Mohr Circles**




Position within sample



Note: Deviator stress corrected for area change and membrane effects. Mohr circles and their interpretation is not covered by BS1377. This is provided for information only.

Remarks:



**Signed:**

Aleksandra Jurochnik
PL Technical Reviewer
**for and on behalf of i2 Analytical Ltd**



**Date Reported:** 10/08/2020

**GF 184.11**

# TEST CERTIFICATE

**Unconsolidated Undrained**

**Triaxial Compression**

Tested in Accordance with:
BS 1377-7: 1990: Clause 8

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

UKAS TESTING 4041

| | | | |
|---|---|---|---|
| Client: | Card Geotechnics Ltd | Client Reference: | CG-38293A |
| Client Address: | 4 Godalming Business Centre, Woolsack Way, Godalming, Surrey, GU7 1XW | Job Number: | 20-21719 |
| | | Date Sampled: | Not Given |
| | | Date Received: | 21/07/2020 |
| Contact: | Ric Wilkinson | Date Tested: | 08/08/2020 |
| Site Address: | 156 West End Lane, West Hampstead | Sampled By: | Not Given |

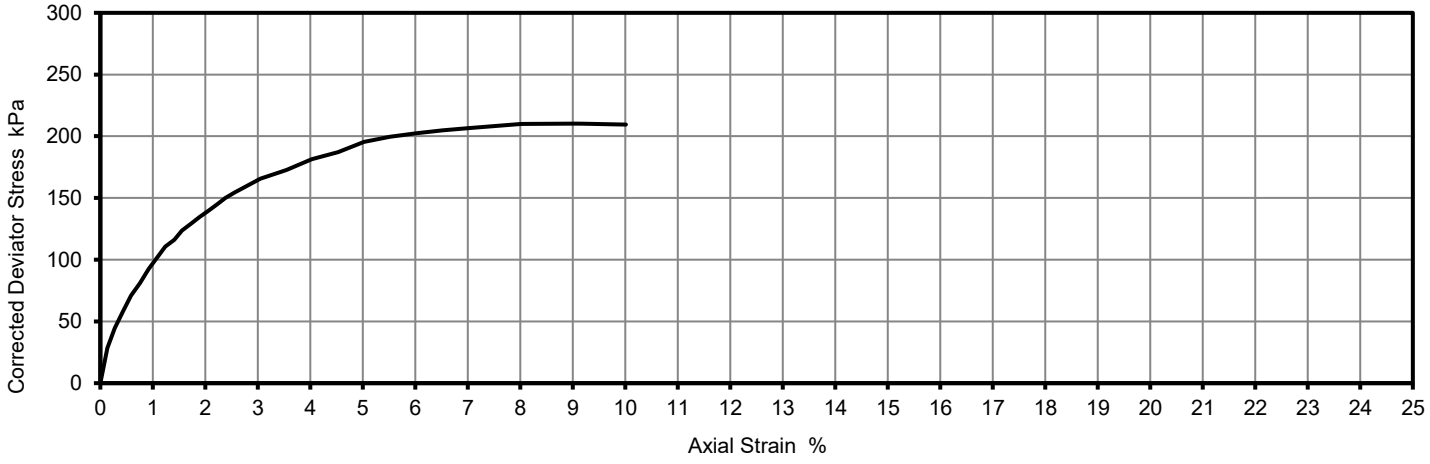
*Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland*

**Test Results:**

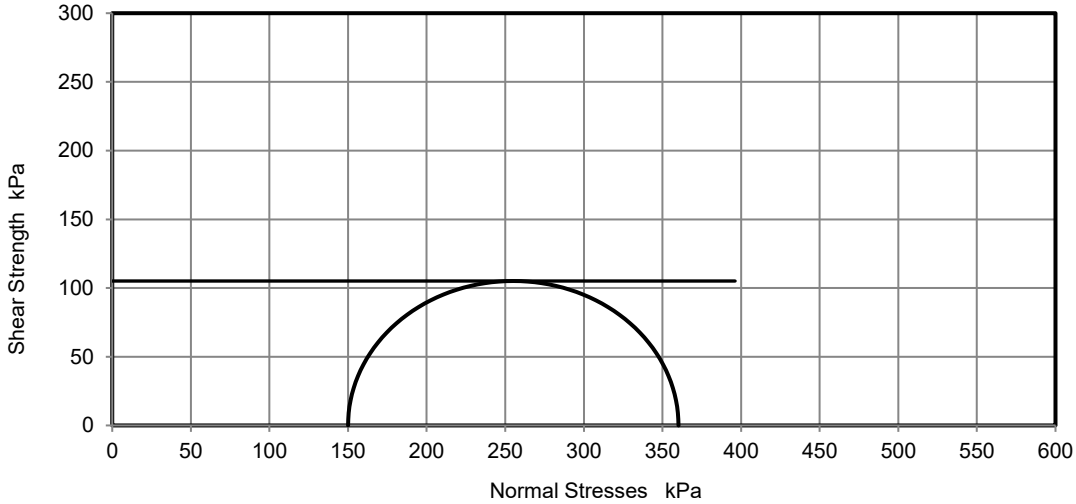
| | | | |
|---|---|---|---|
| Laboratory Reference: | 1575204 | Depth Top [m]: | 7.50 |
| Hole No.: | BH03 | Depth Base [m]: | 7.95 |
| Sample Reference: | Not Given | Sample Type: | U |
| Sample Description: | Brown CLAY | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Test Number | 1 | | Rate of Strain | 1.97 | %/min | |
| Length | 202.58 | mm | Cell Pressure | 150 | kPa | |
| Diameter | 103.53 | mm | Axial Strain at failure | 9.2 | % | |
| Bulk Density | 1.94 | Mg/m3 | Deviator Stress, ( σ1 - σ3 )f | 210 | kPa | |
| Moisture Content | 29 | % | Undrained Shear Strength, cu | 105 | kPa | ½( σ1 - σ3 )f |
| Dry Density | 1.50 | Mg/m3 | Mode of Failure | Compound | | |
| Membrane Correction | 0.53 | kPa | Membrane thickness | 0.26 | mm | |

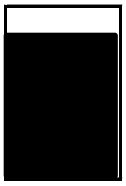
**Deviator Stress v Axial Strain**




**Mohr Circles**




Position within sample



Note: Deviator stress corrected for area change and membrane effects. Mohr circles and their interpretation is not covered by BS1377. This is provided for information only.

Remarks:



**Signed:**

Aleksandra Jurochnik
PL Technical Reviewer
**for and on behalf of i2 Analytical Ltd**



**Date Reported:** 10/08/2020

**GF 184.11**

# TEST CERTIFICATE

**Unconsolidated Undrained**

**Triaxial Compression**

Tested in Accordance with:
BS 1377-7: 1990: Clause 8

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

UKAS TESTING 4041

| | | | |
|---|---|---|---|
| Client: | Card Geotechnics Ltd | Client Reference: | CG-38293A |
| Client Address: | 4 Godalming Business Centre, Woolsack Way, Godalming, Surrey, GU7 1XW | Job Number: | 20-21719 |
| | | Date Sampled: | Not Given |
| | | Date Received: | 21/07/2020 |
| Contact: | Ric Wilkinson | Date Tested: | 08/08/2020 |
| Site Address: | 156 West End Lane, West Hampstead | Sampled By: | Not Given |

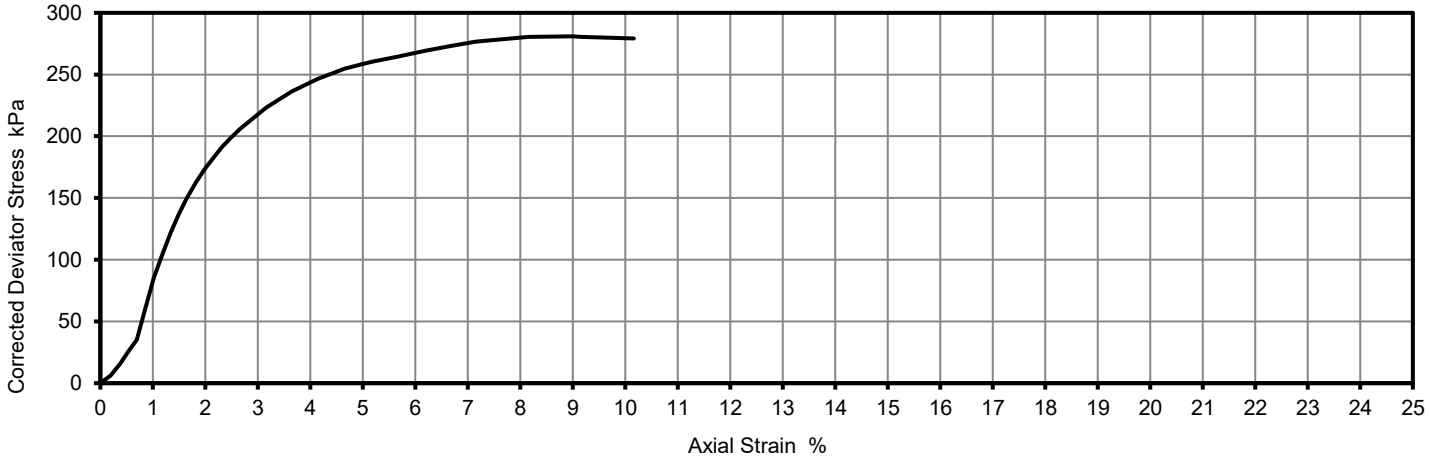
*Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland*

**Test Results:**

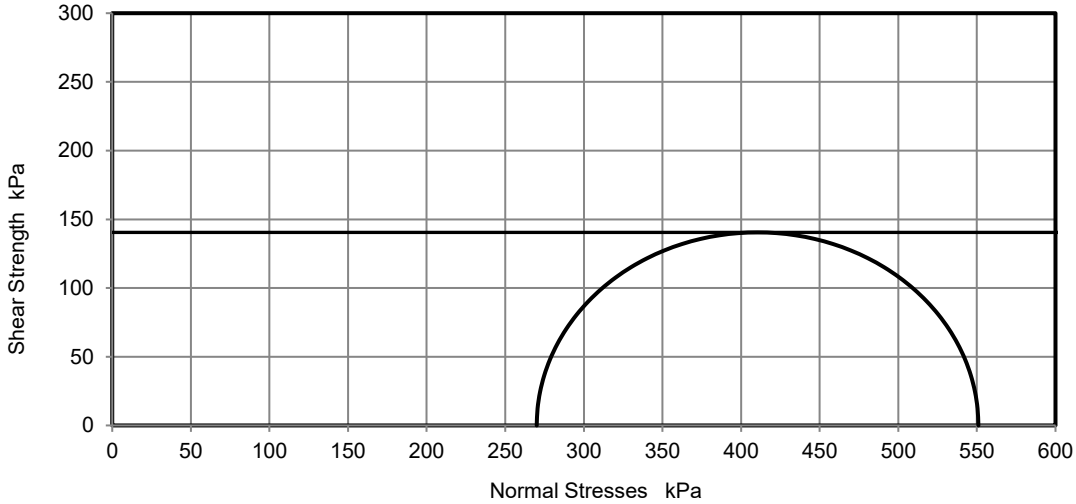
| | | | |
|---|---|---|---|
| Laboratory Reference: | 1575206 | Depth Top [m]: | 13.50 |
| Hole No.: | BH03 | Depth Base [m]: | 13.95 |
| Sample Reference: | Not Given | Sample Type: | U |
| Sample Description: | Dark brown CLAY | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Test Number | 1 | | Rate of Strain | 2.00 | %/min | |
| Length | 198.38 | mm | Cell Pressure | 270 | kPa | |
| Diameter | 104.21 | mm | Axial Strain at failure | 9.0 | % | |
| Bulk Density | 1.97 | Mg/m3 | Deviator Stress, ( σ1 - σ3 )f | 281 | kPa | |
| Moisture Content | 28 | % | Undrained Shear Strength, cu | 140 | kPa | ½( σ1 - σ3 )f |
| Dry Density | 1.55 | Mg/m3 | Mode of Failure | Brittle | | |
| Membrane Correction | 0.44 | kPa | Membrane thickness | 0.22 | mm | |

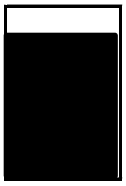
**Deviator Stress v Axial Strain**




**Mohr Circles**




Position within sample



Note: Deviator stress corrected for area change and membrane effects. Mohr circles and their interpretation is not covered by BS1377. This is provided for information only.

Remarks:



**Signed:**

Aleksandra Jurochnik
PL Technical Reviewer
**for and on behalf of i2 Analytical Ltd**



**Date Reported:** 10/08/2020

**GF 184.11**

# TEST CERTIFICATE

**Unconsolidated Undrained**

**Triaxial Compression**

Tested in Accordance with:
BS 1377-7: 1990: Clause 8

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

UKAS TESTING 4041

Environmental Science

| | | | |
|---|---|---|---|
| Client: | Card Geotechnics Ltd | Client Reference: | CG-38293A |
| Client Address: | 4 Godalming Business Centre, Woolsack Way, Godalming, Surrey, GU7 1XW | Job Number: | 20-21719 |
| | | Date Sampled: | Not Given |
| | | Date Received: | 21/07/2020 |
| Contact: | Ric Wilkinson | Date Tested: | 08/08/2020 |
| Site Address: | 156 West End Lane, West Hampstead | Sampled By: | Not Given |

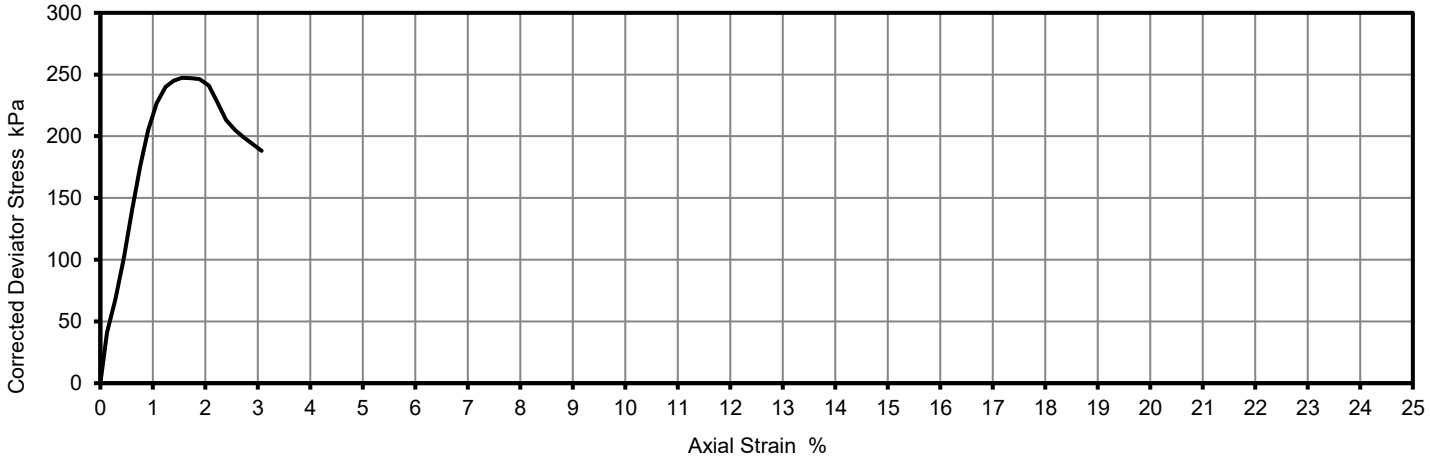
*Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland*

**Test Results:**

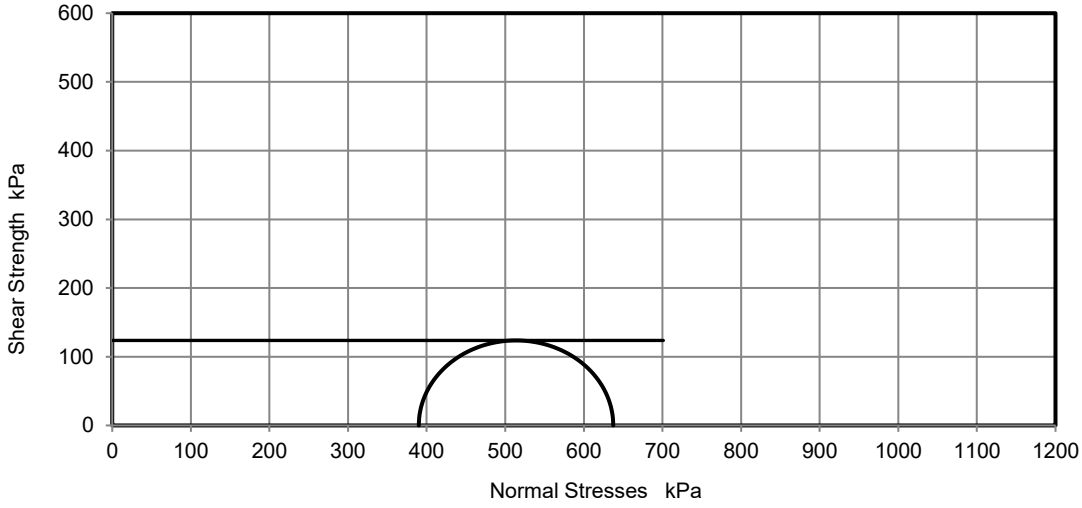
| | | | |
|---|---|---|---|
| Laboratory Reference: | 1575208 | Depth Top [m]: | 19.50 |
| Hole No.: | BH03 | Depth Base [m]: | 19.90 |
| Sample Reference: | Not Given | Sample Type: | U |
| Sample Description: | Dark brown CLAY | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Test Number | 1 | | Rate of Strain | 2.00 | %/min | |
| Length | 197.87 | mm | Cell Pressure | 390 | kPa | |
| Diameter | 102.82 | mm | Axial Strain at failure | 1.6 | % | |
| Bulk Density | 1.98 | Mg/m3 | Deviator Stress, ( σ1 - σ3 )f | 247 | kPa | |
| Moisture Content | 26 | % | Undrained Shear Strength, cu | 124 | kPa | ½( σ1 - σ3 )f |
| Dry Density | 1.57 | Mg/m3 | Mode of Failure | Brittle | | |
| Membrane Correction | 0.09 | kPa | Membrane thickness | 0.21 | mm | |

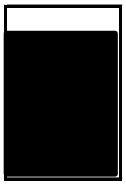
**Deviator Stress v Axial Strain**




**Mohr Circles**




Position within sample



Note: Deviator stress corrected for area change and membrane effects. Mohr circles and their interpretation is not covered by BS1377. This is provided for information only.

Remarks:



**Signed:**

Aleksandra Jurochnik
PL Technical Reviewer
**for and on behalf of i2 Analytical Ltd**



**Date Reported:** 10/08/2020

**GF 184.11**

# APPENDIX I

*Contamination Assessment Tables*

## ASSESSMENT CRITERIA

The table below sets out CGL's rationale for generic assessment criteria (GAC) adoption in order to evaluate risks posed to potential receptors at 156 West End Lane from identified chemical contamination. Potential receptors have been identified with reference to the Part IIA regime and associated DEFRA guidance. As with the Part IIA regime, under the planning regime all receptors (humans, controlled waters, ecology, crops/livestock and buildings) have been considered if there is the potential for them to be adversely affected by exposure to contamination.

***Rationale for Assessment Criteria Adoption***

| Source / Media | CGL's Approach & Rationale |
|---|---|
| *Risks to Human Health (long-term chronic risks)* | |
| Soil contaminants | • Laboratory test results have been compared against Generic Assessment Criteria (GACs) derived in-house by CGL using the Contaminated Land Exposure Assessment (CLEA) model and version 1.071 of the CLEA software. Where Soil Guideline Values (SGVs) have been published previously by the Environment Agency, the CGL GACs have updated these based on current exposure parameters (e.g. updated inhalation rates).<br>• The GACs have been generated assuming a silty gravelly sand type soil and a Soil Organic Material of 1.0% for the Made Ground (measured 0.4-4.9%).<br>• In the event impacts are identified on a site above the GAC level for arsenic, cadmium, chromium VI, benzene or benzo(a)pyrene, the results have been compared to the applicable Category 4 Screening Level (C4SL) published by DEFRA to further assess risks.<br>• The exception to the above relates to lead. The SGV for lead has been withdrawn and the C4SL for lead is used by CGL directly as a first tier of assessment.<br>• The CGL GACs represent conservative screening criteria (set at acceptable or minimal risk) and have generally been calculated using the default parameters for the standard land use scenarios set out in the CLEA technical report and toxicological inputs in line with the requirements of Science Report SC050021/SR2 and, in the case of petroleum hydrocarbons, Science Report P5-080/TR3.<br>• Where a CGL GAC has not been derived alternative assessment criteria will be sourced from current commercially-available sources (including international standards where no suitable UK assessment criteria exists).<br>• Concentrations of cyanide above the laboratory reporting limit are assessed against a Soil Screening Value (SSV) developed by Atkins. Atkins have based this assessment criteria on acute exposure to a 0 to 6 year old child.<br>• Where the dataset is of appropriate size, assessment against the applicable GAC or C4SL is carried out at the 95$^{th}$ percentile of the sample mean (designated $US_{95}$), which is considered to represent a reasonable worst-case scenario. 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.<br>• It is noted that the British Geological Survey 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.<br>• At this time an authoritative GAC is not available for asbestos fibres in soil. A positive identification of asbestos fibres in a soil sample by the laboratory is considered sufficient to warrant additional assessment of risks. Laboratory identification and quantification by microscopy may be required subject to source of material. |
| Dissolved contaminants | • Concentrations of organic constituents detected above the laboratory reporting limit in shallow groundwater or perched water have been assessed against groundwater vapour generic assessment criteria ($GAC_{gwvap}$) developed by the Society of Brownfield Remediation Risk Assessment (SoBRA). These assess chronic risks to human health via the indoor and outdoor air inhalation pathway only. The values assume a sand soil type, a soil organic matter of 1% and a depth below ground level of 650mm. |

| Source / Media | CGL's Approach & Rationale |
|---|---|
| Ground gas | • Concentrations and flow rates of carbon dioxide and methane in ground gas are converted to Gas Screening Values (GSVs) in accordance with CIRIA (2007). Potential risks associated with gas chemistry are evaluated in accordance with guidance presented in CIRIA (2007), NHBC (2007), BSI (2007). |
| Radon | • Risks from the radon content of soil gas are evaluated in accordance with BRE (2011). |
| *Risks to Controlled Waters* | |
| Soil contaminants | • Results from any eluted liquids have been directly compared to Environmental Quality Standards (EQS) and Drinking Water Values (DWV) as an initial screen of water quality. These are considered to be conservative screening criteria. |
| Dissolved contaminants | • Results have been directly compared to Environmental Quality Standards (EQS) and Drinking Water Values (DWV) as an initial screen of water quality. These are considered to be conservative screening criteria. |
| | |
| *Risks to Buildings & Structures* | |
| Water supply pipes | • The evaluation of water supply pipe requirements at the site has been undertaken in general accordance with guidance and criteria produced by the UK Water Industry (2011). |
| Sulfate & pH conditions | • The evaluation of risks to buried concrete has followed the guidance and criteria produced by BRE (2005). |
| | |
| *Risks to Vegetation & Plants* | |
| Soil contaminants | • Risks to plant growth (i.e. phytotoxicity) have been assessed for specific contaminants where the limits for phytotoxic effect proposed (e.g. by BS 3882) are significantly lower than the health GAC. |

**Job Number:**
**Job Reference:**

| Table I2. Data assessment summary - potential soil risks to human health | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Land Use Category:** | | **Residential with homegrown produce consumption** | | | | | **SOM:** | 1.00% |
| **Stratum:** | | **[MADE GROUND]** | | | | | **No. Samples** | 8 |
| **Determinand** | **GAC** mg/kg | **SSL** mg/kg (See Note A) | **Min recorded (mg/kg)** | **Max recorded (mg/kg)** | **No. Samples exceeding GAC** | **No. Samples exceeding SSL** | **$US_{95}$ (mg/kg)** | **$US_{95}$ > GAC** |
| Arsenic | 28 | - | 11 | 23 | 0 | 0 | 23.42 | OK |
| Beryllium | 1.72 | - | 0.65 | 1.2 | 0 | 0 | 1.18 | OK |
| Boron | 290 | - | 1.2 | 5.5 | 0 | 0 | 4.29 | OK |
| Cadmium | 11 | - | < 0.2 | 0.2 | 0 | 0 | 0.17 | OK |
| Chromium (III) | 886 | - | 24 | 180 | 0 | 0 | 133.28 | OK |
| Chromium (VI) | 2.93 | - | < 1.2 | < 1.2 | 0 | 0 | 0.60 | OK |
| Copper | 4220 | - | 12 | 48 | 0 | 0 | 29.26 | OK |
| Lead (note E) | 200 | - | 14 | 290 | 2 | 0 | 260.46 | EXCEED |
| Mercury | 43.3 | - | < 0.3 | 0.9 | 0 | 0 | 0.65 | OK |
| Nickel | 182 | - | 17 | 87 | 0 | 0 | 69.60 | OK |
| Selenium | 350 | - | < 1 | < 1 | 0 | 0 | 0.50 | OK |
| Vanadium | 320 | - | 31 | 74 | 0 | 0 | 59.29 | OK |
| Zinc | 4590 | - | 46 | 120 | 0 | 0 | 88.34 | OK |
| Benzene | 0.09 | - | < 0.001 | < 0.001 | 0 | 0 | 0.00 | OK |
| Toluene | 129 | - | < 0.001 | < 0.001 | 0 | 0 | 0.00 | OK |
| Ethyl benzene | 77 | - | < 0.001 | < 0.001 | 0 | 0 | 0.00 | OK |
| m-Xylene | 63.1 | - | < 0.001 | < 0.001 | 0 | 0 | 0.00 | OK |
| o-Xylene | 64.3 | - | < 0.001 | < 0.001 | 0 | 0 | 0.00 | OK |
| p-Xylene | 60.3 | - | < 0.001 | < 0.001 | 0 | 0 | 0.00 | OK |
| Total Phenols (note C) | 257 | - | < 1 | < 1 | 0 | 0 | 0.50 | OK |
| Total Cyanide (note D) | 34 | - | < 1 | < 1 | 0 | 0 | 0.50 | OK |
| Aliphatic EC5-6 | 39.6 | - | < 0.001 | < 0.001 | 0 | 0 | 0.00 | OK |
| Aliphatic EC6-8 | 84.9 | - | < 0.001 | < 0.001 | 0 | 0 | 0.00 | OK |
| Aliphatic EC8-10 | 18.7 | - | < 0.001 | < 0.001 | 0 | 0 | 0.00 | OK |
| Aliphatic EC10-12 | 93.2 | 50.2 | < 1 | 1.2 | 0 | 0 | 0.97 | OK |
| Aliphatic EC12-16 | 795 | 22.2 | < 2 | 24 | 0 | 1 | 16.41 | OK |
| Aliphatic EC16-35 | 128000 | - | < 16 | 84 | 0 | 0 | 58.92 | OK |
| Aromatic EC5-7 | 0.0528 | - | < 0.001 | < 0.001 | 0 | 0 | 0.00 | OK |
| Aromatic EC7-8 | 129 | - | < 0.001 | < 0.001 | 0 | 0 | 0.00 | OK |
| Aromatic EC8-10 | 25.1 | - | < 0.001 | < 0.001 | 0 | 0 | 0.00 | OK |
| Aromatic EC10-12 | 68.3 | - | < 1 | < 1 | 0 | 0 | 0.50 | OK |
| Aromatic EC12-16 | 137 | - | < 2 | 13 | 0 | 0 | 10.82 | OK |
| Aromatic EC16-21 | 291 | - | < 10 | 26 | 0 | 0 | 17.15 | OK |
| Aromatic EC21-35 | 1120 | - | < 10 | 44 | 0 | 0 | 40.22 | OK |
| Naphthalene | 2.32 | - | < 0.05 | < 0.05 | 0 | 0 | 0.03 | OK |
| Acenaphthylene | 169 | - | < 0.05 | < 0.05 | 0 | 0 | 0.03 | OK |
| Acenaphthene | 206 | - | < 0.05 | 0.25 | 0 | 0 | 0.18 | OK |
| Fluorene | 165 | - | < 0.05 | < 0.05 | 0 | 0 | 0.03 | OK |
| Phenanthrene | 95.8 | - | < 0.05 | 2.1 | 0 | 0 | 1.91 | OK |
| Anthracene | 2330 | - | < 0.05 | 0.7 | 0 | 0 | 0.59 | OK |
| Fluoranthene | 283 | - | < 0.05 | 4.9 | 0 | 0 | 3.99 | OK |
| Pyrene | 616 | - | < 0.05 | 4.5 | 0 | 0 | 3.77 | OK |
| Benzo(a)Anthracene | 7.79 | - | < 0.05 | 3 | 0 | 0 | 2.58 | OK |
| Chrysene | 14.9 | - | < 0.05 | 2.3 | 0 | 0 | 1.97 | OK |
| Benzo(b)fluoranthene | 2.6 | - | < 0.05 | 2.1 | 0 | 0 | 2.17 | OK |
| Benzo(k)fluoranthene | 77.4 | - | < 0.05 | 1.9 | 0 | 0 | 1.96 | OK |
| Benzo(a)Pyrene | 2.23 | - | < 0.05 | 2.2 | 0 | 0 | 2.25 | EXCEED |
| Indeno(1,2,3,cd)pyrene | 27.4 | - | < 0.05 | 1.1 | 0 | 0 | 1.13 | OK |
| Dibenzo(a,h)anthracene | 0.254 | - | < 0.05 | 0.42 | 2 | 0 | 0.42 | EXCEED |
| Benzo(g,h,i)perylene | 316 | - | < 0.05 | 1.4 | 0 | 0 | 1.29 | OK |
| Asbestos in Soils | (Number of samples in which Asbestos detected) | | | | 0 | 0 | 0.00 | 0 |

A. SSL (Soil Saturation Limit) presented for contaminants where GAC exceeds the calculated saturation limit using CLEA. Where the SSL is exceeded, there is the potential for free product.

B. Concentrations for total xylenes should be compared against m-xylene for fresh spills and o-xylene for all other cases.

C. GAC relates to phenol ($C_6H_5OH$) only.

D. Cyanide GAC based on acute exposure of 0-6 year old child (Atkins value).

E. Published C4SL.

### *Data assessment summary – Potential Soil Risk to Vegetation and Plants*

| Determinant | Assessment Criteria (mg/kg) | Measured range (mg/kg) | $US_{95}$ (mg/kg) | $US_{95}$ > Assessment Criteria? (Y/N) #- outlier detected |
|---|---|---|---|---|
| Copper[1] | 135 | 12 to 48 | 29.26 | N |
| Zinc[1] | 200 | 46 to 120 | 88.34 | N# |
| Nickel[1] | 75 | 17 to 87 | 50.11 | N# |
| Boron (water soluble)[2] | 5 | 1.2 to 5.5 | 4.29 | N# |

[1] BSI, (2015). *Specification for topsoil and requirements for use. BS 3882:2015*. Values taken for pH 6-7

[2] Limit for phytotoxic effect. Nable, Banuelos and Paul, (1997). *Boron Toxicity*. Plant and Soil, Volume 193, pp 181-198