



Bartlett Arboretum

White House Lane, Reading



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PROJECT INFORMATION

Project Information

Client Bartlett Tree Experts

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EXECUTIVE SUMMARY

Site Information	
Client	Bartlett Tree Experts
Project	Bartlett Arboretum
OS Co-ordinates	SU 709 657
Site Size	The site is approximately triangular in shape, measuring up to approximately 440x310m in size, covering an area of approximately 9.0 hectares.
Proposals	The site development proposals are understood to comprise a new Arboretum, predominantly comprising re-landscaping of the site with the creation of a small number of new research and maintenance buildings, a new road and car parking area, and a number of pedestrian footpaths leading around the site. Surface water features are proposed in the eastern areas of the site.
Site Description	The site comprises a large, grassed field over the majority of the site, with a wooded area over the north-western corner. The track served several levelled areas amongst the trees, that were associated with former use as a scaffold yard. A two-storey farmhouse is located northern end of the site, with several sheds and workshops surrounding it. The site is bounded to the north by White House Lane, beyond which over the western half is an agricultural machinery sales and service yard, and over the eastern half, a new housing estate. The wider area comprises agricultural fields. The site topographic levels drop from an elevation of around 69.9m above Ordnance Datum (AOD) in the northwest wooded corner down to 63m AOD in the northeast corner, resulting in an elevation change of around 6m over a distance of 330m.
Historic Site Uses	The majority of the site comprised an open green field for the duration of the mapped period, since 1872, with the north western corner of the site as rough pasture, expanding into a larger wooded area in the early 1900's. Ditches and ponds were shown in this area, infilled by the late 1960s, also corresponding to the construction of White House Farm in the north and numerous shed and smaller out buildings surrounding it, and buildings and tracks within the wooded area. Recent google aerial imagery, since 1999, suggests the field has been used for event car parking, and sporting/ fate events. It is understood that the wooded area contained a scaffolding yard in the 2000s and several temporary containers and cabins. In the wider surroundings a clay pit and brickworks were shown directly across the road to the northwest, up until the 1910s, infilled by the early 1970s. A gravel pit was noted approximately 150m south of the site but is no longer referenced following the mid 1900's. The surrounding area has remained predominantly rural throughout historical mapping, with a number of farms and predominantly open fields, wooded areas and small villages. Development of the residential estate immediately north and northeast of the site was recorded sometime between 2017 and 2020.

Ground Conditions	
Geology	The BGS records indicate the site is underlain by the London Clay Formation, with overlying superficial River Terrace Deposits, over the western and central areas of site only (proven to extend across the entire of the site by GI). A small thickness of Made Ground was encountered within the wooded area associated with the creation of the track and storage areas.
Hydrogeology and Hydrology	<u>Hydrogeology</u> The superficial River Terrace Deposits beneath the site are classed as a Secondary (A) aquifer with medium groundwater vulnerability. The underlying London Clay Formation comprise an Unproductive Aquifer with no groundwater vulnerability and likely extremely poor permeability. Shallow perched groundwater was likely to be confined within the overlying superficial River Terrace Deposits, with low permeability London Clay Formation s underlying. There are no active licensed groundwater abstractions within 500m of the site and the site is not within a groundwater Source Protection Zone (SPZ). <u>Hydrology</u> The site sits on a catchment boundary, predominantly lying within the Loddon and Trib catchment with the sites western boundary within the Kennet and Trib catchment, therefore run-off will likely flow west on the western boundary and east from the eastern boundary, as well as the central areas of site following the surface topography, sloping east. Surface waters may pool along the eastern boundary within drainage ditches or within the wooded area in the northwest.
Ground Conditions Encountered	Ground Conditions were typically consistent across the site, with 0.30m of cohesive loamy topsoil. A profile of superficial River Terrace deposits was encountered beneath the site, to depths of between 1.80m – 4.00m, typically to around 2.5m mbgl, shallower in the east, and unproven in the west, this material typically comprised stiff orange brown gravelly clays, (very) dense sands and occasionally (very) dense gravels (BH1). Gravels were fine to coarse angular to subangular flints. Beneath the River Terrace Deposits the London Clay formation was encountered, typically as firm to stiff brown and grey clay, which becomes greyer and stiffer with depth. Groundwater was not encountered during the GI itself but was encountered in the following monitoring program between 1.25-1.50m mbgl within cohesive and granular River Terrace Deposits. These water levels sit between 1.40-2.75m above the boundary with the underlying London Clay Formation. Levels were recorded between 67.68m AOD and 68.12m AOD.
Radon and Ground Gas	The site is not in a Radon Affected Area (less than 1% of homes are estimated to be at or above the action level) and therefore no radon protection measures are required.

	Gas monitoring results indicate a Characteristic Situation 1 for both Methane and Carbon Dioxide, which is classified as Very Low Risk.
Geo-environmental Assessment	
Contamination Assessment	Soil samples were tested against the general assessment criteria for "Public Open Space - Park" land uses using C4SL and S4UL. No exceedances were detected within the soils tested against the Generic Assessment Criteria values adopted for any contaminant. No asbestos was identified in the single Made Ground sample collected and tested. A Hazwaste assessment was carried out on all samples, all of which were identified as non-hazardous with respect to off-site disposal purposes.
Contamination Risk Classification	Low risk.
Outline Mitigation Strategy	No specific mitigation measures are required in terms of protection of human health from site soils, or in terms of risks to controlled waters. Standard task specific PPE and good hygiene practices should be adopted by site groundworkers. A watching brief should be maintained during groundworks for unexpected or unknown contamination if the development includes excavation work within the northwestern wooded area where Made Ground may be more extensive.
Geotechnical Assessment	
Foundations and Floor Slabs	Building proposals are known to be isolated to the central area of site, around the location of exploratory holes WS1 and BH1, where superficial deposits extended to depths of between 2.90m and 4.00m bgl respectively. Traditional shallow foundations should be suitable for the site, and where ground conditions are cohesive (WS1) should extend to depths of at least 0.90m bgl into the cohesive strata, where an allowable bearing pressure of 100kPa should be available. Where granular (BH1, WS2, WS3), the foundations should extend into the dense sands and gravels (between 0.45-0.70m bgl), where an allowable bearing pressure of 125kPa should be available. NHBC standards require consideration when founding in cohesive materials. It is understood that screw piles are being considered for the proposed buildings, these may also be appropriate providing approval by a specialist pile designer. Given the site is underlain by cohesive deposits of medium volume change potential, with numerous future plantations proposed, as well as the likely piled foundation approach for the site, a suspended floor slab is recommended for any proposed buildings.
Excavations	Trial pits were carried out as part of the GI and are anticipated to be stable and achievable using a standard mechanical plant, however, very dense sands and gravels

	were encountered and excavations may require or benefit from use of larger machinery. Significant excavation works is likely to be limited to proposed building areas, with the majority of site proposed for shallow excavations associated with soft landscaping alterations. Although more significant excavations are expected in the east where attenuation ponds are proposed. Temporary excavations within the granular material encountered over the central and western part of the site should be stable in the short term at angles of no greater than 1V:2H (26°), where cohesive deposits are encountered then the batter angles can be at 1V:1.5H (33°). Groundwater was not encountered during the investigation, but levels were monitored to lie between 1.25m and 1.50m below existing site levels (centrally), which may be shallower in the winter months. Any groundwater inflow will need to be controlled by traditional de-watering techniques in accordance with guidance, which may result in the need for discharge consents. Where excavations are required to remain open for medium to long periods and extend beyond the groundwater level within the granular deposits, then shoring may be required.
Earthworks	The proposed levels have not been determined at this stage of the project, but significant level changes are not anticipated, and any cut and fill activities will likely be limited to general platform levelling, with the exception of the proposed attenuation basin in the east of the site. Here cohesive superficial deposits are present to depths of around 2.0m and based on the laboratory PSD tests, these soils can be classified as either a Class 2A (wet cohesive or Class 2B (dry cohesive) when used as a general fill. Compaction testing carried out (on cohesive material) indicates an OMC of 12%, compared to an average moisture content of around 20%. As such, the cohesive superficial deposits will need to undergo moisture treatment to bring the natural moisture content down in line with the OMC.
Buried Concrete Classification	• Made Ground – DS-1 AC-1; • Superficial Deposits – DS1 AC-1; • London Clay Formation – DS-1 AC-1s
Pavement Design	Assuming stripping of the topsoil and any made ground, based on the obtained CBR results and where granular a performance approach can be adopted for the site with a preliminary design CBR value of 10% to be achieved, and where cohesive, a design equilibrium CBR of 3% can be assumed with a restricted design approach. Where localised soft spots are encountered with a CBR value of less than 2%, improvement works are likely to be required.
Geotechnical Risk Category	• Geotechnical Category 1 – Conventional Structures.

1 Introduction

1.1 Commission

Bartlett Tree Experts are proposing the development of a new arboretum with research focus, on a plot of land adjacent to White House Lane, between Spencers Wood and Beech Hill near Reading. To assist with the development of the site proposals, Jubb Consulting Engineers (Jubb) have been appointed to undertake a geotechnical and geo-environmental assessment of the ground conditions for the proposed site use.

This report constitutes the Ground Conditions Assessment (GCA) for the proposed development and provides advice for the geotechnical and geo-environmental design of the development and associated ground contamination or geotechnical hazards.

This report is for the private and confidential use of Bartlett Tree Experts (to whom alone is owed a duty of care) and their professional advisors and consultees; it may not be relied upon or reproduced by any third party for any use without the written agreement of Jubb.

1.2 Objectives

The objectives of this assessment are:

- to assess the geo-environmental ground conditions at the site with due regard to any previous investigation, remediation and validation works undertaken as part of the site enabling works. If necessary, to provide outline recommendations for risk mitigation based on the findings;
- to analyse the intrusive ground investigation results to determine ground conditions, obtain representative values for geotechnical analysis, and identify any geotechnical issues which may affect the proposed development; and
- to make an evaluation of any potential environmental or geotechnical hazards, risks and liabilities to the planned development of the site on the basis of the foregoing studies, and to provide engineering and environmental recommendations for the site, in view of the potential development of the site.

1.3 Scope, Sources & Limitations

A Phase 1 Geo-environmental desktop study was completed by Jubb in May 2023, and has been referenced in the production of this report, as detailed in Section 3.0 of this report.

A ground investigation (GI) was completed by Geo Environmental Group (GEG) in July 2023, to support and supplement the initial assessment of the site, see Section 5.0 for more details.

This report has been carried out in accordance with the following UK legislation and regulatory guidance for site investigations:

Table 1. List of Standard References

Standard Reference	Title	Publisher	Date
BRE SD 1:2005	Concrete in aggressive ground	BRE	2005
BS 10175:2011+A2:2017	Investigation of potentially contaminated sites. Code of practice. Code of practice	BSI	2017
CLR 11:2004	Model procedures for the management of land contamination - contaminated land report	EA	2004
BS EN 1997-1:2004+A1:2013	Eurocode 7. Geotechnical design. General rules	BSI	2013
NA+A1:2014 to BS EN 1997-1:2004+A1:2013	UK National Annex to Eurocode 7. Geotechnical design. General rules	BSI	2014
CIRIA C665:2007	Assessing risks posed by hazardous ground gases to buildings	CIRIA	2007
BS 8485:2015+A1:2019	Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings.	BSI	2019

Standard Reference	Title	Publisher	Date
CIRIA C515:2000	Groundwater Control - Design and practice	CIRIA	2000
BRE 211:2015	Radon: Guidance on protective measures for new buildings and in conjunction with BGS updated radon mapping (Dec 2022).	BRE	2015
BS EN ISO 22475-1:2006	Geotechnical investigation and testing. Sampling methods and groundwater measurements. Technical principles for execution	BSI	2006
BS 1377-1:2016	Methods of test for soils for civil engineering purposes. General requirements and sample preparation	BSI	2016
BS 1377-3:2018	Methods of test for soils for civil engineering purposes. Chemical and electro-chemical testing	BSI	2018
BS 1377-4:1990	Methods of test for soils for civil engineering purposes. Compaction-related tests	BSI	1990
BS 5930:2015	Code of practice for ground investigations.	BSI	2015
BS EN ISO 14688-1:2018	Geotechnical investigation and testing. Identification and classification of soil. Identification and description	BSI	2018
BS EN ISO 14688-2:2018	Geotechnical investigation and testing. Identification and classification of soil. Principles for a classification	BSI	2018
BS EN 1997-2:2007	Eurocode 7. Geotechnical design. Ground investigation and testing	BSI	2007
NA to BS EN 1997-2:2007	UK National Annex to Eurocode 7. Geotechnical design. Ground investigation and testing	BSI	2007
BS EN ISO 17892-1:2014	Geotechnical investigation and testing. Laboratory testing of soil. Determination of water content	BSI	2014
BS EN ISO 17892-2:2014	Geotechnical investigation and testing. Laboratory testing of soil. Determination of bulk density	BSI	2014
BS EN ISO 17892-3:2015	Geotechnical investigation and testing. Laboratory testing of soil. Determination of particle density	BSI	2015
BS EN ISO 17892-4:2016	Geotechnical investigation and testing. Laboratory testing of soil. Determination of particle size distribution	BSI	2016
BS EN ISO 17892-8:2018	Geotechnical investigation and testing. Laboratory testing of soil. Unconsolidated undrained triaxial test	BSI	2018
BS EN ISO 17892-12:2018	Geotechnical investigation and testing. Laboratory testing of soil. Determination of liquid and plastic limits	BSI	2018
BS EN ISO 18674-1:2015	Geotechnical investigation and testing. Geotechnical monitoring by field instrumentation. General rules	BSI	2015

It should be noted that any ground investigation provides only a small sampling of any site and that ground conditions may differ both laterally (across the site) and vertically (with depth) between sample points. Such differing conditions may thus remain undetected by fieldwork. Certain areas may not have been accessible to intrusive survey due to vegetation, live services or other obstructions.

2 Site Setting

2.1 Site Location

The site is located approximately 3km south of Reading, between Spencers Wood and Beech Hill, 300m to the east of the A33, and approximately 2.8km south of junction 11 of the M4. The site comprises Whitehouse Farm and the land immediately to the south. The outline of the site is depicted in Figure 1 below.

Figure 1: Approximate Site Extents & Site Location Plan



The Ordnance Survey National Grid Reference at the centre of the site is SU709657.

A site location plan and aerial photograph are reproduced in **Appendix A**.

2.2 Site Description

The site is approximately 440m in length by 310m in width along its longest axis and covers an area of approximately 9.0 hectares. The site topographic levels drop from an elevation of around 69.9m above Ordnance Datum (AOD) in the northwest wooded corner down to 63m AOD in the northeast corner, resulting in an elevation change of around 6m over a distance of 330m. The entire site typically slopes steadily to the east at a similar gradient as found on the northern boundary, with the exception of the southern part of the western boundary, where levels begin to start to fall westwards.

The site comprises a large, grassed field over the majority of the site, with a 165m by 80m wooded area over the north-western corner, which contains a track that enters from a gateway off Yew Tree Lane, which runs beyond the western boundary. The track served several levelled areas amongst the trees, that were associated with its former use as a scaffold yard. Some areas of ponded water are noted within this wooded area.

The site is bounded to the north by White House Lane, beyond which over the western half is an agricultural machinery sales and service yard, and over the eastern half, a new housing estate. The wider area comprises agricultural fields.

2.3 Site Proposals

The site is proposed to be developed for use as a new arboretum with research focus.

The development comprises various arboretum zones (meadows, tree planting and water bodies), as well as research trial areas and polytunnels. Proposed buildings include research laboratories and maintenance buildings, with the retention of the existing farmhouse building over the northern area, vehicle access with car parking in the western area and the development of a number of attenuation ponds in the north-eastern areas.

A site proposal plan is included in **Appendix B**.

3 Summary of Desk Study Information

The following information offers a summary of the desk study information provided by our Phase 1 Desktop Study Report (Report Ref: 23192-JCE-XX-XX-RP-GE-001-P1).

3.1 Geology and Ground Conditions

The BGS 1:50,000 Solid and Drift Mapping of Reading, Sheet 268, the 1:10,000 Geology Series (Sheet SU76NW) and the online BGS Geology of Britain Viewer, shows the site to be underlain by the London Clay Formation bedrock with superficial River Terrace Deposits (Fifth Terrace) overlying the central and western areas of site. A small area of infilled ground is noted within the wooded area.

The outline of where the River Terrace Deposits is shown underlie is shown within Figure 2 below.

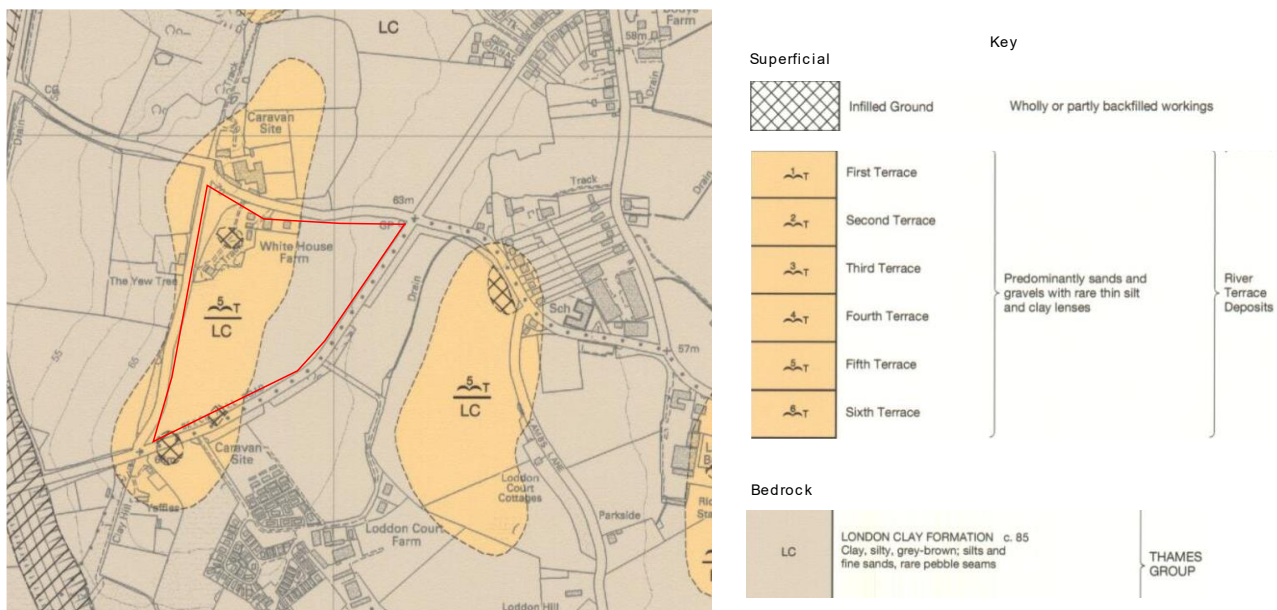


Figure 2: Extract of the BGS 1:10,000 Series

The River Terrace Deposits are noted to typically comprise sand and gravel, locally with lenses of silt, clay or peat, the Fifth Terrace typically comprise flint-rich gravels up to 5 m thick, thicknesses of which will likely thin towards the edges of the deposit.

The London Clay Formation is noted to mainly comprises poorly laminated, blue-grey or grey-brown, slightly calcareous, silty to very silty clay/clayey silt, with some layers of sandy clay. The London Clay is also known to contain carbonate concretions (cement-stone nodules) and disseminated pyrite, thin beds of shells and fine sand partings or pockets of sand.

3.2 Hydrogeology

The superficial River Terrace Deposits beneath the site are classed as a Secondary (A) aquifer with medium groundwater vulnerability, whereas the solid geology London Clay is designated as an unproductive aquifer with no groundwater vulnerability based on the Environment Agency's interactive aquifer designation map.

The areas underlain by the superficial River Terrace Deposits are shown to be within an area indicated to be at risk from limited potential of groundwater flooding.

Shallow perched groundwater is likely to be contained within the overlying superficial River Terrace Deposits, with the underlying low permeability London Clay preventing vertical migration of the groundwater. Recharge to the River Terrace Deposits would be expected to take place locally from rainfall and surface water runoff, predominantly generated onsite due to the sites positioning on a (slight) topographical high between catchment

boundaries. The direction in which any perched water will flow within the river terrace deposits is dependent on the profile of the top of the London Clay, but based on the ponds and standing water is likely to be to the west.

There are no active licensed groundwater abstractions within 500m of the site.

The site was not within a groundwater Source Protection Zone (SPZ).

3.3 Hydrology

Surface water features in the vicinity of the site included Foudry Brook 350m to the west which flows northwards, and tributary streams of the River Loddon 100m to the east and 300m to the southeast, which flow eastwards into the Loddon which is located 1km to the east/ southeast and flows northeast.

Surface water run-off from the majority of the site is likely to flow east following the gradient of the sites topography, the exception being along the western boundary where it is likely to fall westwards. Run-off along this area may feed drainage ditches along the western boundary and flow west towards Foudry Brook. Both the Foudry Brook and the River Loddon ultimately flow in the River Thames just north of Reading.

Environment Agency mapping shows a low risk of surface water flooding associated with areas along the eastern boundary. Several small, isolated areas of medium and high surface water flood risk is recorded within the wooded area in the north-western area of the site and relate to the surface depressions and ponded water areas.

There are no surface water abstractions recorded within 500m of the site.

3.4 Radon Risks

The site is not in a Radon Affected Area (less than 1% of homes are estimated to be at or above the action level) and therefore no radon protection measures are required.

3.5 Unexploded Ordinance (UXO) Risk

A non-specialist UXO screening exercise has been undertaken from review of readily available bomb risk maps, historical and geological maps. These sources suggest a low bomb risk, and indicated no further assessment was required.

3.6 Site History

The site history was assessed by a study of historic Ordnance Survey Maps dating back to 1872, and indicated the majority of the site comprised an open green field for the duration of the mapped period, with the north western corner of the site as rough pasture, expanding into a larger wooded area in the early 1900's. Ditches and ponds were shown in this area, infilled by the late 1960s, corresponding to the construction of White House Farm and numerous shed and smaller out buildings surrounding it, and buildings and tracks within the wooded area.

In the wider surroundings a clay pit and brickworks were shown directly across the road to the northwest, up until the 1910s, shown as infilled by the early 1970s. White House Farm was originally located just to the north of the site, but it was replaced by the agricultural sheds and workshops associated with its current land use, whilst White House Farm moved onto the subject site. A gravel pit was noted approximately 150m south of the site but is no longer referenced following the mid 1900's.

The green field within the site (the majority of the total site area) has remained unchanged throughout the mapped period, and recent google aerial imagery (1999 – present), suggests it was used for event car parking, and sporting/ fate events.

Although not shown on the historical maps, it is known from the previous owner that the wooded area was used as a scaffolding yard in the 2000s and contained several temporary containers and cabins.

The surrounding area has remained predominantly rural throughout historical mapping, with a number of farms and predominantly open fields, wooded areas and small villages, the closest of which was Spencers Wood, approximately 1km to the northeast. Development of the residential estate immediately north and northeast of the site was recorded sometime between 2017 and 2020.

3.7 Preliminary Risk Assessment (Contamination)

The following section provides a Preliminary Risk Assessment (PRA) of contamination at the site and develops an initial Conceptual Site Model (CSM) to establish whether there are any potentially unacceptable risks associated with proposed development at the site.

The CSM provides a method to characterise potential site risks, by outlining potential sources of contamination, identifying potential receptors that may be impacted, and determining potential pathways by which sources may affect receptors.

A preliminary CSM has been derived from an assessment of the sites' environmental setting, site history, and review of previous reports.

The Risk Assessment Methodology and Definitions are set out in **Appendix C** to this report.

3.7.1 Potential Sources of Contamination

The potential contaminants described below were identified from a study of the site history. The principal contaminative sources are as follows:

On-site (locally in area of existing development)

- Made Ground, associated with historical construction activities and imported fill, possibly including elevated concentrations of metals, metalloids, asbestos fibres, Asbestos Containing Materials, PAH and petroleum hydrocarbons.
- Made Ground, potentially containing asbestos fibres and Asbestos Containing Materials from maintenance and repair of existing and dilapidated sheds, barns and other structures.

Off-site

- Quarry backfill, associated with the former clay pit located to the northwest of the site (within 50m) and the gravel pit to the south (150m), possibly including metals, metalloids, asbestos, PAH and petroleum hydrocarbons.
- Landfilled waste (quarry backfill) including household, commercial and industrial. Whilst the landfill cells were expected to be lined and capped, there is no evidence to confirm that this was undertaken, although the landfill site is predominantly recorded within the impermeable London Clay
- Ground gases (carbon dioxide and methane) and leachate from organic materials in the backfill to the former quarry, now filled, located 50m northwest.

Groundwater flow is not anticipated to flow towards the site as the presence of the River Terrace Deposits within the edge of the landfill is not expected due to the original quarry being associated with clay (London Clay).

No other potential off-site sources of contamination were identified.

3.7.2 Potential Receptors

The following potential receptors were identified, based on the proposed development of the site for Public Open Space (Park) purposes:

- People (site end users – staff and visitors).
- Development end use (buildings, utilities and landscaping).
- Groundwater: Secondary A aquifer status of the River Terrace Deposits.

- Surface water: overland flow to eastern boundary and off-site to ditches and streams further east.
- Surface water: proposed surface water features.
- Ecology: Proposed vegetation from end-use as an Arboretum, affecting plant life, specimens, and research.

3.7.3 Preliminary Conceptual Site Model (CSM)

The potential key contaminative substances, potential receptors and possible pathways as identified by the Jubb Phase 1 report are summarised in the table below, assuming a worst-case scenario.

The preliminary CSM will be used to target any further site investigation and will be developed and refined, based on the results of the site investigation.

Table 2: Summary of preliminary conceptual site model

Preliminary Conceptual Site Model						
Sources	Receptor	Pathway	Consequence	Probability	Risk	Comments
Made Ground, associated with historical construction activities and imported fill, possibly including elevated concentrations of metals, metalloids, asbestos fibres, Asbestos Containing Materials, PAH and petroleum hydrocarbons.	People Groundwater Surface water Ecology	Ingestion Inhalation Direct Contact Root uptake Leaching through unsaturated zone	Medium	Low likelihood	Low/Moderate (Locally) Low (majority of site)	Isolated to previously/ currently developed area in the north. Low risk to majority of site.
Hydrocarbon fuels from leakage and spillage of onsite	People Groundwater Surface water Ecology	Ingestion Direct Contact Root uptake Leaching through unsaturated zone	Mild	Low likelihood	Low (Very Low (majority of site))	Isolated areas in the north of the site, considered easy to investigate.
Asbestos within ground from former buildings, sheds and other structures demolished	People	Inhalation	Medium	Low likelihood	Low/Moderate Low (majority of site)	Numerous small shed/ barn/ container structures on site potentially containing asbestos containing materials. Low risk if remaining undisturbed. Low risk to majority of site.
Ground gases (carbon dioxide and methane) from backfilled clay pit/landfill.	Future Site Users;	Inhalation	Medium	Low likelihood	Low/Moderate risk	Low potential for ground gases from backfilled pits and quarries to the north

4 Ground Investigation Works

4.1 General

A ground investigation (GI) was undertaken by Geo Environmental Group (GEG) after being scoped by Jubb. The ground investigation comprised a combination of window sampling, trial pitting and a cable percussion borehole and were carried out on 19 July 2023.

The ground investigation comprised the following site activities;

- 5 no. dynamic samples (WS01 to WS05) to 5m depth bgl, with SPT testing at 1m intervals through-out and sampling at 0.5m depth intervals.
- 1 no. cable percussion borehole (BH01) drilled to 10m depth. The purpose of the drilling will be to assess the thickness of overlying gravels and to assess the strength of the underlying clay soils through regular SPT testing, collection of samples and also collect geotechnical data for pile design.
- 1 no. installation to 10m within the deeper borehole, and 3 no. installations to 5m within the window sample holes (shallower due to shallower refusals).
- 4 no. monitoring visits to record gas/groundwater levels.
- 5 no. trial pits across the site to provide general site coverage and to allow soakaway testing to be carried out.
- 3 no. soakaway tests in selected pits where attenuation basins and permeable paving is proposed and carried out to BRE 365 with 3 fillings where infiltration rates allow (not possible).
- 6 no. TRL DCPs at selected locations in order to provide correlated CBR results.

The exploratory hole locations were decided by Jubb, based on the outline of the development proposal, with holes being moved accordingly with regards to site constraints at the time of the siteworks. The hole locations are shown in the actual exploratory hole plan (Bartlett Arboretum, Actual Exploratory Hole Plan, Project No. 23192, Drawing No. GES02, Rev A, dated 6th August 2023) contained in **Appendix C**.

The exploratory holes were set out at locations provided by Jubb and adjusted where necessary to take account of site constraints.

The factual ground investigation works are detailed in the following report and included in **Appendix G**.

- Geo Environmental Group Factual Ground Investigation, Bartlett Arboretum, Reading. Report No. GEG-23-795/GI, dated August 2023.

4.1.1 Cable Percussive Boreholes

1 no. cable percussive borehole (BH1) was drilled to a depth of 10m below ground level (bgl), using a Dando 2000 cable percussive drilling rig.

The cable percussive borehole targeted deeper ground conditions and was more capable of penetrating dense ground or coarse gravels associated with the River Terrace Deposits.

Standard Penetration Testing (SPT) and undisturbed (U100) samples were carried out at 1.0/1.50m intervals throughout the run of the borehole with disturbed samples taken at regular intervals within the soils.

A groundwater and gas monitoring standpipe was installed within the borehole to 2.70m upon completion to allow for groundwater and gas monitoring, the borehole was backfilled and sealed with bentonite.

4.1.2 Window Samples

A total of 5 no. window samples (WS1 – WS5) were drilled to depths of between 1.25m and 4.45m bgl. Standard Penetration Tests (SPTs) were taken at regular intervals of 1.0m throughout each window sample to allow assessment of in-situ density or stiffness of the ground.

Disturbed samples were taken at regular intervals within all window samples to give a comprehensive record of strata encountered, with environmental samples being taken at select intervals within all window samples. Pocket penetrometer tests were undertaken within the cohesive deposits where ground conditions were suitable.

Groundwater and gas monitoring standpipes were installed to the base of selected boreholes, WS1 and WS4, on completion, to depths of 4.0m and 1.0m bgl respectively, to allow for groundwater and gas monitoring to be carried out. The remaining window sample locations were backfilled with arisings on completion and ground conditions reinstated to match pre-existing conditions as best as practically possible.

Window Samples WS2-WS4, were terminated early due to refusals within the shallow River Terrace Deposits, between 1.25m and 1.325m bgl, associated with very dense sands, ceasing further progression of the drilling rig.

4.1.3 Trial Pits

A total of 5 no. trial pits (TP1 – TP5) were excavated around the site to achieve maximum coverage, to depths of between 2.3m in TP5, and 2.8m in TP4. Excavations were completed using a 6 tonne tracked excavator.

Disturbed, bulk geotechnical and environmental soil samples were taken at regular intervals throughout the pits. After detailed examination, measurement and sampling, the excavations were backfilled with arisings and compacted in layers using the machines bucket to match pre-existing conditions as best as practically possible.

4.1.4 In-situ Testing

4.1.4.1 TRL Dynamic Cone Penetrometer (DCP) Tests

TLR Dynamic Cone Penetrometer (DCP) testing was carried out around the site in areas likely to be covered by pavement or hardstanding. A number of these TRLs were undertaken adjacent window sample locations, including TRL2 adjacent WS1, TRL3 adjacent WS3, and TRL4 adjacent WS4. The tests were performed to maximum depths of 1.17m bgl in order to obtain an equivalent California Bearing Ratio (CBR) value.

4.1.4.2 Soakaway Testing

Soakaway testing was carried out within trial pits TP1, TP2, and TP5, at depths of between 2.3mbgl and 2.4mbgl, with the base of the pits within the cohesive River Terrace Deposits. One filling of the pit was only achieved due to slow infiltration rates.

4.2 Exploration Sampling Strategy

Exploratory hole locations were positioned to provide sufficient coverage of the site as follows:

Table 3: Sampling Strategy

Exploratory Hole	Notes/Rational
BH1	Cable Percussive borehole strategically placed under proposed building locations in order to assess deeper ground conditions at depth and collect information on soil strengths.
WS1 – WS5	Window sample borehole were positioned for general site coverage and sampling of any made ground and shallow superficial deposits and to allow installation of groundwater and gas standpipes.
TP1 - TP5	Trial pits were positioned for general site coverage and to allow collection of bulk soil samples for laboratory testing, and to enable soakaway testing.
TRL1 - TRL6	TRL DCP, in-situ CBR testing positioned across the site to determine CBR values of shallow subsoils at founding depths to aid with pavement design.

4.3 Contamination Testing

The sampling strategy was based on obtaining sufficient samples from across the site. Relevant samples were submitted for a general 'greenfield' suite of testing, determinants as detailed below, with the exception of a single

sample from WS4 where made ground was encountered. These were scheduled immediately after the ground investigation campaign to avoid any laboratory holding time deviations.

Table 4: Contamination Suite

Suite	Determinants
Contamination Suite (Greenfield) - Soil	As, Cd, Cr(III), Cr(VI), Cu, Hg, Pb, Ni, Se, Zn, PAH's (PAH-16MS), Phenols, Organic Matter, Sulphate and sulphide.
Contamination Suite (Brownfield) - Soil	As, Cd, Cr(III), Cr(VI), Cu, Hg, Pb, Ni, Se, Zn, Asbestos screening, PAH's (PAH-16MS), total and speciated TPHs (C6-C40), Phenols, Organic Matter, and Asbestos (screening).

4.4 Geotechnical Testing

Geotechnical testing for the current phase of works was carried out by GSTL and Chemtest Environmental Limited in accordance with *BS1377: Methods of test for soils for civil engineering purposes*, as listed in the table below:

Table 5: Geotechnical Testing – GEOLABS Ltd

No. of Tests	Test	Test Method
Classification Tests		
11	Moisture Content tests	BS1377: Part 7.
8	Atterberg tests	BS1377: Part 2.
3	Particle Size Distribution tests (wet sieve)	BS1377: Part 2.
Compaction Testing		
2	Dry density / moisture content	BS1377: Part 4.
Soil Strength Testing		
2	Quick Undrained Triaxial	BS EN ISO 17892-8
Chemical Testing		
5	BRE Suite D	BRE Special Digest
3	pH & Sulphate (2:1) extract	BRE Special Digest

4.4.1 Contamination Testing

The geo-environmental testing was carried out by Eurofins Chemtest (UKAS and MCERTS accredited) on behalf of GEG. Sub-samples were taken from the exploratory holes and placed in appropriate environmental containers before being sent by courier to the laboratory in cool boxes. The number of soil samples tested are summarised in Table 6.

Table 6: Soil Contamination Testing

Exploratory Hole	Depth (mbgl)	Analysis Undertaken
TP01	0.10	Contamination Suite (Greenfield) - Soil
TP02	0.10	
TP04	0.50	
WS01	0.50	Organic matter, pH, sulphate (as SO ₄) - water soluble (2:1), sulphate (as SO ₄) - total sulphide.
WS02	0.10	
WS03	0.10	
		PAH - speciated (EPA 16).

WS05	0.10	Phenols - total (monohydric).
WS4	0.10	Contamination Suite (Brownfield) - Soil Arsenic, boron, cadmium, chromium, chromium - III, chromium, copper, lead, mercury, nickel, selenium, zinc, cyanide - total, cyanide - free. Organic matter, pH, sulphate (as SO₄) - water soluble (2:1), sulphate (as SO₄) – total sulphide. PAH - Speciated (EPA 16) INC Total. TPH band (C6 - C8), TPH band (C8 - C10), TPH band (C10 - C12), TPH band (C12 - C16), TPH band (C16 - C21), TPH band (C21 -C35), TPH band (C35 - C40), TPH Total (C6 - C40), phenols - total (monohydric). Asbestos

5 Ground Conditions

5.1 Ground Conditions Encountered

The ground conditions encountered during the ground investigation are summarised in the table below.

Table 7: Ground Conditions Summary

Description	Stratum	Encountered in	Average depth to top of stratum (m bgl)	Average depth to base of stratum (m bgl)	Average thickness (m)
Grass over: Firm friable brown (slightly) sandy (slightly) gravelly CLAY. Gravel is fine to coarse sub-angular and sub-rounded flint.	Topsoil	All Exploratory Locations, except WS4	0.00	0.30	0.30
Firm dark brown sandy gravelly CLAY. Gravel is fine to coarse sub-rounded and sub-angular flint and quartzite with rare brick fragments.	Made Ground	WS4	0.00	0.40	0.40
Firm orangish brown mottled grey slightly sandy (very) gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse flint. Occasional pockets of light brown silt. Occasional bands or lenses of flint gravel	River Terrace Deposits - Clay	BH1, WS1, and TP1-TP5	0.30	1.80-4.00*	1.50-3.70*
Dense light brown clayey very gravelly SAND. Gravel is fine to coarse sub-angular and sub-rounded flint.	River Terrace Deposits - Sand	WS1-WS5, TP4			
Medium dense to dense light or orange brown clayey sandy GRAVEL of fine to coarse subangular to subrounded flint.	River Terrace Deposits - Gravel	BH1, WS4, TP5 (Central) western area			
Stiff to very stiff brown and grey clay. Becoming greyer and stiffer with depth. Occasional presence of shell fragments.	London Clay Formation	All Exploratory Locations (except WS4)	1.80-4.00	Not proven	

Notes: * - Generally unproven within window sample boreholes

5.1.1 Made Ground/Topsoil

Made Ground was only encountered in WS4, down to a depth of 0.40m bgl and comprised firm dark brown sandy gravelly clay with gravel consisting of flint, quartzite and rare brick. The shallow made ground is likely present across parts of the wooded area, associated with the levelling of the site area to form a trackway and levelled storage areas.

Topsoil was encountered in all exploratory hole locations within the field, down to depths of between 0.20m and 0.40m bgl. The topsoil typically comprised firm friable brown sandy slightly gravelly clay. Gravel was fine to coarse sub-angular and sub-rounded flints.

Given the minimal thickness of Made Ground encountered, no laboratory testing was carried out within it.

5.2 River Terrace Deposits

Although only shown to be present in the west (geologic mapping), the GI encountered superficial River Terrace Deposit soils across the entirety of the site, albeit the granular deposits did correlate to the position of the deposits shown on the geological map.

The River Terrace Deposits were encountered in all exploratory locations, across the entirety of the site, directly below the topsoil (or Made Ground), from between 0.20-0.40m bgl, to depths of between (greater than) 1.25m and 4.00m bgl. The River Terrace Deposits comprised a combination of cohesive and granular material, either firm to stiff sandy variably gravelly clay and medium dense to very dense variably clayey very gravelly sand or slightly clayey sandy gravel. Gravel was present in all deposits as angular to subangular, fine to coarse flints. These soils were typically brown, grey and orangish brown.

The granular material was more present over the central and western parts of the site, with the cohesive components more over the eastern part of the site and under the granular deposits elsewhere. Window sample refusal occurred at shallow depths within the granular material indicating its dense nature.

5.2.1.1 Classification Testing

8 no. soil samples were taken from the Superficial Deposits for moisture content testing. The granular deposits recorded moisture contents of between 5.9% and 9.0% with an average of around 7%, whereas the cohesive deposits recorded values between 9.7% to 30% with an average of around 20%.

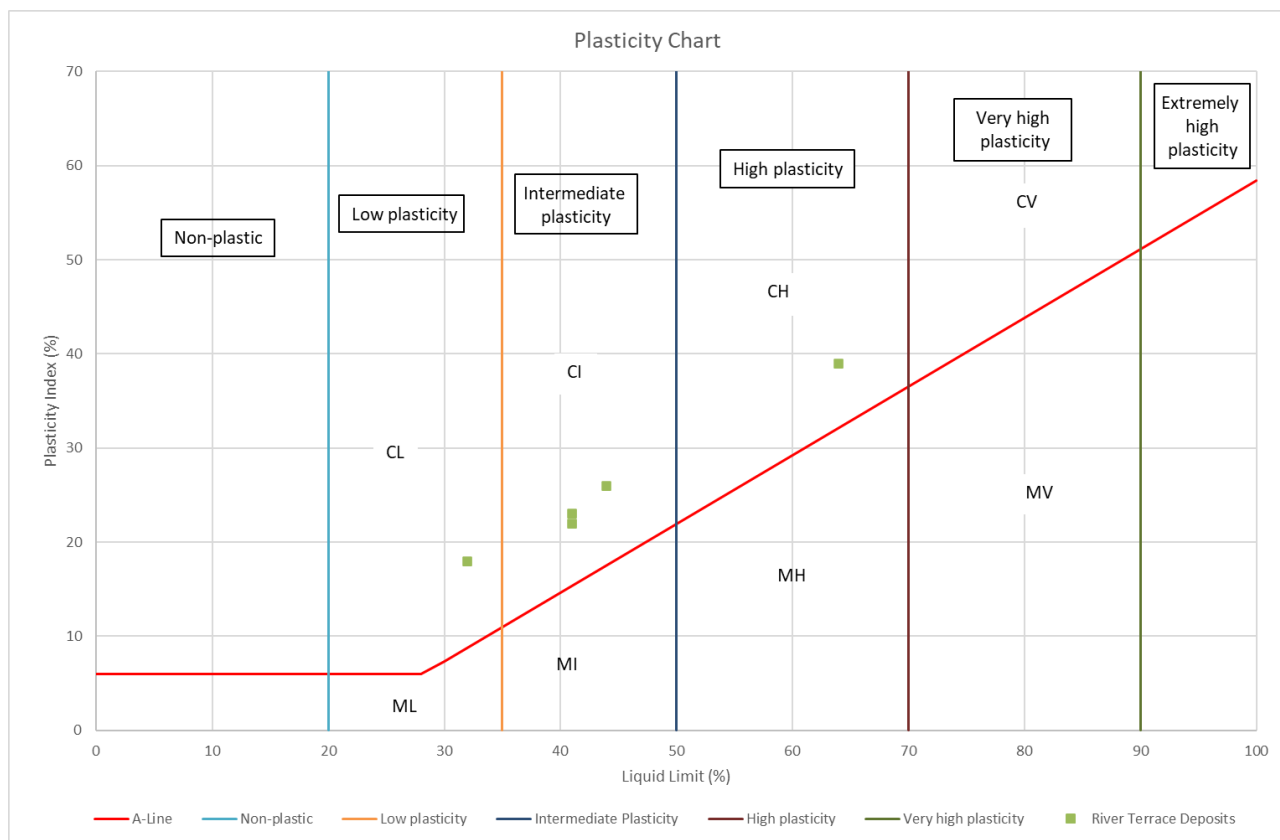
Atterberg testing was undertaken on 5 no. samples of the cohesive River Terrace Deposits, with plasticity index values between 18% and 39%, with an average of around 26%. The results are summarised in the table below.

Table 8. Summary of River Terrace Deposit Soils - Atterberg Testing

Summary Atterberg Testing Data: River Terrace Deposit Soils			
	Minimum	Maximum	Average
Natural Moisture Content	9.7	30	20
Liquid Limit	32	64	44
Plastic Limit	14	25	19
Plasticity Index	18	39	26

An A line plot of the results are shown in Figure 3 below.

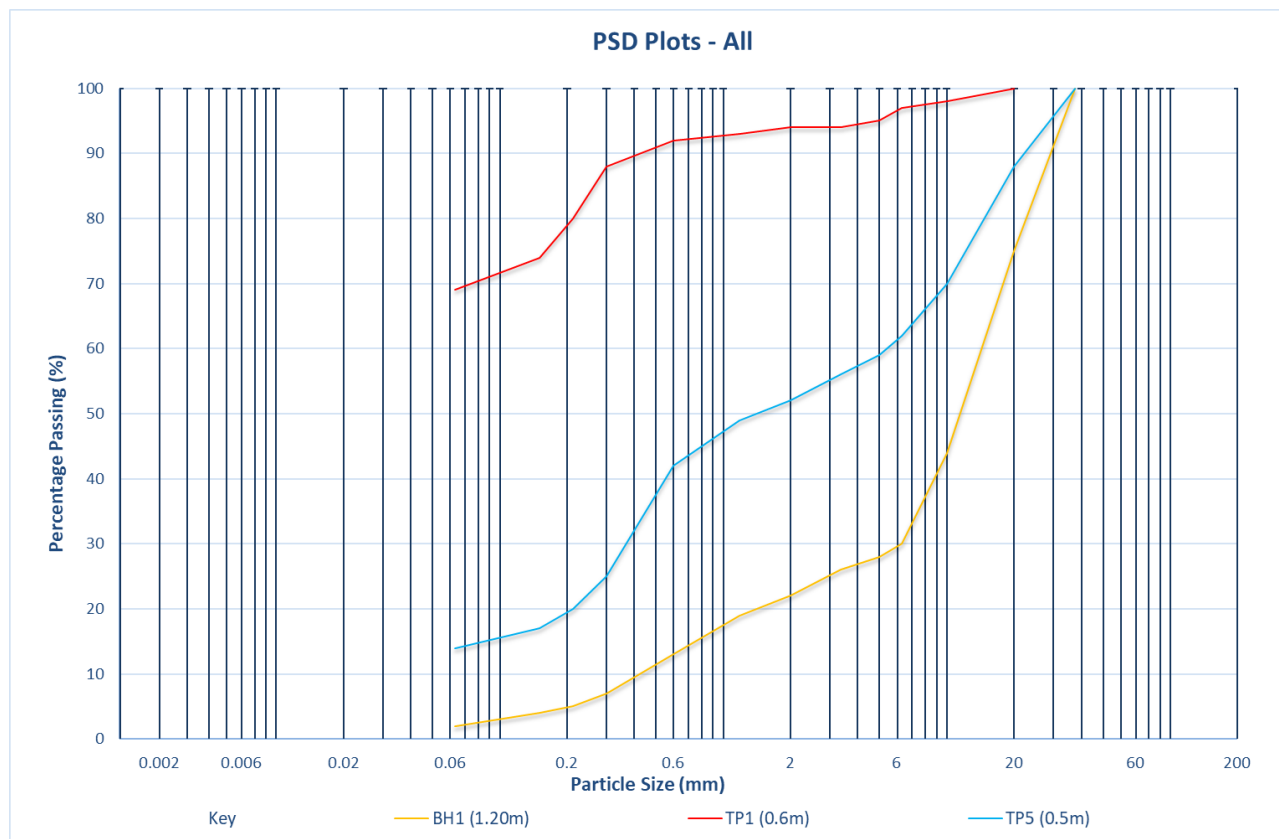
Figure 3: Superficial Deposits Atterberg Testing



The results show that the cohesive deposits generally have a low to intermediate plasticity, although one shallow sample from TP5 recorded a high plasticity. The material generally had a medium volume change potential with changes in moisture content.

3 no. particle size distribution (PSD) tests were carried out on samples taken from the superficial River Terrace Deposit soils at a depth range of 0.60 – 1.50m bgl, 2 no. were from the granular deposits and 1 no. from the cohesive deposits. The plots showing the grain size distribution are shown in Figure 4 below.

Figure 4: Particle size distribution chart of River Terrace Deposits



Based on the results the material tested can be classified as:

- Slightly clayey/silty sandy GRAVEL (BH1 and TP5).
- Slightly gravelly sandy CLAY (TP1).

The results correspond well to what was recorded in the field logs.

5.2.1.2 Strength Testing

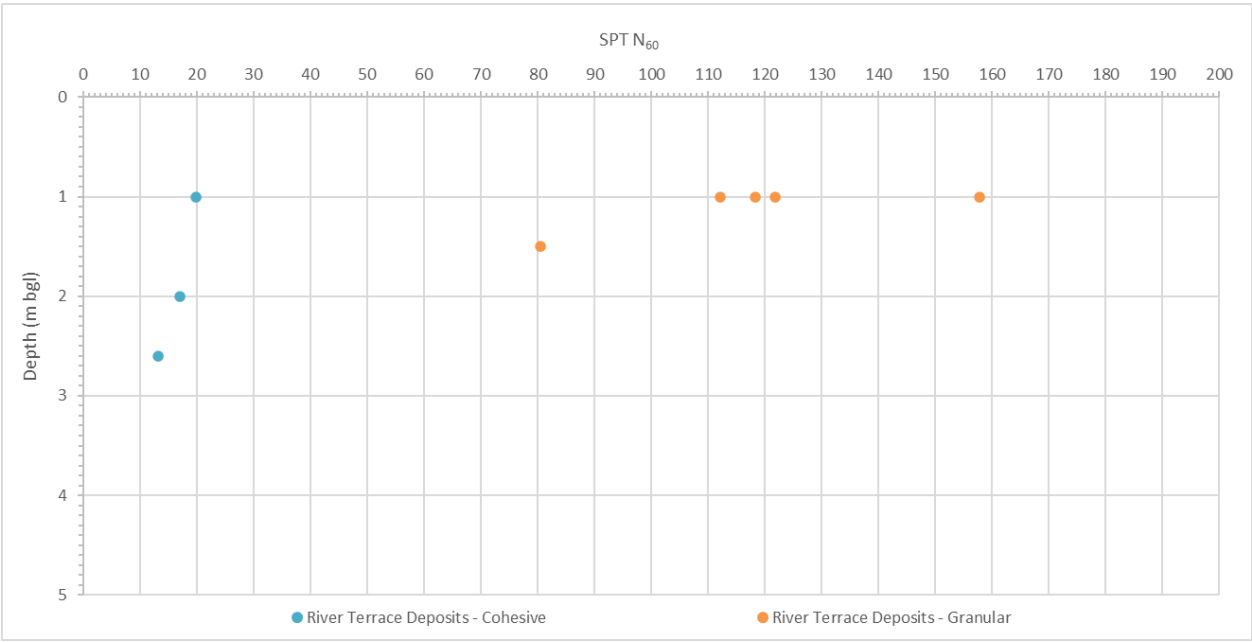
Granular

A total of 8 no. standard penetration tests (SPT) were carried out within the superficial River Terrace Deposit soils. The testing was carried out between 1m and 2.6m bgl depth. The SPT N_{60} results been split into granular (sand and gravel) and cohesive (clay) units.

SPT tests within the granular River Terrace Deposits (5 no.) all generally refused within the strata with extrapolated SPT N values ranging between 73 and 111, therefore indicating very dense sands and gravels.

SPT results are as shown in Figure 5 below.

Figure 5. SPT Results



Cohesive

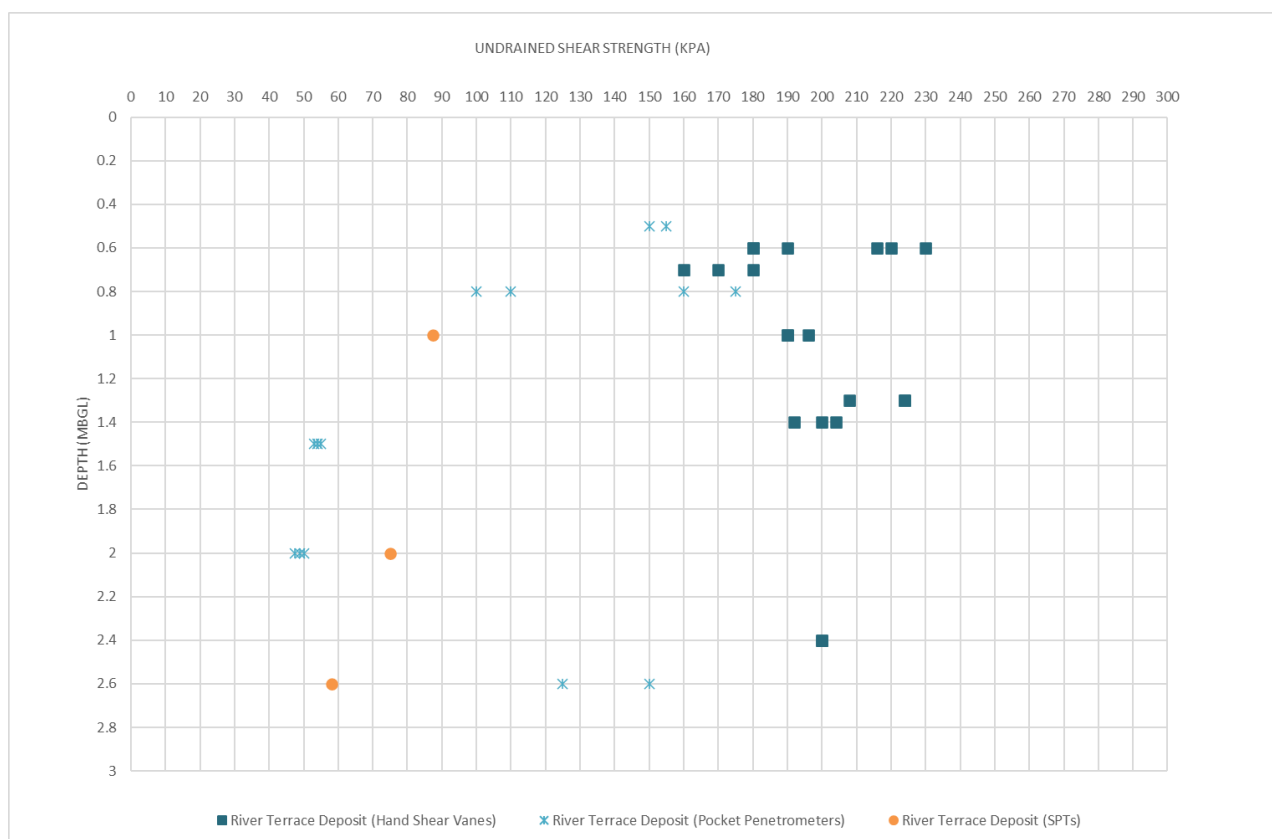
Undrained shear strength values for the cohesive deposits have been obtained using in-situ testing such as hand shear vanes and pocket penetrometers which were carried out within the trial pits and the window sample holes. SPT N values obtained from within the cohesive strata have also been used and converted to undrained shear strength using known correlations.

20 no. hand shear vane tests were carried out from 4 no. locations and depths across the site within the cohesive superficial deposits between 0.6m and 2.4m bgl. 14 no. pocket penetrometer tests were carried out from 6 no. locations/ depths across the site within the cohesive superficial deposits between 0.5m and 2.6m bgl.

SPT N values within the cohesive River Terrace Deposits (3 no.) ranged between 13 and 20 and have been correlated to an undrained shear strength using a conversion factor of 4.4 based on a plasticity index of 26%.

The results have been presented in Figure 6 below:

Figure 6. Undrained Shear Strength derived from In-Situ Testing and SPT N values



The results indicated an undrained shear strength ranging between 48kPa and 230kPa. The results show a very stiff upper cohesive material, which is shown to reduce in strength with depth, but this likely corresponds to deeper cohesive layers beneath the shallower granular deposits, so the reduction in strength is likely due to water softening due to the water perched within the overlying granular material.

Combining all results from hand shear vane tests, pocket penetrometer tests, and cohesive SPT results an average C_u value of 150kPa and a lower quartile of 100kPa is indicated.

5.3 London Clay Formation

The London Clay Formation was encountered underlying the River Terrace Deposits in 6 no. exploratory holes (BH1, WS1 & TP1-TP4) from depths of between 1.80m and 4.00m to the base of the exploratory holes. These soils typically comprised firm to very stiff variably sandy CLAY with shell fragments.

The London Clay Formation comprised an upper profile of firm brown clays, becoming grey and orange brown around 6.5m bgl, representing the weathered horizon and becoming unweathered and grey occasionally mottled brown from 9.0m bgl.

5.3.1.1 Classification Testing

3 no. soil samples were taken from the upper profile soils of the London Clay Formation (BH1, TP3, and WS1) between depths of 2.5m and 4.0mbgl. The 3 no. samples had indicated natural moisture contents of between 20% and 26% (average – 24%), and plasticity index values of between 31% and 34% (average 33%). A summary of the results is presented in the table below.

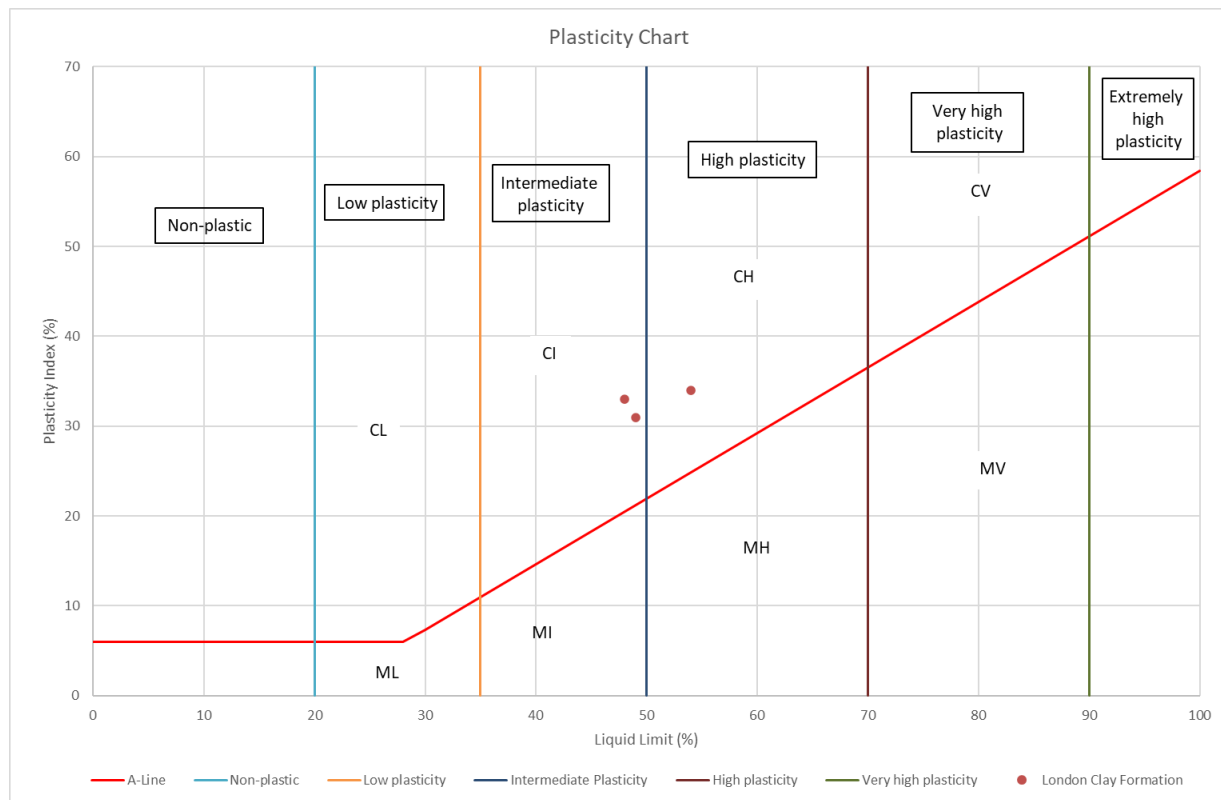
Table 9: London Clay Plasticity Index Testing Summary

	Minimum %	Maximum %	Average %
Natural Moisture Content	20	26	24

Liquid Limit	48	54	50
Plastic Limit	15	20	18
Plasticity Index	31	34	33

The results are plotted on the A-Line plot within Figure 7 below and show the clay to have an intermediate to high plasticity with medium volume change potential.

Figure 7. London Clay Formation - Atterberg Chart



5.3.1.2 Strength Testing

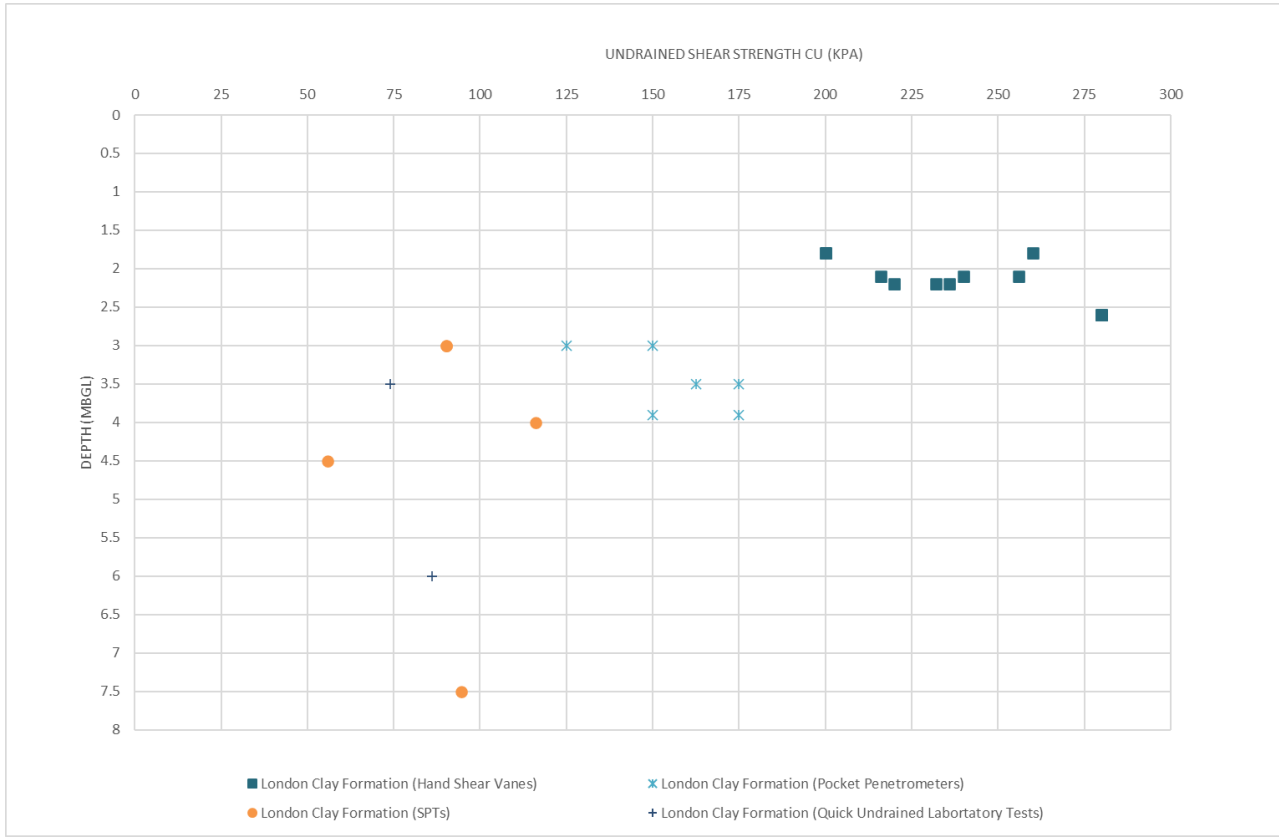
A total of 4 no. standard penetration tests (SPT) were carried out within the London Clay Formation soils from SPT testing of both the window sample rig (WS1) and the cable percussive rig (BH1). The testing was carried out between 3.0m and 7.5m bgl depth. N values ranged between 14 and 38, with an average SPT N value of 27 and a lower quartile of 21. Using a conversion factor of 4.3 based on a plasticity index of 33%, undrained shear strengths of between 60kPa and 163kPa are calculated, indicating the material to be firm to very stiff.

12 no. hand shear vane tests were carried out from 4 no. locations and depths across the site within the London Clay Formation between 1.8m and 2.6m bgl and recorded undrained shear strength values of between 200kPa and 280kPa. 6 no. pocket penetrometer tests were carried out at 3 different depths from WS1 within the London Clay Formation between 3.0m and 3.9m bgl and recorded undrained shear strength values of between 125kPa and 175kPa.

2 no. quick undrained triaxial tests were carried out on samples of the London Clay Formation from 3.5m and 6.0mbgl, indicating undrained shear strength (C_u) of 74 and 86kPa, respectively.

All the results have been presented in Figure 8 below:

Figure 8. Undrained Shear Strength derived from In-Situ Testing and SPT N values



The results indicated an undrained shear strength ranging between 56kPa and 280kPa, indicating firm to very stiff material.

Hand shear vanes consistently indicate the highest values, around 240kPa, with pocket penetrometer results indicating results around 150kPa. Laboratory testing and SPT correlations give more conservative undrained strengths of around 80kPa.

5.4 Summary of Geotechnical Parameters

The soil parameters for the two geological units identified to be present on site are derived from laboratory tests and suitable known correlations from in-situ testing. The River Terrace Deposits have been split into the cohesive and granular components. The range of derived soil parameters are shown below (average result in bracket) in Table 10. Note that the parameters are not characteristic parameters and the designer should select appropriate parameters based on the relevant geotechnical design.

Table 10: Summary of Geotechnical Parameters

Parameter	Geological Unit		
	River Terrace Deposits – Granular	River Terrace Deposits – Cohesive	London Clay
Unit Weight (γ) kN/m ³	19	18	20
Undrained Shear Strength (c_u) kPa	-	50-230 (100)	50-280 (150)
Effective Angle of Friction (Φ') °	40	28	26

Coefficient of volume compressibility (m_v) m^2/MN	-	0.156 – 0.10	0.16-0.08
Deformation Modulus (E_d) MPa	50-75	10-15	15-40

5.5 Groundwater

No groundwater was encountered in any of the exploratory holes during the site works.

Groundwater monitoring standpipes were installed in three of the exploratory holes and three fortnightly monitoring visits were undertaken. The installation details are summarised in Table 11 below, and the results of the monitoring visits are presented in Table 12.

Table 11: Monitoring Well Installation Summary

Borehole ID	Groundwater Level During GI	Installation depth (mbgl)	Reported response zone (mbgl)	Stratum
BH1	Not encountered	2.80	1.0-2.80	RTD
WS1	Not encountered	4.00	1.0-4.00	RTD & LCF
WS4	Not encountered	1.10	0.50-1.00	RTD

Notes: RTD – River Terrace Deposits, LCF – London Clay Formation

Table 12. Summary of groundwater monitoring results

Date	Elevation (m AOD)		Groundwater Level (m BGL / m AOD)			
	Top of borehole	Base of Well	03/08/2023	10/08/2023	17/08/2023	23/08/2023
BH1	68.95	66.25	1.25 67.70	1.24 67.71	1.27 67.68	1.26 67.69
WS1	69.50	65.50	1.50 68.00	1.38 68.12	1.40 68.10	1.40 68.10
WS4	69.30	68.30	Dry	Dry	Dry	Dry

Notes: - = Dry

The results from the groundwater monitoring indicate groundwater level within the central area of site lies between 1.25-1.50m bgl, lying within the granular River Terrace Deposit, between approximately 1.40-2.75m above the boundary with the underlying London Clay Formation. Levels were recorded between 67.68m AOD and 68.12m AOD, with the water level at WS4 being unknown, but below 68.30m AOD.

BH1 and WS1 are both located centrally within the site area and provide groundwater levels in respect to the proposed building areas, and therefore, with the shallow refusal of the remainder of the window sample locations.

No groundwater ingress was encountered within exploratory holes during the GI works across the entirety of the site. However, this includes locations where groundwater was later encountered during monitoring.

5.6 Visual and Olfactory Evidence of Contamination

Other than the inclusion of anthropogenic material such as rare brick fragments within the Made Ground of WS4, no other visual or olfactory evidence of contamination was noted.

6 Generic Quantitative Risk Assessment (Contamination)

6.1 General

The following comprises a Generic Quantitative Risk Assessment (GQRA) of contamination risk, in accordance with the methodology set out in **Appendix H**.

The following updated conceptual model information has been taken from the information obtained in **Section 4.0 and Section 5.0** and from the site walkover. Contamination testing carried out during the ground investigation has been used to supplement the preliminary conceptual model presented in **Section 4.0**.

6.2 Proposed Development and Land Use

It is understood the site is to be developed into a research arboretum and therefore a Public Open Space (POS) - Park use has been adopted. The development predominantly comprises various arboretum zones (meadows, tree planting and water bodies), as well as research trial areas and polytunnels. However, buildings are proposed centrally, these include research laboratories and maintenance buildings, with associated infrastructure (pavements and car parking).

6.3 Risks to Human Health

6.3.1 Soils

This section summarises chemical results from the recent geotechnical investigation carried out by GEG.

The generic assessment criteria used in this case are generally the LQM/CIEH Suitable 4 Use Levels (S4ULs), based on minimal or tolerable risk and are intended to be protective of human health. Different criteria are provided for a variety of land use, and the criteria for "Public Open Space – Park" has been adopted here.

Both the C4SL and S4UL are based on current best practice and reflect the most up to date guidance and legislation. The exception to this is use of the C4SL levels for Lead, as S4UL are not provided for this substance.

Statistical testing is used where data sets are suitable. The critical issue is sample numbers. For data sets with low sample numbers or where sampling is targeted at specific areas, individual sample test results are compared directly with the screening values. Larger and non-targeted data sets are subject to statistical testing.

A summary of the chemical test results and a comparison against the relevant assessment criteria used in this case, are given in the tables below.

In accordance with best practice, individual exceedances of the relevant assessment criteria have been identified and comment provided where necessary.

6.3.1.1 Metals and Semi Metals

The table below summarises the chemical results for metals and semi-metals on site from the current phase of investigation:

Table 13: Summary of Soil Contamination – Metals and Semi Metals

Contaminant	C4SL/ S4UL mg/kg	Source	Measured concentrations mg/kg		95% UCL ***	Number of individual exceedances
			Minimum	Maximum		
Arsenic	170	S4UL	5.8	20.0	-	0/8
Boron	46000	S4UL	0.3	9.5	-	0/8
Cadmium	532	S4UL	<0.2	2.4	-	0/8
Chromium (III)	33000	S4UL	12.0	53.0	-	0/8

Chromium (VI)	220	C4SL	<1.2		-	0/8
Copper	44000	S4UL	11.0	24.0	-	0/8
Lead (ref 1)	580	S4UL	11.0	62.0	-	0/8
Mercury (Elemental)	30	S4UL	<0.3		-	0/8
Nickel	3400	S4UL	5.2	14.0	-	0/8
Selenium	1800	CIEH	<1.0		-	0/8
Zinc	170000	-	27	260	-	0/8

- C4SL – DEFRA Category 4 Screening Levels (2014).
- S4UL – CIEH/LQM Sutable 4 Use Levels (2015).
- SGV – CLEA Soil Guideline Values (2009).
- *95% Upper Confidence Limit (UCL) statistical analysis not undertaken where there are no contaminant exceedances and/or insufficient number of samples

No significant metal elevations were detected, with no exceedances above POS Park use GAC values for metals and semi-metals.

6.3.1.2 Polyaromatic Hydrocarbons

The table below summarises the results for speciated PAHs on site.

Table 14: Summary of Soil Contamination – PAHs

Contaminant	SGV/ GAC (mg/kg)	Source	Measured concentrations (mg/kg)		95% UCL***	Number of individual exceedances
			Minimum	Maximum		
Naphthalene	1900	S4UL	<0.05	0.40	-	0/8
Acenaphthylene	30000	S4UL	<0.05	0.05	-	0/8
Acenaphthene	30000	S4UL	<0.05	0.05	-	0/8
Fluorene	20000	S4UL	<0.05	0.05	-	0/8
Phenanthrene	6200	S4UL	<0.05	0.08	-	0/8
Anthracene	150000	S4UL	<0.05	0.05	-	0/8
Fluoranthene	6300	S4UL	<0.05	0.24	-	0/8
Pyrene	15000	S4UL	<0.05	0.22	-	0/8
Benzo[a]anthracene	56	S4UL	<0.05	0.11	-	0/8
Chrysene	110	S4UL	<0.05	0.14	-	0/8
Benzo[b]fluoranthene	15	S4UL	<0.05	0.18	-	0/8
Benzo[k]fluoranthene	410	S4UL	<0.05	0.08	-	0/8
Benzo[a]pyrene	12	S4UL	<0.05	0.13	-	0/8
Indeno[123-cd]pyrene	170	S4UL	<0.05	0.09	-	0/8
Dibenz[ah]anthracene	1.3	S4UL	<0.05	0.05	-	0/8
Benzo[ghi]perylene	1500	S4UL	<0.05	0.11	-	0/8

Notes:

- S4UL – CIEH/LQM Sutable 4 Use Levels (2015).
- *95% Upper Confidence Limit (UCL) statistical analysis not undertaken where there are no contaminant exceedances and/or insufficient number of samples

No exceedances of PAH above POS Park use GAC values were recorded in any of the samples tested.

6.3.1.3 Petroleum Hydrocarbons

Testing for petroleum hydrocarbons was typically not carried out, as the majority of the site was underlain by natural deposits with no source, or visual or olfactory evidence identified. Made Ground was encountered within the wooded area to the northwest, so TPH testing was undertaken on a single sample from WS4.

TPH C6-21 ranges were all below their limit of detections with slight elevations (above LODs) in the C21-40 range, With a value of 21mg/kg. Total TPH (C6-40) was determined as 22mg/kg, which is well below any GAC values so is not considered further.

6.3.2 Ground Gas

Groundwater and Gas monitoring standpipes were installed in BH1, WS1, and WS4. The window sample wells were installed to the base the borehole (depths of 1m and 4m), the cable percussive borehole was installed to 2.80m (base of casing).

The monitoring results are shown below in Table 15 which indicated values of 0% for Methane (CH₄). Carbon Dioxide (CO₂) levels ranging between 0.9% and 5.6%. No positive flow rates were observed during any of the visits.

Table 15: In situ ground Gas Monitoring Results

Date	Atmospheric Pressure (mb)	Bore hole No:	Methane CH ₄ (%)	Carbon Dioxide CO ₂ (%)	Oxygen (%v/V)	Flow Rate (l/hr)
03/08/2023	994-995 Rising	BH1	0.0	2.2	14.7	0.0
		WS1	0.0	1.1	19.6	0.0
		WS4	0.0	0.9	20.3	0.0
10/08/2023	1012 Falling	BH1	0.0	2.3	14.5	0.0
		WS1	0.0	1.0	19.3	0.0
		WS4	0.0	2.3	16.6	0.0
17/08/2023	1013-1012 Falling	BH1	0.0	1.9	16.3	0.0
		WS1	0.0	1.1	19.9	0.0
		WS4	0.0	5.2	14.7	0.0
23/08/2023	1013 Falling	BH1	0.0	1.7	17.2	0.0
		WS1	0.0	1.1	20.1	0.0
		WS4	0.0	5.6	14.5	0.0

The results have been assessed in accordance with CIRIA C665, with Gas Screening Values (GSV) calculated a worst-case basis (highest concentration of CH₄ or CO₂, irrespective of location or monitoring date). As zero gas flow was recorded in all of the visits, the minimum limit of detection value of 0.1l/hr has been used in this analysis.

The monitoring results recorded a maximum carbon dioxide level of 5.6% (WS4) and using the minimum limit of detection value of 0.1l/hr a gas screening value (GSV) of 0.0056/hr has been calculated, which results in a Characteristic Situation 1 – very low risk classification.

Carbon dioxide concentrations slightly exceed 5% in two visits from WS4, and guidance from CIRIA C665 suggests consideration should be given to increasing to a Characteristic Situation 2 – low risk, where carbon dioxide is greater than 5%. As there was limited Made Ground in this area and away from any of the proposed buildings, CS2 classification is not deemed necessary.

Therefore, the assessment indicates a Characteristic Situation 1 for both Methane and Carbon Dioxide, which is classified as Very Low Risk, and in accordance with BS:8485 guidance no specific gas protection measures will be required for the site.

6.3.3 Radon

The site is not in a Radon Affected Area (less than 1% of homes are estimated to be at or above the action level) and therefore no radon protection measures are required.

6.3.4 Asbestos

Asbestos screening was carried out on a single sample, where Made Ground was encountered, and no asbestos was identified.

Due to the limited Made Ground encountered during the GI, this assessment may not be indicative of all Made Ground across the site, likely within the northwestern areas. If ground disturbance, soil movement, or existing building demolition is required within these areas than further assessment may be required, to ensure spreading or further contamination of asbestos containing soils does not occur.

Before the demolition of existing buildings an assessment of ACM presence should be undertaken by a specialist contractor.

6.4 Risk to Controlled Waters

Given the site is generally underlain by natural soils with no evidence of contamination no significant risk to controlled waters is expected.

6.5 Risks to Flora and Fauna

A number of metals in soils can inhibit plant growth, and as the site is to be developed for use as a research arboretum, the following comprises a brief assessment of select metals from all chemical testing undertaken, this comprises 8 no. shallow soil samples (including the Made Ground sample), using GAC values from the *Department of the Environmental Publication, Code of Practice for Agricultural Use of Sewage Sludge, 1996*.

Table 16: GAC for Phytotoxic Risks

Metal	Max value (mg/kg)	Generic Assessment Criteria (mg/kg)			
		pH 5.0 - <5.5	pH 5.5 - <6.0	pH 6.0 – <7.0	pH >7.0
Copper	24	80	100	135	200
Nickel	14	50	60	75	110
Zinc	260	200	200	200	300

No exceedances of copper or nickel were identified. Zinc was generally encountered at levels below 54mg/kg, with the exception of a single result from WS3 at 0.1m bgl which recorded a value of 260mg/kg. Given the pH value of the sample was 8.4, the highest observed on site, it is below the limit of 300mg/kg used for samples with pH of greater than 7. The lower pH values encountered across the site are typically associated with topsoil and River Terrace Deposit soils in the lower lying east of the site.

Therefore, no significant risks to flora or fauna have been identified at the site.

6.6 Risks to Adjacent Land and Third Parties

No significant risk to neighbouring occupiers has been identified.

6.7 Potential Geo-Environmental Liabilities

Potential geo-environmental liabilities under Part 2A of the Environmental Protection Act 1990 (as amended) and the Groundwater Regulations (GWR) 2009, relating to the site in its current condition and proposed end use is not considered likely based on the tests data available.

6.8 Off Site Disposal

Hazwaste

All soil sample data has been screened and classified in accordance with WM3 methodology (using Hazwaste Software) to identify if the site soils would be classified as hazardous or are non-hazardous waste for disposal purposes.

The WM3 waste assessment indicates all material tested on the site are non-hazardous and as such, should any soils be excavated and removed from site they can be deposited at a non-hazardous or an inert landfill.

A copy of the Hazwaste Assessment Report is provided in **Appendix E**.

6.9 Updated Conceptual Site Model

Table 17 shows the updated conceptual site model, which has been formulated based on the information obtained in the ground investigation and historic data.

Table 17: Updated Conceptual Site Model

Updated Conceptual Site Model						
Sources	Receptor	Pathway	Consequence	Probability	Risk	Recommended Action (to clarify level of risk and assess suitable mitigation measures or to mitigate the risk)
Made Ground, associated with historical construction activities and imported fill, possibly including elevated concentrations of metals, metalloids, asbestos fibres, Asbestos Containing Materials, PAH and petroleum hydrocarbons.	People Groundwater Surface water Ecology	Ingestion Inhalation Direct Contact Root uptake Leaching through unsaturated zone	Mild	Unlikely	Very Low Risk	No exceedances of metals recorded.
Hydrocarbon fuels from leakage and spillage of onsite	People Groundwater Surface water Ecology	Ingestion Direct Contact Root uptake Leaching through unsaturated zone	Medium	Unlikely	Low Risk	No evidence of hydrocarbon contamination encountered and no exceedances within the made ground tested.
Asbestos within ground from former buildings, sheds and other structures demolished	People	Inhalation	Medium	Unlikely	Low Risk	No asbestos identified within soil tested from made ground.
Ground gases (carbon dioxide and methane) from backfilled clay pit/landfill.	Future Site Users;	Inhalation	Medium	Unlikely	Very Low Risk	Gas monitoring confirmed the site to be a Characteristic Situation 1 – very low risk.

6.10 Contamination Risk Summary

No exceedances were detected within the soils tested against the Generic Assessment Criteria values adopted for any contaminant.

No asbestos was identified within the limited Made Ground encountered across the site.

Gas risk at the site has been categorised as Characteristic Situation of CS1 (Very Low Risk) requiring no special protection.

All samples tested were classified as 'non-hazardous waste'.

6.10.1 Proposed Mitigation Strategy

Based on the above assessment, no specific mitigation measures are required in terms of protection of human health from site soils, or in terms of risks to controlled waters.

Standard task specific PPE and good hygiene practices should be adopted by site groundworkers.

A watching brief should be maintained during groundworks for unexpected or unknown contamination if the development includes excavation work within the northwestern wooded area where Made Ground may be more extensive.

7 GEOTECHNICAL ASSESSMENT

7.1 Introduction

The site is proposed to be developed for use as a new arboretum. The development comprises various arboretum zones (meadows, tree planting and water bodies), as well as research trial areas and polytunnels.

Proposed buildings cover a limited area across the site and include research laboratories and maintenance buildings, vehicle access with car parking and the development of a number of attenuation ponds in the north-eastern areas.

7.2 Excavations

It is not known what the proposed finished levels for the site are, but excavations should be readily achievable using standard mechanical plant with toothed buckets. The granular River Terrace Deposits are recorded as very dense so larger machinery may be required to penetrate through this layer if required. Excavations within the development, are likely to consist of soft landscaping alterations covering the majority of the site (i.e., tree root balls, planting, etc) and excavation of shallow soils to founding levels for pavements and structures. More significant excavations are expected in the east where attenuation ponds are proposed.

Temporary excavations within the granular material encountered over the central and western part of the site should be stable in the short term at angles of no greater than 1V:2H (26°), where cohesive deposits are encountered then the batter angles can be at 1V:1.5H (33°).

A risk assessment of the stability of any open excavation should be undertaken by a competent person and appropriate measures adopted to ensure safe working practise in and around open excavations. Further guidance on responsibilities and requirements for working near, and in, excavations can be obtained from the Construction Design and Management Regulations (2015); Construction Information Sheet 47: Inspections and Reports (2005) and HSG47: Avoiding Danger from Underground Services.

Groundwater was not encountered during the investigation, but levels were monitored to lie between 1.25m and 1.50m below existing site levels (centrally), which may be shallower in the winter months.

Any groundwater inflow should be readily controlled by traditional de-watering techniques such as sump and pump techniques in accordance with guidance given in the CIRIA Report C750 groundwater Control – design and practice. Any discharge consents required should be in place prior to starting works. Where excavations are required to remain open for medium to long periods and extend beyond the groundwater level within the granular deposits, then shoring may be required.

7.3 Foundation Options

Building proposals are known to be isolated to the central area of site, around the location of exploratory holes WS1 and BH1, where cohesive (and granular) superficial deposits extended to depths of between 2.90m and 4.00m bgl respectively.

Traditional shallow foundations should be suitable for the site, extending to depths of at least 0.9m below ground level within the cohesive strata that is at least firm in strength around the area of WS1. An allowable bearing pressure of at least 100kPa should be available within this stratum. In the areas of BH1, WS2 and WS3 any foundations should extend through the shallow clay layer and into the dense gravel layer encountered at depths of between 0.45m and 0.7mbgl, where a greater allowable bearing pressure is available, but given the unknown thickness of the gravel in WS2 and WS3 should be limited to around 125kPa. In the area of BH1 where the gravel thickness is known then an allowable bearing pressure could be greater if required, subject to confirmation of proposed loads.

Within the clay deposits a minimum foundation depth of 0.9m is required, but this should be deepened in accordance with NHBC standards where the foundations are proposed to be placed near to any existing or future plantations. This will need consideration given the nature of the proposed end use of the site. Foundations across the same structure should be placed within the same stratum to limit differential settlement across the building.

It is understood that screw piles are being considered for the proposed buildings. It is recommended that the exploratory hole logs are provided to the specialist pile designer to see if the ground is suitable and that suitable penetration depths within the dense gravels can be achieved. The piles will need to be designed by the specialist and will require a minimum embedment to resist any uplift.

It is recommended that definite values of bearing capacity be obtained from piling contractors, for their specific piles, and that all piles are designed in accordance with Eurocode 7.

7.4 Floor Slabs

Given the site is underlain by cohesive deposits of medium volume change potential, with numerous future plantations proposed, as well as the likely piled foundation approach for the site, a suspended floor slab is recommended for any proposed buildings.

7.5 Earthworks

The proposed levels have not been determined at this stage of the project, but significant level changes are not anticipated, and any cut and fill activities will likely be limited to general platform levelling. However, the excavation of attenuation basins in the east may generate soils requiring to be placed elsewhere on site. The exploratory hole logs indicate the soils in these areas will likely comprise cohesive River Terrace Deposit to around 2.10m bgl (61.90m AOD), with cohesive London Clay below.

Any earthworks on site will likely involve both the granular and cohesive River Terrace Deposits as well as some London Clay should excavations extend that far. The soil materials have been compared to the requirements of the Specification for Highways Works, Series 600 – Earthworks - Manual of Contract Documents for Highways Works, Volume 1, and the cohesive material can be classified as either a Class 2A (wet cohesive or Class 2B (dry cohesive) when used as a general fill. Where granular, the superficial deposits can be classified as Class 1A well graded granular material.

Compaction testing was carried out on 2 no. samples within the cohesive superficial deposits. These tests were conducted using a 2.5kg rammer and the results are summarised in the table below and plotted on the compaction curve in Figure 9 below.

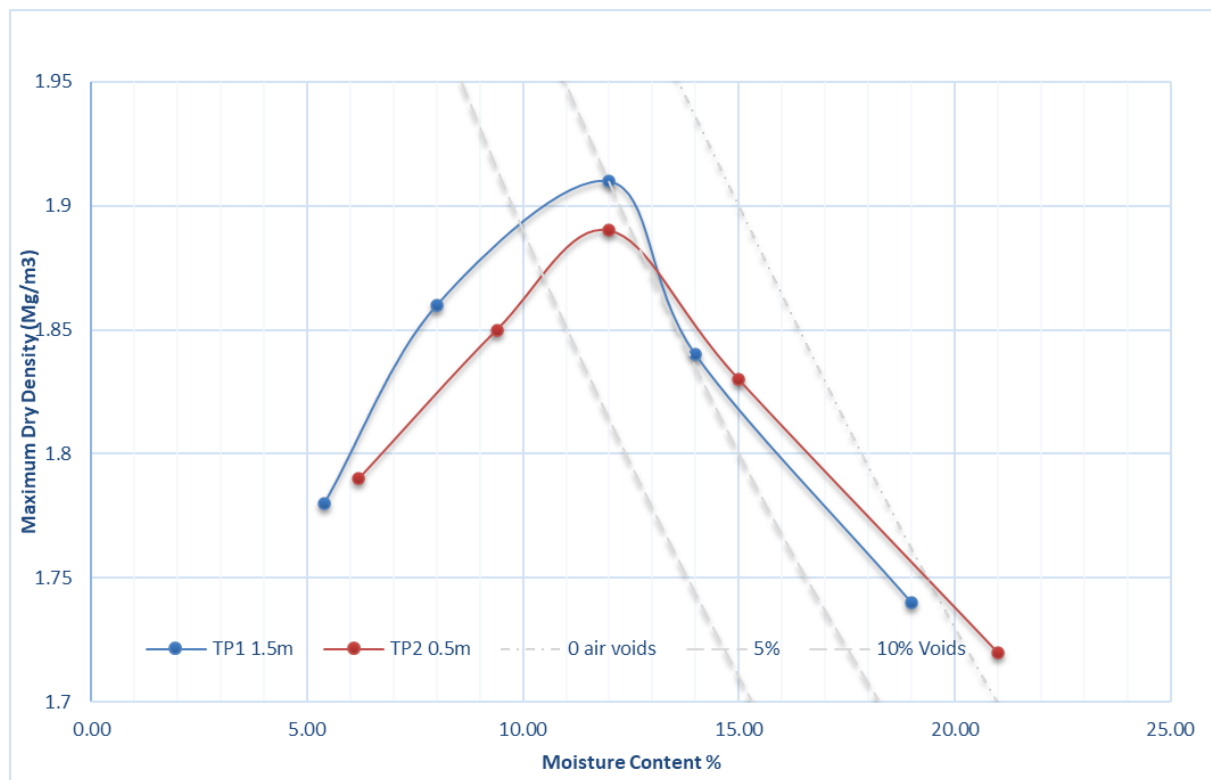
Table 18. Summary of Compaction Results

Hole ID	Depth bgl (m)	Report*	Initial Natural MC (%)	Average MC (%)	OMC (%)	Max Dry Density (Mg/m ³)	Degree of Compaction based on Natural Moisture Content (%)
TP1	1.50	SD – Clay	19	20%	12	1.91	91%
TP2	0.50	SD – Clay	21		12	1.89	91%

Note: SD – Superficial Deposit soils

A table summarising the findings is presented below, the OMC required for maximum compaction was 12% in both tests lower. Initial moisture contents of the tests were determined as 19% and 21%, in line with the average moisture content of cohesive River Terrace Deposit soils, average 20% in all cases.

Figure 9: Compaction Curves



Based on the above results, the material tested was wet of its optimum moisture content and can be compacted to around 91% of its maximum dry density (MDD) at its natural moisture content. Some form of moisture treatment will likely be required in order to reduce the moisture content in order for it to be compacted to 95% on its MDD.

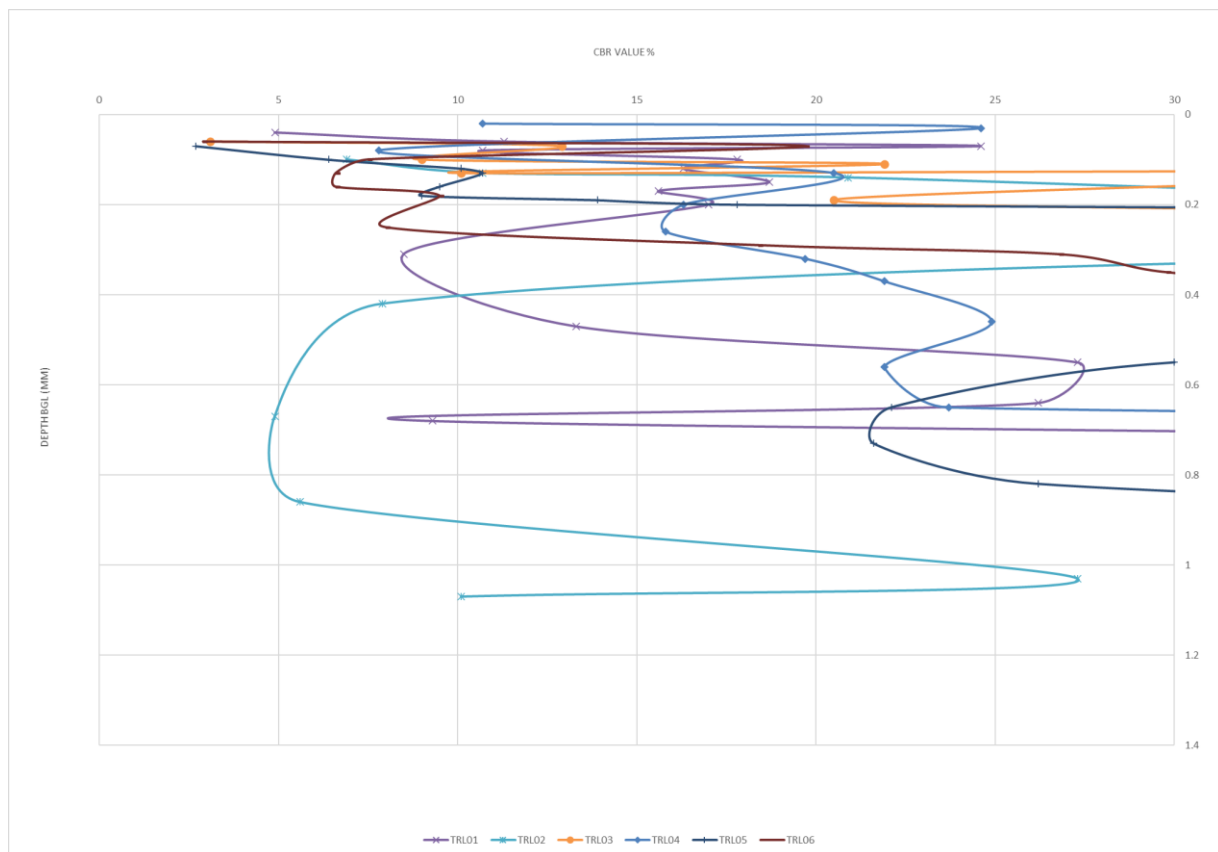
As outlined in the Series 600 Earthworks specification, any site won superficial material can be compacted in accordance with Tab 6/4 Method 1 / 2 for general fill uses.

These conditions are at the time of testing, which was during the summer months, in-situ conditions on site are variable and therefore should any earthworks be required, then construction stage testing should confirm the moisture content at the time of excavation.

7.6 Pavement Design

In situ CBR testing was carried out by TRL dynamic cone penetration tests at six locations, adjacent to select window samples, to maximum depths of 1.17mbgl. The number of blows and amount of penetration was used to correlate the California Bearing Ratio (CBR). This correlation was conducted in accordance with the Interim Advice Note 73/06 Revision 1 (2009), design Guidance for Road Pavement Foundations (Draft HD25). The derived CBR vs depth graph is presented in Figure 10 below.

Figure 10: CBR vs Depth correlated from DCP Testing



When taking into account a topsoil strip of around 300mm under any proposed pavements, then the CBR of the likely formation level were generally observed to be around to be 5% to >30%. The lower value from TRL02 was positioned next to WS1 so likely relates to the more cohesive soils.

As such, a preliminary design CBR value of **10%** can be assumed from preliminary design of the subgrade material where dense granular material is present (assuming stripping of any made ground), where a Performance Design Approach can be adopted for the site.

Where the exposed subgrade material is cohesive, then a design equilibrium CBR of **3%** can be assumed and a Restricted Design Approach in accordance with CD 225 Design for new pavement foundations is followed.

Where localised soft spots are encountered with a CBR value of less than 2%, improvement works are likely to be required. Improvement works should be carried out in accordance with DMRB IAN 73/06 Rev 1 Chapter 5. In summary, consideration may be given to the following potential remedial techniques:

- excavation and re-engineering or replacement of weaker soils;
- the inclusion of geosynthetic reinforcement within the unbound layers of the capping and sub-grade;
- where cohesive soils are present and they are deemed suitable for treatment with hydraulic binders;
- to employ modification and/or stabilisation techniques on the formation; and
- where granular soils are present, de-watering and re-engineering the formation.

Notwithstanding, any site investigation can, by its very nature, only sample the soils at discrete locations within the site. Variability is inevitable and this should be included for in the design of the works.

7.7 Protection of Buried Concrete

BRE-SD1 concrete aggressivity testing was carried out on 3 no. samples within the London Clay Formation, with 2:1 water soluble sulphate and pH testing on an additional 1 no. sample of made ground, and 5 no. superficial deposit samples. The results are shown below:

Table 19: Summary of BRE-SD1 Concrete Sulphate Class Assessment

Hole ID	Depth (mbgl)	pH	2:1 Water Soluble Sulphate (mg/l)	Acid Soluble Sulphate (%)	Total Sulphur (%)	Total Potential Sulphate (SO ₄ %)	DS Class	ACEC Class
Made Ground								
WS4	0.10	7.1	35.6	-	-	-	DS-1	AC-1
Superficial Deposits								
TP4	0.50	8	8.5	-	-	-	DS-1	AC-1
WS1	0.50	7.4	6.7	-	-	-	DS-1	AC-1
TP1	1.00	5.6	36	-	-	-	DS-1	AC-1
TP3	0.50	6.6	7.2	-	-	-	DS-1	AC-1
BH1	3.00	8.1	25	-	-	-	DS-1	AC-1
London Clay Formation								
BH1	5.50	8.0	39	0.10	0.01	0.03	DS-1	AC-1s
TP3	2.70	7.9	16	0.01	0.01	0.03	DS-1	AC-1s
WS1	3.00	7.7	90.6	0.055	0.026	0.078	DS-1	AC-1s

Oxidisable sulphates were below 0.3% so pyrite is assumed to be absent and the classification has been based on the results of the water soluble sulphate test results alone.

Based on the design sulphate class, characteristic value of pH and assessment of groundwater mobility, and with reference to table C1 of BRE Special Digest: 2005, the ACEC class for each soil types are presented below. Groundwater has been assumed to be static within the impermeable London Clay Formation and mobile within the Made Ground and Superficial Deposits.

Concrete placed within the various materials has the following concrete Design Sulphate (DS) Class and Aggressivity Chemical Environment for Concrete (ACEC) Class:

- Made Ground – DS1 AC-1;
- Superficial Deposits – DS1 AC-1;
- London Clay Formation – DS-1 AC-1s (disturbed or undisturbed).

7.8 Soakaway Design

The drainage strategy for the site (Ref 23192-FRADS-01_v1, dated August 2023) suggests the possible surface water drainage options as infiltration via soakaways, or attenuation and discharge into the existing drainage ditch that runs along the eastern boundary.

Soakaways were undertaken in TP1, TP2 and TP5 at depths of around 2m, with the base of the pits within the London Clay Formation and cohesive River Terrace Deposit soils. The soakaway tests targeted areas of proposed drainage (permeable car parking and attenuation ponds). The tests were run for between 228 and 338 minutes

and resulted in a drop of water level over the test period of between 2.5cm and 6cm, which was insufficient for an infiltration rate to be calculated.

Whilst no testing was completed with the base of the pits within the granular material, where they are off greater thickness over the higher central areas of the site, it is considered they are not ideal to receive surface water via soakaway.

Based on these results, soakaways are not considered a suitable drainage option for the proposed site and the attenuation option and discharge into the adjacent drainage ditch is the preferable option.

The base depth of the proposed attenuation pond in the south of the site has been set at 1.3m below finished levels (1.0m depth with 0.3m freeboard). Groundwater was not encountered within the trial pits in this area and the material was all cohesive, so groundwater unlikely to be encountered within the top 1.5m of existing surface levels although this may change during the wetter winter months.

8 GEOTECHNICAL RISK REGISTER

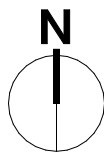
A Geotechnical Risk Register is a method of identifying hazards which may arise during the construction phase of works based on the data currently obtained for the site. The register is a work in progress and as further information arises, it should be updated in order to quantify the risk. At this stage, the aspects covered by the register are attributed to Cost and Health and Safety, although as site works commence, programme may become a prominent factor.

A Ground Risk Register that was started at the commencement of the ground investigation is contained within **Appendix F**.

9 References

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APPENDIX A: SITE LOCATION PLAN



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Do not scale from this drawing for construction purposes.

All dimensions must be checked by the contractor before commencing work on site.

Unless otherwise noted, boundaries have not been surveyed. The recipient of this drawing should satisfy themselves of their precise location before commencing work on site.

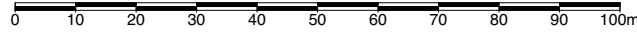
Any discrepancies are to be brought to the attention of Snug Architects Ltd.

If in doubt, ask.

Notes

 Application Boundary

Rev	Date	Description	DB/CB
-----	------	-------------	-------



project
Bartlett Arboretum
White House Farm
White House Lane
Reading, RG7 1HR

status
PLANNING

drawing title
Site Location Plan

drawn	checked	date	scale
RM	RB	12 2022	1:1250

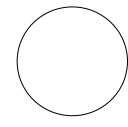
Drawing Code

Project	Originator	Vol	Lev	Type	Role	Number	Rev
P1138 - SNUG - XX - XX - DR - A - 0001 -							

59 Rumbridge Street,
Totton, Southampton,
Hampshire SO40 9DR

info@snugarchitects.co.uk
www.snugarchitects.co.uk
02382 029500



 Site Location Plan
Scale 1:1250

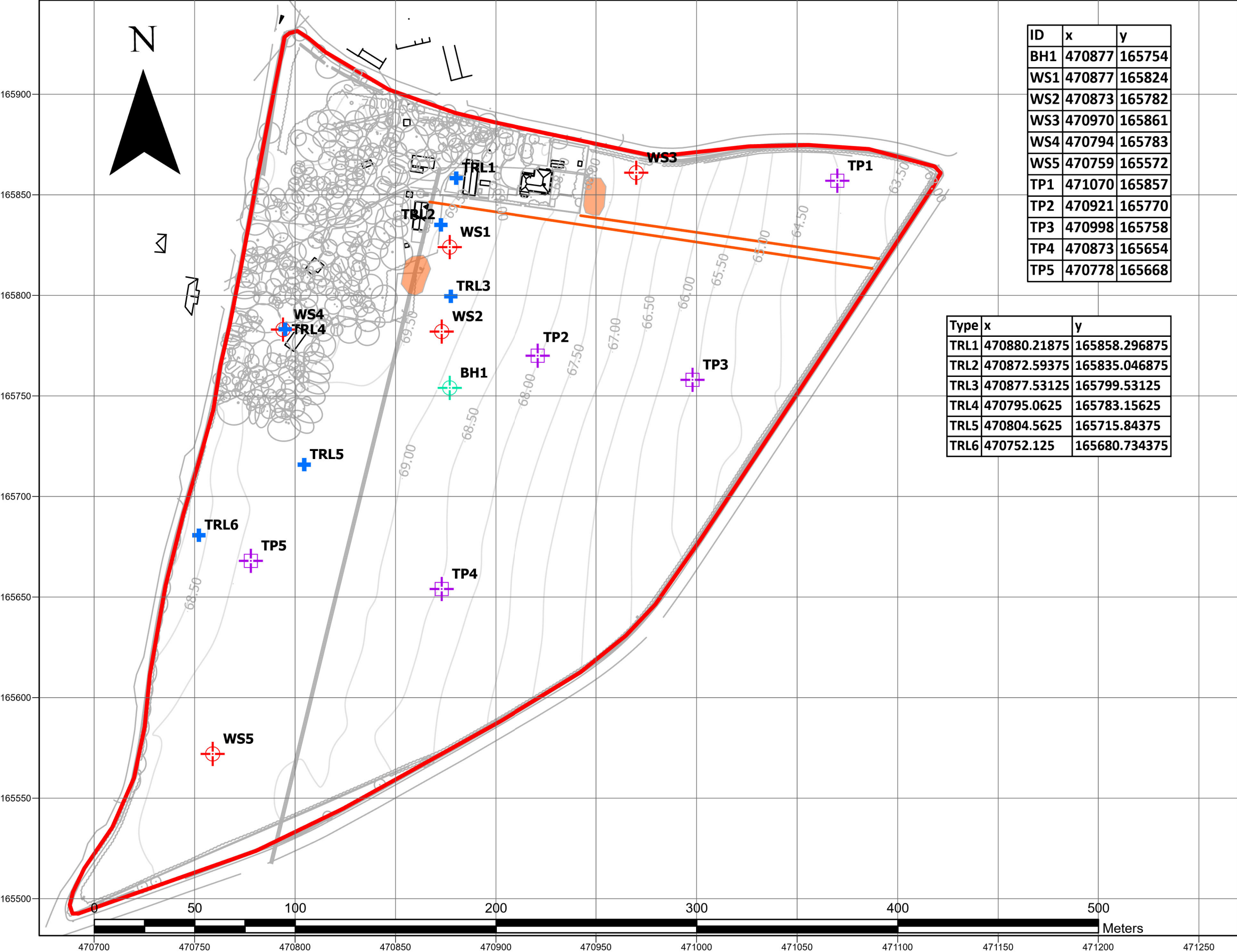
APPENDIX B: PROPOSED SITE DEVELOPMENT PLAN

Proposed Masterplan Key Areas

- Research beds
- Pathways and main routes
- Waterbody
- Species rich grass meadow
- Proposed tree planting
- Existing woodland



APPENDIX C: EXPLORATORY HOLE LOCATION PLAN



SiteBoundary

BH

TP

WS

TRL DCPs

Suspected Water Pipes

Suspected Septic Tank Locations

Survey_Trees

Survey_Buildings

Survey_Contours

Notes:

Soakaway tests performed within:
TP1, TP2, and TP5

By: DW

Date: 06/09/2023

Check:

Date:

Project

Bartlett Arboretum

Title

Actual Exploratory Hole Plan

Client

Bartlett Tree Experts

Scale at A3: 1:x000

Job No. 23192

Drawing No. GES02

Rev. A

Jubb

APPENDIX D: CONTAMINATION RISK ASSESSMENT METHODOLOGY AND DEFINITIONS

CONTAMINATION ASSESSMENT METHODOLOGY

The DEFRA and Environment Agency Contaminated Land Report 11 (CLR11) 'Model Procedures for the Management of Land Contamination' provides a technical framework for structured decision making about land contamination.

A1. Definition of Risk

CLR11 defines risk as "a combination of probability, or frequency, of occurrence of a defined hazard and the magnitude of the consequences of the occurrence".

A2. The Concept of the 'Pollutant Linkage'

In the context of contaminated land, there are three essential elements to any risk:

- a **contaminant (or source)** – a substance that is in, on or under land and has the potential to cause harm or cause pollution of controlled waters.
- a **receptor** - humans, ecological system, water body or property.
- a **pathway** – a route or means by which a receptor can be exposed to, or affected by, a contaminant.

Each of these elements can exist separately; however, they create a risk only where they are linked together forming a **pollutant linkage**.

A3. Conceptual Site Models

A conceptual site model represents the characteristics of the site in diagrammatic or written form that shows the possible relationships between contaminants, pathways and receptors (pollutant linkages).

For all potential pollutant linkages identified, the *consequence* and *probability* of occurrence is qualitatively assessed, and a *risk* assigned.

A4. The Tiered Risk Assessment Approach

CLR11 presents a tiered approach to risk:

Tier 1 *Preliminary risk assessment (PRA)*

The purpose of the preliminary risk assessment is to develop an initial conceptual model of the site and to establish whether or not there are potentially unacceptable risks. If potential risks are identified the initial conceptual model is developed in subsequent tiers of the risk assessment process.

Tier 2 *Generic quantitative risk assessment (GQRA)*

The purpose of the generic quantitative risk assessment is to establish whether generic assessment criteria and assumptions are appropriate for assessing the risks and, if so, to apply them to establish whether there are actual or potential unacceptable risks. It also determines whether further detailed quantitative risk assessment is required.

Tier 3 *Detailed quantitative risk assessment (DQRA)*

The purpose of the detailed quantitative risk assessment is to establish and use more detailed site specific information and criteria to decide whether there are unacceptable risks. It may be used as the sole method of quantitative assessments of risks, or it may be used to refine earlier assessments using generic assessment criteria.

B. RISK ASSESSMENT DEFINITIONS

B1. General

The following classification and definition of risk assessment has been based on that set out in NHBC and EA Publication R&D 66 – Guidance on the Safe Development of Housing on Land Affected by Contamination (2008).

The key to the classification is that the designation of risk is based upon the consideration of both:

- the magnitude of the potential consequence (i.e. severity)**, which considers both the potential severity of the hazard, and the sensitivity of the receptor.
- the magnitude of probability (i.e. likelihood)**, which considers both the presence of the hazard, the receptor, and the integrity of the pathway.

B2. Classification of Consequence

Classification	Definition	Examples
Severe	Highly elevated concentrations likely to result in “significant harm” to human health as defined by the EPA 1990, Part 2A, if exposure occurs. Equivalent to EA Category 1 pollution incident including persistent and/or extensive effects on water quality; leading to closure of a potable abstraction point; major impact on amenity value or major damage to agriculture or commerce. Major damage to aquatic or other ecosystems, which is likely to result in a substantial adverse change in its functioning or harm to a species of special interest that endangers the long-term maintenance of the population. Catastrophic damage to crops, buildings or property.	Significant harm to humans is defined in circular 01/2006 as death, disease*, serious injury, genetic mutation, birth defects or the impairment of reproductive functions. Major fish kill in surface water from large spillage of contaminants from site. Highly elevated concentrations of List I and II substances present in groundwater close to small potable abstraction (high sensitivity). Explosion, causing building collapse (can also equate to immediate human health risk if buildings are occupied).
Medium	Elevated concentrations which could result in “significant harm” to human health as defined by the EPA 1990, Part 2A if exposure occurs. Equivalent to EA Category 2 pollution incident including significant effect on water quality; notification required to abstractors; reduction in amenity value or significant damage to agriculture or commerce. Significant damage to aquatic or other ecosystems, which may result in a substantial adverse change in its functioning or harm to a species of special interest that may endanger the long-term maintenance of the population. Significant damage to crops, buildings or property.	Significant harm to humans is defined in circular 01/2006 as death, disease*, serious injury, genetic mutation, birth defects or the impairment of reproductive functions. Damage to building rendering it unsafe to occupy e.g. foundation damage resulting in instability. Ingress of contaminants through plastic potable water pipes.
Mild	Exposure to human health unlikely to lead to “significant harm”. Equivalent to EA Category 3 pollution incident including minimal or short lived effect on water quality; marginal effect on amenity value, agriculture or commerce. Minor or short lived damage to aquatic or other ecosystems, which is unlikely to result in a substantial adverse change in its functioning or harm to a species of special interest that would endanger the long-term maintenance of the population. Minor damage to crops, buildings or property.	Exposure could lead to slight short-term effects (e.g. mild skin rash). Surface spalling of concrete.
Minor	No measurable effect on humans. Equivalent to insubstantial pollution incident with no observed effect on water quality or ecosystems. Repairable effects of damage to buildings, structures and services.	The loss of plants in a landscaping scheme. Discoloration of concrete.

* For these purposes, disease is to be taken to mean an unhealthy condition of the body or a part of it and can include, for example, cancer, liver dysfunction or extensive skin ailments. Mental dysfunction is included only insofar as it is attributable to the effects of a pollutant on the body of the person concerned.

B3. Classification of Probability

Only applies if there is a possibility of a pollutant linkage being present.

Classification	Definition	Examples
High likelihood	There is pollutant linkage and an event would appear very likely in the short-term and almost inevitable over the long-term, or there is evidence at the receptor of harm or pollution.	a) Elevated concentrations of toxic contaminants are present in soils in the top 0.5m in a residential garden. b) Ground/groundwater contamination could be present from chemical works, containing a number of USTs, having been in operation on the same site for over 50
Likely	There is pollutant linkage and all the elements are present and in the right place which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short-term and likely over the long-term.	a) Elevated concentrations of toxic contaminants are present in soils at depths of 0.5-1.0m in a residential garden, or the top 0.5m in public open space. b) Ground/groundwater contamination could be present from an industrial site containing a UST present between 1970 and 1990. The tank is known to be single skin. There is no evidence of leakage although there are no records of integrity tests.
Low likelihood	There is pollutant linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a long period such an event would take place and is less likely in the shorter term.	a) Elevated concentrations of toxic contaminants are present in soils at depths >1m in a residential garden, or 0.5-1.0m in public open space. b) Ground/groundwater contamination could be present on a light industrial unit constructed in the 1990s containing a UST in operation over the last 10 years – the tank is double skinned but there is no integrity testing or evidence of leakage.
Unlikely	There is pollutant linkage but circumstances are such that it is improbable that an event would occur even in the very long-term.	a) Elevated concentrations of toxic contaminants are present below hard standing. b) Light industrial unit <10 yrs. old containing a double-skinned UST with annual integrity testing results available.

Note: A pollution linkage must first be established before probability is classified. If there is no pollution linkage, then there is no potential risk. If there is no pollution linkage, then there is no need to apply tests for probability and consequence.

For example, if there is surface contamination and a major aquifer is present at depth, but this major aquifer is overlain by an aquiclude of significant thickness then there is no pollution linkage and the risks to the major aquifer are not assessed. The report should identify both the source and the receptor but state that because there is no linkage there are no potential risks.

B4. The Classification of Risk

		Consequence			
		Severe	Medium	Mild	Minor
Probability	High likelihood	Very high risk	High risk	Moderate risk	Low risk
	Likely	High risk	Moderate risk	Moderate/low risk	Low risk
	Low likelihood	Moderate risk	Moderate/low risk	Low risk	Very low risk
	Unlikely	Moderate/low risk	Low risk	Very low risk	Very low risk

B5. Description of the Classified Risks

Very high risk

There is a high probability that severe harm could arise to a designated receptor from an identified hazard at the site without remediation action OR there is evidence that severe harm to a designated receptor is already occurring. Realisation of that risk is likely to present a substantial liability to be site owner/or occupier. Investigation is required as a matter of urgency and remediation works likely to follow in the short-term.

High risk

Harm is likely to arise to a designated receptor from an identified hazard at the site without remediation action. Realisation of the risk is likely to present a substantial liability to the site owner/or occupier. Investigation is required as a matter of urgency to clarify the risk. Remediation works may be necessary in the short-term and are likely over the longer term.

Moderate risk

It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, and if any harm were to occur it is more likely, that the harm would be relatively mild. Further investigative work is normally required to clarify the risk and to determine the potential liability to site owner/occupier. Some remediation works may be required in the longer term.

Low risk

It is possible that harm could arise to a designated receptor from identified hazard, but it is likely at worst, that this harm if realised would normally be mild. It is unlikely that the site owner/or occupier would face substantial liabilities from such a risk. Further investigative work (which is likely to be limited) to clarify the risk may be required. Any subsequent remediation works are likely to be relatively limited.

Very low risk

It is a low possibility that harm could arise to a designated receptor, but it is likely at worst, that this harm if realised would normally be mild or minor.

No potential risk

There is no potential risk if no pollution linkage has been established.

B6. Definitions

Term	Definition
Hazard	A property or situation which in certain circumstances could lead to harm. The properties of different hazards must be assessed in relation to their potential to affect the various receptors.
Risk	A combination of the probability or frequency of the occurrences of a defined hazard AND the magnitude of the consequences of that occurrence.
Probability	The mathematical expression of the chance of a particular event in a given period of time [e.g. probability of 0.2 is equivalent to 20% or a 1 in 5 chance].
Impact	The adverse effects (or harm) arising from a defined hazard which impairs the quality of the environment or human health in the short or longer term.
Pollution linkage	An identified pathway is capable of exposing a receptor to a contaminant and that contaminant is capable of harming the receptor.

APPENDIX E: HAZWASTE CLASSIFICATION REPORT

Waste Classification Report

HazWasteOnline™ classifies waste as either **hazardous** or **non-hazardous** based on its chemical composition, related legislation and the rules and data defined in the current UK or EU technical guidance (Appendix C) (note that HP 9 Infectious is not assessed). It is the responsibility of the classifier named below to:

- understand the origin of the waste
- select the correct List of Waste code(s)
- confirm that the list of determinands, results and sampling plan are fit for purpose
- select and justify the chosen metal species (Appendix B)
- correctly apply moisture correction and other available corrections
- add the meta data for their user-defined substances (Appendix A)
- check that the classification engine is suitable with respect to the national destination of the waste (Appendix C)



QPQ2G-P4TDP-YKATN

To aid the reviewer, the laboratory results, assumptions and justifications managed by the classifier are highlighted in pale yellow.

Job name

23192

Description/Comments

Project

23192

Site

Bartlett Arboretum

Classified by

Name: **Philip Webber**
 Date: **01 Sep 2023 14:27 GMT**
 Telephone: **01752 222200**
 Company: **Jubb Consulting Engineers Ltd**
Unit 1 Ensign House
Parkway Court
Marsh Mills
PL6 8LR

HazWasteOnline™ provides a two day, hazardous waste classification course that covers the use of the software and both basic and advanced waste classification techniques. Certification has to be renewed every 3 years.

HazWasteOnline™ Certification:

Course	Date
Hazardous Waste Classification	50% complete

Purpose of classification

2 - Material Characterisation

Address of the waste

N/A

Post Code N/A

SIC for the process giving rise to the waste

41201 Construction of commercial buildings

Description of industry/producer giving rise to the waste

Made Ground

Description of the specific process, sub-process and/or activity that created the waste

Made Ground

Description of the waste

Shallow site soils



Job summary

#	Sample name	Depth [m]	Classification Result	Hazard properties	Page
1	TP4	0.5	Non Hazardous		3
2	WS1	0.5	Non Hazardous		5
3	WS2	0.1	Non Hazardous		7
4	WS3	0.1	Non Hazardous		9
5	WS4	0.1	Non Hazardous		11
6	TP1	0.1	Non Hazardous		13
7	TP2	0.1	Non Hazardous		15
8	WS5	0.1	Non Hazardous		17

Related documents

#	Name	Description
1	General Brownfield Soils	waste stream template used to create this Job

Report

Created by: Philip Webber

Created date: 01 Sep 2023 14:27 GMT

Appendices	Page
Appendix A: Classifier defined and non GB MCL determinands	19
Appendix B: Rationale for selection of metal species	20
Appendix C: Version	20

Classification of sample: TP4

✔ **Non Hazardous Waste**
Classified as **17 05 04**
in the List of Waste

Sample details

Sample name:	LoW Code:
TP4	Chapter: 17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
Sample Depth:	Entry: 17 05 04 (Soil and stones other than those mentioned in 17 05 03)
0.5 m	
Moisture content:	
9.8%	
(no correction)	

Hazard properties

None identified

Determinands

Moisture content: 9.8% No Moisture Correction applied (MC)

#	Determinand			CLP Note	User entered data	Conv. Factor	Compound conc.		Classification value	MC Applied	Conc. Not Used
	EU CLP index number	EC Number	CAS Number								
1	arsenic { arsenic trioxide }				11 mg/kg	1.32	14.524 mg/kg	0.00145 %			
	033-003-00-0	215-481-4	1327-53-3								
2	cadmium { cadmium sulfide }			1	<0.2 mg/kg	1.285	<0.257 mg/kg	<0.00002 %			<LOD
	048-010-00-4	215-147-8	1306-23-6								
3	chromium in chromium(III) compounds { chromium(III) oxide (worst case) }				33 mg/kg	1.462	48.231 mg/kg	0.00482 %			
		215-160-9	1308-38-9								
4	chromium in chromium(VI) compounds { chromium(VI) oxide }				<1.2 mg/kg	1.923	<2.308 mg/kg	<0.000231 %			<LOD
	024-001-00-0	215-607-8	1333-82-0								
5	lead { lead chromate }			1	11 mg/kg	1.56	17.158 mg/kg	0.0011 %			
	082-004-00-2	231-846-0	7758-97-6								
6	mercury { mercury dichloride }				<0.3 mg/kg	1.353	<0.406 mg/kg	<0.0000406 %			<LOD
	080-010-00-X	231-299-8	7487-94-7								
7	copper { dicopper oxide; copper (I) oxide }				13 mg/kg	1.126	14.637 mg/kg	0.00146 %			
	029-002-00-X	215-270-7	1317-39-1								
8	nickel { nickel dihydroxide }				13 mg/kg	1.579	20.533 mg/kg	0.00205 %			
	028-008-00-X	235-008-5 [1] 234-348-1 [2]	12054-48-7 [1] 11113-74-9 [2]								
9	selenium { selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex }				<1 mg/kg	1.405	<1.405 mg/kg	<0.000141 %			<LOD
	034-002-00-8										
10	zinc { zinc oxide }				33 mg/kg	1.245	41.076 mg/kg	0.00411 %			
	030-013-00-7	215-222-5	1314-13-2								
11	pH				8 pH		8 pH	8pH			
			PH								
12	naphthalene				<0.05 mg/kg		<0.05 mg/kg	<0.000005 %			<LOD
	601-052-00-2	202-049-5	91-20-3								
13	acenaphthylene				<0.05 mg/kg		<0.05 mg/kg	<0.000005 %			<LOD
		205-917-1	208-96-8								
14	acenaphthene				<0.05 mg/kg		<0.05 mg/kg	<0.000005 %			<LOD
		201-469-6	83-32-9								
15	fluorene				<0.05 mg/kg		<0.05 mg/kg	<0.000005 %			<LOD
		201-695-5	86-73-7								

#	Determinand			CLP Note	User entered data	Conv. Factor	Compound conc.	Classification value	MC Applied	Conc. Not Used
	EU CLP index number	EC Number	CAS Number							
16	phenanthrene	201-581-5	85-01-8		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
17	anthracene	204-371-1	120-12-7		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
18	fluoranthene	205-912-4	206-44-0		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
19	pyrene	204-927-3	129-00-0		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
20	benzo[a]anthracene	601-033-00-9	200-280-6		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
21	chrysene	601-048-00-0	205-923-4		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
22	benzo[b]fluoranthene	601-034-00-4	205-911-9		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
23	benzo[k]fluoranthene	601-036-00-5	205-916-6		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
24	benzo[a]pyrene; benzo[def]chrysene	601-032-00-3	200-028-5		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
25	indeno[123-cd]pyrene	205-893-2	193-39-5		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
26	dibenz[a,h]anthracene	601-041-00-2	200-181-8		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
27	benzo[ghi]perylene	205-883-8	191-24-2		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
Total:								0.0155 %		

Key

	User supplied data
	Determinand values ignored for classification, see column 'Conc. Not Used' for reason
	Determinand defined or amended by HazWasteOnline (see Appendix A)
	Speciated Determinand - Unless the Determinand is Note 1, the Conversion Factor is used to calculate the compound concentration
<LOD	Below limit of detection
CLP: Note 1	Only the metal concentration has been used for classification

Classification of sample: WS1

 **Non Hazardous Waste**
Classified as **17 05 04**
in the List of Waste

Sample details

Sample name:	LoW Code:
WS1	Chapter:
Sample Depth:	17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
0.5 m	Entry:
Moisture content:	17 05 04 (Soil and stones other than those mentioned in 17 05 03)
12%	
(no correction)	

Hazard properties

None identified

Determinands

Moisture content: 12% No Moisture Correction applied (MC)

#	Determinand			CLP Note	User entered data	Conv. Factor	Compound conc.		Classification value	MC Applied	Conc. Not Used
	EU CLP index number	EC Number	CAS Number								
1	 arsenic { arsenic trioxide }				20 mg/kg	1.32	26.407	mg/kg	0.00264 %		
	033-003-00-0	215-481-4	1327-53-3								
2	 cadmium { cadmium sulfide }			1	<0.2 mg/kg	1.285	<0.257	mg/kg	<0.00002 %		<LOD
	048-010-00-4	215-147-8	1306-23-6								
3	 chromium in chromium(III) compounds { chromium(III) oxide (worst case) }				53 mg/kg	1.462	77.462	mg/kg	0.00775 %		
		215-160-9	1308-38-9								
4	 chromium in chromium(VI) compounds { chromium(VI) oxide }				<1.2 mg/kg	1.923	<2.308	mg/kg	<0.000231 %		<LOD
	024-001-00-0	215-607-8	1333-82-0								
5	 lead { lead chromate }			1	16 mg/kg	1.56	24.957	mg/kg	0.0016 %		
	082-004-00-2	231-846-0	7758-97-6								
6	 mercury { mercury dichloride }				<0.3 mg/kg	1.353	<0.406	mg/kg	<0.0000406 %		<LOD
	080-010-00-X	231-299-8	7487-94-7								
7	 copper { dicopper oxide; copper (I) oxide }				24 mg/kg	1.126	27.021	mg/kg	0.0027 %		
	029-002-00-X	215-270-7	1317-39-1								
8	 nickel { nickel dihydroxide }				14 mg/kg	1.579	22.113	mg/kg	0.00221 %		
	028-008-00-X	235-008-5 [1] 234-348-1 [2]	12054-48-7 [1] 11113-74-9 [2]								
9	 selenium { selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex }				<1 mg/kg	1.405	<1.405	mg/kg	<0.000141 %		<LOD
	034-002-00-8										
10	 zinc { zinc oxide }				48 mg/kg	1.245	59.746	mg/kg	0.00597 %		
	030-013-00-7	215-222-5	1314-13-2								
11	pH				7.4 pH		7.4	pH	7.4 pH		
			PH								
12	naphthalene				<0.05 mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
	601-052-00-2	202-049-5	91-20-3								
13	acenaphthylene				<0.05 mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
		205-917-1	208-96-8								
14	acenaphthene				<0.05 mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
		201-469-6	83-32-9								
15	fluorene				<0.05 mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
		201-695-5	86-73-7								

#	Determinand			CLP Note	User entered data	Conv. Factor	Compound conc.	Classification value	MC Applied	Conc. Not Used
	EU CLP index number	EC Number	CAS Number							
16	phenanthrene	201-581-5	85-01-8		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
17	anthracene	204-371-1	120-12-7		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
18	fluoranthene	205-912-4	206-44-0		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
19	pyrene	204-927-3	129-00-0		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
20	benzo[a]anthracene	601-033-00-9	200-280-6		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
21	chrysene	601-048-00-0	205-923-4		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
22	benzo[b]fluoranthene	601-034-00-4	205-911-9		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
23	benzo[k]fluoranthene	601-036-00-5	205-916-6		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
24	benzo[a]pyrene; benzo[def]chrysene	601-032-00-3	200-028-5		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
25	indeno[123-cd]pyrene	205-893-2	193-39-5		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
26	dibenz[a,h]anthracene	601-041-00-2	200-181-8		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
27	benzo[ghi]perylene	205-883-8	191-24-2		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
Total:								0.0234 %		

Key

	User supplied data
	Determinand values ignored for classification, see column 'Conc. Not Used' for reason
	Determinand defined or amended by HazWasteOnline (see Appendix A)
	Speciated Determinand - Unless the Determinand is Note 1, the Conversion Factor is used to calculate the compound concentration
<LOD	Below limit of detection
CLP: Note 1	Only the metal concentration has been used for classification

Classification of sample: WS2

✔ **Non Hazardous Waste**
Classified as **17 05 04**
in the List of Waste

Sample details

Sample name:	LoW Code:
WS2	Chapter:
Sample Depth:	17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
0.1 m	Entry:
Moisture content:	17 05 04 (Soil and stones other than those mentioned in 17 05 03)
4.4%	
(no correction)	

Hazard properties

None identified

Determinands

Moisture content: 4.4% No Moisture Correction applied (MC)

#	Determinand			CLP Note	User entered data	Conv. Factor	Compound conc.		Classification value	MC Applied	Conc. Not Used
	EU CLP index number	EC Number	CAS Number								
1	arsenic { arsenic trioxide }				6.2 mg/kg	1.32	8.186 mg/kg	0.000819 %			
	033-003-00-0	215-481-4	1327-53-3								
2	cadmium { cadmium sulfide }			1	0.3 mg/kg	1.285	0.386 mg/kg	0.00003 %			
	048-010-00-4	215-147-8	1306-23-6								
3	chromium in chromium(III) compounds { chromium(III) oxide (worst case) }				15 mg/kg	1.462	21.923 mg/kg	0.00219 %			
		215-160-9	1308-38-9								
4	chromium in chromium(VI) compounds { chromium(VI) oxide }				<1.2 mg/kg	1.923	<2.308 mg/kg	<0.000231 %			<LOD
	024-001-00-0	215-607-8	1333-82-0								
5	lead { lead chromate }			1	30 mg/kg	1.56	46.794 mg/kg	0.003 %			
	082-004-00-2	231-846-0	7758-97-6								
6	mercury { mercury dichloride }				<0.3 mg/kg	1.353	<0.406 mg/kg	<0.0000406 %			<LOD
	080-010-00-X	231-299-8	7487-94-7								
7	copper { dicopper oxide; copper (I) oxide }				14 mg/kg	1.126	15.762 mg/kg	0.00158 %			
	029-002-00-X	215-270-7	1317-39-1								
8	nickel { nickel dihydroxide }				5.2 mg/kg	1.579	8.213 mg/kg	0.000821 %			
	028-008-00-X	235-008-5 [1] 234-348-1 [2]	12054-48-7 [1] 11113-74-9 [2]								
9	selenium { selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex }				<1 mg/kg	1.405	<1.405 mg/kg	<0.000141 %			<LOD
	034-002-00-8										
10	zinc { zinc oxide }				54 mg/kg	1.245	67.215 mg/kg	0.00672 %			
	030-013-00-7	215-222-5	1314-13-2								
11	pH				7.4 pH		7.4 pH	7.4 pH			
			PH								
12	naphthalene				<0.05 mg/kg		<0.05 mg/kg	<0.000005 %			<LOD
	601-052-00-2	202-049-5	91-20-3								
13	acenaphthylene				<0.05 mg/kg		<0.05 mg/kg	<0.000005 %			<LOD
		205-917-1	208-96-8								
14	acenaphthene				<0.05 mg/kg		<0.05 mg/kg	<0.000005 %			<LOD
		201-469-6	83-32-9								
15	fluorene				<0.05 mg/kg		<0.05 mg/kg	<0.000005 %			<LOD
		201-695-5	86-73-7								

#	Determinand			CLP Note	User entered data	Conv. Factor	Compound conc.	Classification value	MC Applied	Conc. Not Used
	EU CLP index number	EC Number	CAS Number							
16	phenanthrene	201-581-5	85-01-8		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
17	anthracene	204-371-1	120-12-7		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
18	fluoranthene	205-912-4	206-44-0		0.09 mg/kg		0.09 mg/kg	0.000009 %		
19	pyrene	204-927-3	129-00-0		0.08 mg/kg		0.08 mg/kg	0.000008 %		
20	benzo[a]anthracene	601-033-00-9	200-280-6		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
21	chrysene	601-048-00-0	205-923-4		0.05 mg/kg		0.05 mg/kg	0.000005 %		
22	benzo[b]fluoranthene	601-034-00-4	205-911-9		0.06 mg/kg		0.06 mg/kg	0.000006 %		
23	benzo[k]fluoranthene	601-036-00-5	205-916-6		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
24	benzo[a]pyrene; benzo[def]chrysene	601-032-00-3	200-028-5		0.05 mg/kg		0.05 mg/kg	0.000005 %		
25	indeno[123-cd]pyrene	205-893-2	193-39-5		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
26	dibenz[a,h]anthracene	601-041-00-2	200-181-8		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
27	benzo[ghi]perylene	205-883-8	191-24-2		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
Total:								0.0157 %		

Key

	User supplied data
	Determinand values ignored for classification, see column 'Conc. Not Used' for reason
	Determinand defined or amended by HazWasteOnline (see Appendix A)
	Speciated Determinand - Unless the Determinand is Note 1, the Conversion Factor is used to calculate the compound concentration
<LOD	Below limit of detection
CLP: Note 1	Only the metal concentration has been used for classification

Classification of sample: WS3

 **Non Hazardous Waste**
Classified as **17 05 04**
in the List of Waste

Sample details

Sample name:	LoW Code:
WS3	Chapter:
Sample Depth:	17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
0.1 m	Entry:
Moisture content:	17 05 04 (Soil and stones other than those mentioned in 17 05 03)
8.4%	
(no correction)	

Hazard properties

None identified

Determinands

Moisture content: 8.4% No Moisture Correction applied (MC)

#	Determinand			CLP Note	User entered data	Conv. Factor	Compound conc.		Classification value	MC Applied	Conc. Not Used
	EU CLP index number	EC Number	CAS Number								
1	 arsenic { arsenic trioxide }				6.3 mg/kg	1.32	8.318 mg/kg	0.000832 %			
	033-003-00-0	215-481-4	1327-53-3								
2	 cadmium { cadmium sulfide }			1	2.4 mg/kg	1.285	3.085 mg/kg	0.00024 %			
	048-010-00-4	215-147-8	1306-23-6								
3	 chromium in chromium(III) compounds { chromium(III) oxide (worst case) }				14 mg/kg	1.462	20.462 mg/kg	0.00205 %			
		215-160-9	1308-38-9								
4	 chromium in chromium(VI) compounds { chromium(VI) oxide }				<1.2 mg/kg	1.923	<2.308 mg/kg	<0.000231 %			<LOD
	024-001-00-0	215-607-8	1333-82-0								
5	 lead { lead chromate }			1	62 mg/kg	1.56	96.709 mg/kg	0.0062 %			
	082-004-00-2	231-846-0	7758-97-6								
6	 mercury { mercury dichloride }				<0.3 mg/kg	1.353	<0.406 mg/kg	<0.0000406 %			<LOD
	080-010-00-X	231-299-8	7487-94-7								
7	 copper { dicopper oxide; copper (I) oxide }				18 mg/kg	1.126	20.266 mg/kg	0.00203 %			
	029-002-00-X	215-270-7	1317-39-1								
8	 nickel { nickel dihydroxide }				5.8 mg/kg	1.579	9.161 mg/kg	0.000916 %			
	028-008-00-X	235-008-5 [1] 234-348-1 [2]	12054-48-7 [1] 11113-74-9 [2]								
9	 selenium { selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex }				<1 mg/kg	1.405	<1.405 mg/kg	<0.000141 %			<LOD
	034-002-00-8										
10	 zinc { zinc oxide }				260 mg/kg	1.245	323.626 mg/kg	0.0324 %			
	030-013-00-7	215-222-5	1314-13-2								
11	 pH				8.4 pH		8.4 pH	8.4 pH			
			PH								
12	naphthalene				<0.05 mg/kg		<0.05 mg/kg	<0.000005 %			<LOD
	601-052-00-2	202-049-5	91-20-3								
13	 acenaphthylene				<0.05 mg/kg		<0.05 mg/kg	<0.000005 %			<LOD
		205-917-1	208-96-8								
14	 acenaphthene				<0.05 mg/kg		<0.05 mg/kg	<0.000005 %			<LOD
		201-469-6	83-32-9								
15	 fluorene				<0.05 mg/kg		<0.05 mg/kg	<0.000005 %			<LOD
		201-695-5	86-73-7								

#	Determinand			CLP Note	User entered data	Conv. Factor	Compound conc.	Classification value	MC Applied	Conc. Not Used
	EU CLP index number	EC Number	CAS Number							
16	phenanthrene	201-581-5	85-01-8		0.07 mg/kg		0.07 mg/kg	0.000007 %		
17	anthracene	204-371-1	120-12-7		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
18	fluoranthene	205-912-4	206-44-0		0.24 mg/kg		0.24 mg/kg	0.000024 %		
19	pyrene	204-927-3	129-00-0		0.22 mg/kg		0.22 mg/kg	0.000022 %		
20	benzo[a]anthracene	601-033-00-9	200-280-6		0.11 mg/kg		0.11 mg/kg	0.000011 %		
21	chrysene	601-048-00-0	205-923-4		0.14 mg/kg		0.14 mg/kg	0.000014 %		
22	benzo[b]fluoranthene	601-034-00-4	205-911-9		0.17 mg/kg		0.17 mg/kg	0.000017 %		
23	benzo[k]fluoranthene	601-036-00-5	205-916-6		0.08 mg/kg		0.08 mg/kg	0.000008 %		
24	benzo[a]pyrene; benzo[def]chrysene	601-032-00-3	200-028-5		0.13 mg/kg		0.13 mg/kg	0.000013 %		
25	indeno[123-cd]pyrene	205-893-2	193-39-5		0.08 mg/kg		0.08 mg/kg	0.000008 %		
26	dibenz[a,h]anthracene	601-041-00-2	200-181-8		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
27	benzo[ghi]perylene	205-883-8	191-24-2		0.09 mg/kg		0.09 mg/kg	0.000009 %		
Total:								0.0452 %		

Key

	User supplied data
	Determinand values ignored for classification, see column 'Conc. Not Used' for reason
	Determinand defined or amended by HazWasteOnline (see Appendix A)
	Speciated Determinand - Unless the Determinand is Note 1, the Conversion Factor is used to calculate the compound concentration
<LOD	Below limit of detection
CLP: Note 1	Only the metal concentration has been used for classification

Classification of sample: WS4

✔ **Non Hazardous Waste**
Classified as **17 05 04**
in the List of Waste

Sample details

Sample name:	LoW Code:
WS4	Chapter:
Sample Depth:	17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
0.1 m	Entry:
Moisture content:	17 05 04 (Soil and stones other than those mentioned in 17 05 03)
5.3%	
(no correction)	

Hazard properties

None identified

Determinands

Moisture content: 5.3% No Moisture Correction applied (MC)

#	Determinand			CLP Note	User entered data	Conv. Factor	Compound conc.		Classification value	MC Applied	Conc. Not Used
	EU CLP index number	EC Number	CAS Number								
1	arsenic { arsenic trioxide }				5.8 mg/kg	1.32	7.658 mg/kg	0.000766 %			
	033-003-00-0	215-481-4	1327-53-3								
2	cadmium { cadmium sulfide }			1	<0.2 mg/kg	1.285	<0.257 mg/kg	<0.00002 %			<LOD
	048-010-00-4	215-147-8	1306-23-6								
3	chromium in chromium(III) compounds { chromium(III) oxide (worst case) }				12 mg/kg	1.462	17.539 mg/kg	0.00175 %			
		215-160-9	1308-38-9								
4	chromium in chromium(VI) compounds { chromium(VI) oxide }				<1.2 mg/kg	1.923	<2.308 mg/kg	<0.000231 %			<LOD
	024-001-00-0	215-607-8	1333-82-0								
5	lead { lead chromate }			1	17 mg/kg	1.56	26.517 mg/kg	0.0017 %			
	082-004-00-2	231-846-0	7758-97-6								
6	mercury { mercury dichloride }				<0.3 mg/kg	1.353	<0.406 mg/kg	<0.0000406 %			<LOD
	080-010-00-X	231-299-8	7487-94-7								
7	copper { dicopper oxide; copper (I) oxide }				12 mg/kg	1.126	13.511 mg/kg	0.00135 %			
	029-002-00-X	215-270-7	1317-39-1								
8	nickel { nickel dihydroxide }				6.6 mg/kg	1.579	10.425 mg/kg	0.00104 %			
	028-008-00-X	235-008-5 [1] 234-348-1 [2]	12054-48-7 [1] 11113-74-9 [2]								
9	selenium { selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex }				<1 mg/kg	1.405	<1.405 mg/kg	<0.000141 %			<LOD
	034-002-00-8										
10	zinc { zinc oxide }				39 mg/kg	1.245	48.544 mg/kg	0.00485 %			
	030-013-00-7	215-222-5	1314-13-2								
11	pH				7.1 pH		7.1 pH	7.1 pH			
			PH								
12	naphthalene				<0.05 mg/kg		<0.05 mg/kg	<0.000005 %			<LOD
	601-052-00-2	202-049-5	91-20-3								
13	acenaphthylene				<0.05 mg/kg		<0.05 mg/kg	<0.000005 %			<LOD
		205-917-1	208-96-8								
14	acenaphthene				<0.05 mg/kg		<0.05 mg/kg	<0.000005 %			<LOD
		201-469-6	83-32-9								
15	fluorene				<0.05 mg/kg		<0.05 mg/kg	<0.000005 %			<LOD
		201-695-5	86-73-7								

#	Determinand			CLP Note	User entered data	Conv. Factor	Compound conc.	Classification value	MC Applied	Conc. Not Used
	EU CLP index number	EC Number	CAS Number							
16	phenanthrene	201-581-5	85-01-8		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
17	anthracene	204-371-1	120-12-7		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
18	fluoranthene	205-912-4	206-44-0		0.13 mg/kg		0.13 mg/kg	0.000013 %		
19	pyrene	204-927-3	129-00-0		0.12 mg/kg		0.12 mg/kg	0.000012 %		
20	benzo[a]anthracene	601-033-00-9	200-280-6		0.06 mg/kg		0.06 mg/kg	0.000006 %		
21	chrysene	601-048-00-0	205-923-4		0.07 mg/kg		0.07 mg/kg	0.000007 %		
22	benzo[b]fluoranthene	601-034-00-4	205-911-9		0.08 mg/kg		0.08 mg/kg	0.000008 %		
23	benzo[k]fluoranthene	601-036-00-5	205-916-6		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
24	benzo[a]pyrene; benzo[def]chrysene	601-032-00-3	200-028-5		0.07 mg/kg		0.07 mg/kg	0.000007 %		
25	indeno[123-cd]pyrene	205-893-2	193-39-5		0.05 mg/kg		0.05 mg/kg	0.000005 %		
26	dibenz[a,h]anthracene	601-041-00-2	200-181-8		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
27	benzo[ghi]perylene	205-883-8	191-24-2		0.05 mg/kg		0.05 mg/kg	0.000005 %		
28	TPH (C6 to C40) petroleum group		TPH		22 mg/kg		22 mg/kg	0.0022 %		
Total:								0.0142 %		

Key

	User supplied data
	Determinand values ignored for classification, see column 'Conc. Not Used' for reason
•	Determinand defined or amended by HazWasteOnline (see Appendix A)
•	Speciated Determinand - Unless the Determinand is Note 1, the Conversion Factor is used to calculate the compound concentration
<LOD	Below limit of detection
CLP: Note 1	Only the metal concentration has been used for classification

Supplementary Hazardous Property Information

HP 3(i): Flammable "flammable liquid waste: liquid waste having a flash point below 60°C or waste gas oil, diesel and light heating oils having a flash point > 55°C and ≤ 75°C"

Force this Hazardous property to non hazardous because Not at flammable concentration

Hazard Statements hit:

Flam. Liq. 3; H226 "Flammable liquid and vapour."

Because of determinand:

TPH (C6 to C40) petroleum group: (conc.: 0.0022%)

Classification of sample: TP1

✔ **Non Hazardous Waste**
Classified as **17 05 04**
in the List of Waste

Sample details

Sample name:	LoW Code:
TP1	Chapter:
Sample Depth:	17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
0.1 m	Entry:
Moisture content:	17 05 04 (Soil and stones other than those mentioned in 17 05 03)
13%	
(no correction)	

Hazard properties

None identified

Determinands

Moisture content: 13% No Moisture Correction applied (MC)

#	Determinand			CLP Note	User entered data	Conv. Factor	Compound conc.		Classification value	MC Applied	Conc. Not Used
	EU CLP index number	EC Number	CAS Number								
1	arsenic { arsenic trioxide }				6.4 mg/kg	1.32	8.45 mg/kg	0.000845 %			
	033-003-00-0	215-481-4	1327-53-3								
2	cadmium { cadmium sulfide }			1	<0.2 mg/kg	1.285	<0.257 mg/kg	<0.00002 %			<LOD
	048-010-00-4	215-147-8	1306-23-6								
3	chromium in chromium(III) compounds { chromium(III) oxide (worst case) }				20 mg/kg	1.462	29.231 mg/kg	0.00292 %			
		215-160-9	1308-38-9								
4	chromium in chromium(VI) compounds { chromium(VI) oxide }				<1.2 mg/kg	1.923	<2.308 mg/kg	<0.000231 %			<LOD
	024-001-00-0	215-607-8	1333-82-0								
5	lead { lead chromate }			1	33 mg/kg	1.56	51.474 mg/kg	0.0033 %			
	082-004-00-2	231-846-0	7758-97-6								
6	mercury { mercury dichloride }				<0.3 mg/kg	1.353	<0.406 mg/kg	<0.0000406 %			<LOD
	080-010-00-X	231-299-8	7487-94-7								
7	copper { dicopper oxide; copper (I) oxide }				14 mg/kg	1.126	15.762 mg/kg	0.00158 %			
	029-002-00-X	215-270-7	1317-39-1								
8	nickel { nickel dihydroxide }				7 mg/kg	1.579	11.056 mg/kg	0.00111 %			
	028-008-00-X	235-008-5 [1] 234-348-1 [2]	12054-48-7 [1] 11113-74-9 [2]								
9	selenium { selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex }				<1 mg/kg	1.405	<1.405 mg/kg	<0.000141 %			<LOD
	034-002-00-8										
10	zinc { zinc oxide }				53 mg/kg	1.245	65.97 mg/kg	0.0066 %			
	030-013-00-7	215-222-5	1314-13-2								
11	pH				6.8 pH		6.8 pH	6.8 pH			
			PH								
12	naphthalene				0.15 mg/kg		0.15 mg/kg	0.000015 %			
	601-052-00-2	202-049-5	91-20-3								
13	acenaphthylene				<0.05 mg/kg		<0.05 mg/kg	<0.000005 %			<LOD
		205-917-1	208-96-8								
14	acenaphthene				<0.05 mg/kg		<0.05 mg/kg	<0.000005 %			<LOD
		201-469-6	83-32-9								
15	fluorene				<0.05 mg/kg		<0.05 mg/kg	<0.000005 %			<LOD
		201-695-5	86-73-7								

#	Determinand			CLP Note	User entered data	Conv. Factor	Compound conc.	Classification value	MC Applied	Conc. Not Used
	EU CLP index number	EC Number	CAS Number							
16	phenanthrene	201-581-5	85-01-8		0.08 mg/kg		0.08 mg/kg	0.000008 %		
17	anthracene	204-371-1	120-12-7		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
18	fluoranthene	205-912-4	206-44-0		0.22 mg/kg		0.22 mg/kg	0.000022 %		
19	pyrene	204-927-3	129-00-0		0.2 mg/kg		0.2 mg/kg	0.00002 %		
20	benzo[a]anthracene	601-033-00-9	200-280-6		0.11 mg/kg		0.11 mg/kg	0.000011 %		
21	chrysene	601-048-00-0	205-923-4		0.12 mg/kg		0.12 mg/kg	0.000012 %		
22	benzo[b]fluoranthene	601-034-00-4	205-911-9		0.18 mg/kg		0.18 mg/kg	0.000018 %		
23	benzo[k]fluoranthene	601-036-00-5	205-916-6		0.07 mg/kg		0.07 mg/kg	0.000007 %		
24	benzo[a]pyrene; benzo[def]chrysene	601-032-00-3	200-028-5		0.13 mg/kg		0.13 mg/kg	0.000013 %		
25	indeno[123-cd]pyrene	205-893-2	193-39-5		0.09 mg/kg		0.09 mg/kg	0.000009 %		
26	dibenz[a,h]anthracene	601-041-00-2	200-181-8		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
27	benzo[ghi]perylene	205-883-8	191-24-2		0.11 mg/kg		0.11 mg/kg	0.000011 %		
Total:								0.0169 %		

Key

	User supplied data
	Determinand values ignored for classification, see column 'Conc. Not Used' for reason
•	Determinand defined or amended by HazWasteOnline (see Appendix A)
•	Speciated Determinand - Unless the Determinand is Note 1, the Conversion Factor is used to calculate the compound concentration
<LOD	Below limit of detection
CLP: Note 1	Only the metal concentration has been used for classification

Classification of sample: TP2

✔ **Non Hazardous Waste**
Classified as **17 05 04**
in the List of Waste

Sample details

Sample name:	LoW Code:
TP2	Chapter:
Sample Depth:	17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
0.1 m	Entry:
Moisture content:	17 05 04 (Soil and stones other than those mentioned in 17 05 03)
4.1%	
(no correction)	

Hazard properties

None identified

Determinands

Moisture content: 4.1% No Moisture Correction applied (MC)

#	Determinand			CLP Note	User entered data	Conv. Factor	Compound conc.		Classification value	MC Applied	Conc. Not Used
	EU CLP index number	EC Number	CAS Number								
1	arsenic { arsenic trioxide }				9.1 mg/kg	1.32	12.015 mg/kg	0.0012 %			
	033-003-00-0	215-481-4	1327-53-3								
2	cadmium { cadmium sulfide }			1	<0.2 mg/kg	1.285	<0.257 mg/kg	<0.00002 %			<LOD
	048-010-00-4	215-147-8	1306-23-6								
3	chromium in chromium(III) compounds { chromium(III) oxide (worst case) }				20 mg/kg	1.462	29.231 mg/kg	0.00292 %			
		215-160-9	1308-38-9								
4	chromium in chromium(VI) compounds { chromium(VI) oxide }				<1.2 mg/kg	1.923	<2.308 mg/kg	<0.000231 %			<LOD
	024-001-00-0	215-607-8	1333-82-0								
5	lead { lead chromate }			1	32 mg/kg	1.56	49.914 mg/kg	0.0032 %			
	082-004-00-2	231-846-0	7758-97-6								
6	mercury { mercury dichloride }				<0.3 mg/kg	1.353	<0.406 mg/kg	<0.0000406 %			<LOD
	080-010-00-X	231-299-8	7487-94-7								
7	copper { dicopper oxide; copper (I) oxide }				14 mg/kg	1.126	15.762 mg/kg	0.00158 %			
	029-002-00-X	215-270-7	1317-39-1								
8	nickel { nickel dihydroxide }				7.2 mg/kg	1.579	11.372 mg/kg	0.00114 %			
	028-008-00-X	235-008-5 [1] 234-348-1 [2]	12054-48-7 [1] 11113-74-9 [2]								
9	selenium { selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex }				<1 mg/kg	1.405	<1.405 mg/kg	<0.000141 %			<LOD
	034-002-00-8										
10	zinc { zinc oxide }				51 mg/kg	1.245	63.48 mg/kg	0.00635 %			
	030-013-00-7	215-222-5	1314-13-2								
11	pH				6.6 pH		6.6 pH	6.6 pH			
			PH								
12	naphthalene				0.4 mg/kg		0.4 mg/kg	0.00004 %			
	601-052-00-2	202-049-5	91-20-3								
13	acenaphthylene				<0.05 mg/kg		<0.05 mg/kg	<0.000005 %			<LOD
		205-917-1	208-96-8								
14	acenaphthene				<0.05 mg/kg		<0.05 mg/kg	<0.000005 %			<LOD
		201-469-6	83-32-9								
15	fluorene				<0.05 mg/kg		<0.05 mg/kg	<0.000005 %			<LOD
		201-695-5	86-73-7								

#	Determinand			CLP Note	User entered data	Conv. Factor	Compound conc.	Classification value	MC Applied	Conc. Not Used
	EU CLP index number	EC Number	CAS Number							
16	phenanthrene	201-581-5	85-01-8		0.07 mg/kg		0.07 mg/kg	0.000007 %		
17	anthracene	204-371-1	120-12-7		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
18	fluoranthene	205-912-4	206-44-0		0.11 mg/kg		0.11 mg/kg	0.000011 %		
19	pyrene	204-927-3	129-00-0		0.11 mg/kg		0.11 mg/kg	0.000011 %		
20	benzo[a]anthracene	601-033-00-9	200-280-6		0.06 mg/kg		0.06 mg/kg	0.000006 %		
21	chrysene	601-048-00-0	205-923-4		0.07 mg/kg		0.07 mg/kg	0.000007 %		
22	benzo[b]fluoranthene	601-034-00-4	205-911-9		0.11 mg/kg		0.11 mg/kg	0.000011 %		
23	benzo[k]fluoranthene	601-036-00-5	205-916-6		0.05 mg/kg		0.05 mg/kg	0.000005 %		
24	benzo[a]pyrene; benzo[def]chrysene	601-032-00-3	200-028-5		0.08 mg/kg		0.08 mg/kg	0.000008 %		
25	indeno[123-cd]pyrene	205-893-2	193-39-5		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
26	dibenz[a,h]anthracene	601-041-00-2	200-181-8		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
27	benzo[ghi]perylene	205-883-8	191-24-2		0.06 mg/kg		0.06 mg/kg	0.000006 %		
Total:								0.017 %		

Key

	User supplied data
	Determinand values ignored for classification, see column 'Conc. Not Used' for reason
	Determinand defined or amended by HazWasteOnline (see Appendix A)
	Speciated Determinand - Unless the Determinand is Note 1, the Conversion Factor is used to calculate the compound concentration
<LOD	Below limit of detection
CLP: Note 1	Only the metal concentration has been used for classification

Classification of sample: WS5

 **Non Hazardous Waste**
Classified as **17 05 04**
in the List of Waste

Sample details

Sample name:	LoW Code:
WS5	Chapter:
Sample Depth:	17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
0.1 m	Entry:
Moisture content:	17 05 04 (Soil and stones other than those mentioned in 17 05 03)
4.6%	
(no correction)	

Hazard properties

None identified

Determinands

Moisture content: 4.6% No Moisture Correction applied (MC)

#	Determinand			CLP Note	User entered data	Conv. Factor	Compound conc.		Classification value	MC Applied	Conc. Not Used
	EU CLP index number	EC Number	CAS Number								
1	 arsenic { arsenic trioxide }				6.2 mg/kg	1.32	8.186 mg/kg	0.000819 %			
	033-003-00-0	215-481-4	1327-53-3								
2	 cadmium { cadmium sulfide }			1	<0.2 mg/kg	1.285	<0.257 mg/kg	<0.00002 %			<LOD
	048-010-00-4	215-147-8	1306-23-6								
3	 chromium in chromium(III) compounds { chromium(III) oxide (worst case) }				13 mg/kg	1.462	19 mg/kg	0.0019 %			
		215-160-9	1308-38-9								
4	 chromium in chromium(VI) compounds { chromium(VI) oxide }				<1.2 mg/kg	1.923	<2.308 mg/kg	<0.000231 %			<LOD
	024-001-00-0	215-607-8	1333-82-0								
5	 lead { lead chromate }			1	22 mg/kg	1.56	34.316 mg/kg	0.0022 %			
	082-004-00-2	231-846-0	7758-97-6								
6	 mercury { mercury dichloride }				<0.3 mg/kg	1.353	<0.406 mg/kg	<0.0000406 %			<LOD
	080-010-00-X	231-299-8	7487-94-7								
7	 copper { dicopper oxide; copper (I) oxide }				11 mg/kg	1.126	12.385 mg/kg	0.00124 %			
	029-002-00-X	215-270-7	1317-39-1								
8	 nickel { nickel dihydroxide }				5.2 mg/kg	1.579	8.213 mg/kg	0.000821 %			
	028-008-00-X	235-008-5 [1] 234-348-1 [2]	12054-48-7 [1] 11113-74-9 [2]								
9	 selenium { selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex }				<1 mg/kg	1.405	<1.405 mg/kg	<0.000141 %			<LOD
	034-002-00-8										
10	 zinc { zinc oxide }				27 mg/kg	1.245	33.607 mg/kg	0.00336 %			
	030-013-00-7	215-222-5	1314-13-2								
11	pH				6.8 pH		6.8 pH	6.8 pH			
			PH								
12	naphthalene				0.29 mg/kg		0.29 mg/kg	0.000029 %			
	601-052-00-2	202-049-5	91-20-3								
13	acenaphthylene				<0.05 mg/kg		<0.05 mg/kg	<0.000005 %			<LOD
		205-917-1	208-96-8								
14	acenaphthene				<0.05 mg/kg		<0.05 mg/kg	<0.000005 %			<LOD
		201-469-6	83-32-9								
15	fluorene				<0.05 mg/kg		<0.05 mg/kg	<0.000005 %			<LOD
		201-695-5	86-73-7								

#	Determinand			CLP Note	User entered data	Conv. Factor	Compound conc.	Classification value	MC Applied	Conc. Not Used
	EU CLP index number	EC Number	CAS Number							
16	phenanthrene	201-581-5	85-01-8		0.07 mg/kg		0.07 mg/kg	0.000007 %		
17	anthracene	204-371-1	120-12-7		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
18	fluoranthene	205-912-4	206-44-0		0.16 mg/kg		0.16 mg/kg	0.000016 %		
19	pyrene	204-927-3	129-00-0		0.14 mg/kg		0.14 mg/kg	0.000014 %		
20	benzo[a]anthracene	601-033-00-9	200-280-6		0.08 mg/kg		0.08 mg/kg	0.000008 %		
21	chrysene	601-048-00-0	205-923-4		0.08 mg/kg		0.08 mg/kg	0.000008 %		
22	benzo[b]fluoranthene	601-034-00-4	205-911-9		0.14 mg/kg		0.14 mg/kg	0.000014 %		
23	benzo[k]fluoranthene	601-036-00-5	205-916-6		0.05 mg/kg		0.05 mg/kg	0.000005 %		
24	benzo[a]pyrene; benzo[def]chrysene	601-032-00-3	200-028-5		0.1 mg/kg		0.1 mg/kg	0.00001 %		
25	indeno[123-cd]pyrene	205-893-2	193-39-5		0.07 mg/kg		0.07 mg/kg	0.000007 %		
26	dibenz[a,h]anthracene	601-041-00-2	200-181-8		<0.05 mg/kg		<0.05 mg/kg	<0.000005 %		<LOD
27	benzo[ghi]perylene	205-883-8	191-24-2		0.07 mg/kg		0.07 mg/kg	0.000007 %		
Total:								0.0109 %		

Key

	User supplied data
	Determinand values ignored for classification, see column 'Conc. Not Used' for reason
•	Determinand defined or amended by HazWasteOnline (see Appendix A)
	Speciated Determinand - Unless the Determinand is Note 1, the Conversion Factor is used to calculate the compound concentration
<LOD	Below limit of detection
CLP: Note 1	Only the metal concentration has been used for classification

Appendix A: Classifier defined and non GB MCL determinands

■ **chromium(III) oxide (worst case)** (EC Number: 215-160-9, CAS Number: 1308-38-9)

Description/Comments: Data from C&L Inventory Database

Data source: <https://echa.europa.eu/information-on-chemicals/cl-inventory-database/-/discli/details/33806>

Data source date: 17 Jul 2015

Hazard Statements: Acute Tox. 4; H332 , Acute Tox. 4; H302 , Eye Irrit. 2; H319 , STOT SE 3; H335 , Skin Irrit. 2; H315 , Resp. Sens. 1; H334 , Skin Sens. 1; H317 , Repr. 1B; H360FD , Aquatic Acute 1; H400 , Aquatic Chronic 1; H410

■ **pH** (CAS Number: PH)

Description/Comments: Appendix C4

Data source: WM3 1st Edition 2015

Data source date: 25 May 2015

Hazard Statements: None.

■ **acenaphthylene** (EC Number: 205-917-1, CAS Number: 208-96-8)

Description/Comments: Data from C&L Inventory Database

Data source: <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>

Data source date: 17 Jul 2015

Hazard Statements: Acute Tox. 4; H302 , Acute Tox. 1; H330 , Acute Tox. 1; H310 , Eye Irrit. 2; H319 , STOT SE 3; H335 , Skin Irrit. 2; H315

■ **acenaphthene** (EC Number: 201-469-6, CAS Number: 83-32-9)

Description/Comments: Data from C&L Inventory Database

Data source: <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>

Data source date: 17 Jul 2015

Hazard Statements: Eye Irrit. 2; H319 , STOT SE 3; H335 , Skin Irrit. 2; H315 , Aquatic Acute 1; H400 , Aquatic Chronic 1; H410 , Aquatic Chronic 2; H411

■ **fluorene** (EC Number: 201-695-5, CAS Number: 86-73-7)

Description/Comments: Data from C&L Inventory Database

Data source: <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>

Data source date: 06 Aug 2015

Hazard Statements: Aquatic Acute 1; H400 , Aquatic Chronic 1; H410

■ **phenanthrene** (EC Number: 201-581-5, CAS Number: 85-01-8)

Description/Comments: Data from C&L Inventory Database

Data source: <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>

Data source date: 06 Aug 2015

Hazard Statements: Acute Tox. 4; H302 , Eye Irrit. 2; H319 , STOT SE 3; H335 , Carc. 2; H351 , Skin Sens. 1; H317 , Aquatic Acute 1; H400 , Aquatic Chronic 1; H410 , Skin Irrit. 2; H315

■ **anthracene** (EC Number: 204-371-1, CAS Number: 120-12-7)

Description/Comments: Data from C&L Inventory Database

Data source: <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>

Data source date: 17 Jul 2015

Hazard Statements: Eye Irrit. 2; H319 , STOT SE 3; H335 , Skin Irrit. 2; H315 , Skin Sens. 1; H317 , Aquatic Acute 1; H400 , Aquatic Chronic 1; H410

■ **fluoranthene** (EC Number: 205-912-4, CAS Number: 206-44-0)

Description/Comments: Data from C&L Inventory Database

Data source: <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>

Data source date: 21 Aug 2015

Hazard Statements: Acute Tox. 4; H302 , Aquatic Acute 1; H400 , Aquatic Chronic 1; H410

■ **pyrene** (EC Number: 204-927-3, CAS Number: 129-00-0)

Description/Comments: Data from C&L Inventory Database; SDS Sigma Aldrich 2014

Data source: <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>

Data source date: 21 Aug 2015

Hazard Statements: Skin Irrit. 2; H315 , Eye Irrit. 2; H319 , STOT SE 3; H335 , Aquatic Acute 1; H400 , Aquatic Chronic 1; H410

■ **indeno[123-cd]pyrene** (EC Number: 205-893-2, CAS Number: 193-39-5)

Description/Comments: Data from C&L Inventory Database

Data source: <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>

Data source date: 06 Aug 2015

Hazard Statements: Carc. 2; H351

■ **benzo[ghi]perylene** (EC Number: 205-883-8, CAS Number: 191-24-2)

Description/Comments: Data from C&L Inventory Database; SDS Sigma Aldrich 28/02/2015
Data source: <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>
Data source date: 23 Jul 2015
Hazard Statements: Aquatic Acute 1; H400 , Aquatic Chronic 1; H410

■ **TPH (C6 to C40) petroleum group** (CAS Number: TPH)

Description/Comments: Hazard statements taken from WM3 1st Edition 2015; Risk phrases: WM2 3rd Edition 2013
Data source: WM3 1st Edition 2015
Data source date: 25 May 2015
Hazard Statements: Flam. Liq. 3; H226 , Asp. Tox. 1; H304 , STOT RE 2; H373 , Muta. 1B; H340 , Carc. 1B; H350 , Repr. 2; H361d , Aquatic Chronic 2; H411

Appendix B: Rationale for selection of metal species

arsenic {arsenic trioxide}

Worst case species based on hazard statements

cadmium {cadmium sulfide}

Worst case species based on hazard statements

chromium in chromium(III) compounds {chromium(III) oxide (worst case)}

Worst case species based on hazard statements

chromium in chromium(VI) compounds {chromium(VI) oxide}

Worst case species based on hazard statements

lead {lead chromate}

Worst case species based on hazard statements

mercury {mercury dichloride}

Worst case species based on hazard statements

copper {dicopper oxide; copper (I) oxide}

Most likely common species

nickel {nickel dihydroxide}

Worst case species based on hazard statements

selenium {selenium compounds with the exception of cadmium sulposelenide and those specified elsewhere in this Annex}

Worst case species based on hazard statements

zinc {zinc oxide}

Most likely to occur in oxides form in soils.

Appendix C: Version

HazWasteOnline Classification Engine: **WM3 1st Edition v1.2.GB - Oct 2021**
HazWasteOnline Classification Engine Version: 2023.237.5731.10565 (25 Aug 2023)
HazWasteOnline Database: 2023.237.5731.10565 (25 Aug 2023)



This classification utilises the following guidance and legislation:

WM3 v1.2.GB - Waste Classification - 1st Edition v1.2.GB - Oct 2021

CLP Regulation - Regulation 1272/2008/EC of 16 December 2008

1st ATP - Regulation 790/2009/EC of 10 August 2009

2nd ATP - Regulation 286/2011/EC of 10 March 2011

3rd ATP - Regulation 618/2012/EU of 10 July 2012

4th ATP - Regulation 487/2013/EU of 8 May 2013

Correction to 1st ATP - Regulation 758/2013/EU of 7 August 2013

5th ATP - Regulation 944/2013/EU of 2 October 2013

6th ATP - Regulation 605/2014/EU of 5 June 2014

WFD Annex III replacement - Regulation 1357/2014/EU of 18 December 2014

Revised List of Waste 2014 - Decision 2014/955/EU of 18 December 2014

7th ATP - Regulation 2015/1221/EU of 24 July 2015

8th ATP - Regulation (EU) 2016/918 of 19 May 2016

9th ATP - Regulation (EU) 2016/1179 of 19 July 2016

10th ATP - Regulation (EU) 2017/776 of 4 May 2017

HP14 amendment - Regulation (EU) 2017/997 of 8 June 2017

13th ATP - Regulation (EU) 2018/1480 of 4 October 2018

14th ATP - Regulation (EU) 2020/217 of 4 October 2019

15th ATP - Regulation (EU) 2020/1182 of 19 May 2020

The Chemicals (Health and Safety) and Genetically Modified Organisms (Contained Use)(Amendment etc.) (EU Exit)

Regulations 2020 - UK: 2020 No. 1567 of 16th December 2020

The Waste and Environmental Permitting etc. (Legislative Functions and Amendment etc.) (EU Exit) Regulations 2020 - UK:

2020 No. 1540 of 16th December 2020

GB MCL List - version 1.1 of 09 June 2021

APPENDIX F: GEOTECHNICAL RISK REGISTER

CATEGORY			RISK ASSESSMENT							CONTROL MEASURES				
REFERENCE No.	CDM – H&S	PROJECT	HAZARD <i>Record the nature of the hazard.</i>	CAUSE <i>Note the conditions that may lead to a hazard causing harm or disruption.</i>	CONSEQUENCE <i>List the consequences, should the hazard come into effect</i>	PROJECT STAGE				CONTROL MEASURES <i>List those measures that you consider may be put in place to</i>	RESIDUAL RISK RATING			METHOD OF COMMUNICATION <i>List risk communication media additional to this document</i>
						PRE-CONSTRUCTION	CONSTRUCTION	OPERATION & MAINTENANCE	DECOMMISSIONING		LIKELIHOOD	EFFECT	RISK RATING	
1	X		Excavations - Collapse/Instability	Excessive Groundwater/ Rainfall Soft Ground Conditions Cuttings too steep/insufficient support. Shallow groundwater.	Damage to Plant and Equipment Death or Serious Injury		X			Shoring is expected within excavations deeper than 1m or manned	L	M	L	Ground Conditions Assessment Report
2	X	X	Contamination Site Soils	Localised elevated metals encountered.	Human Health Issues Increased Disposal Costs	X	X			Ground investigation identified no soil contamination. No remedial measure are considered necessary.	L	L	L	Ground Conditions Assessment Report
3		X	Aggressive Chemicals (Sulphates)	Sulphate Levels	Degradation of concrete used in the ground. Failure of foundations to meet			X		Any concrete placed should be designed	L	M	L	Sulphate section of Ground Conditions Assessment Report

CATEGORY			RISK ASSESSMENT							CONTROL MEASURES				
REFERENCE No.	CDM – H&S	PROJECT	HAZARD <i>Record the nature of the hazard.</i>	CAUSE <i>Note the conditions that may lead to a hazard causing harm or disruption.</i>	CONSEQUENCE <i>List the consequences, should the hazard come into effect</i>	PROJECT STAGE				CONTROL MEASURES <i>List those measures that you consider may be put in place to</i>	RESIDUAL RISK RATING			METHOD OF COMMUNICATION <i>List risk communication media additional to this document</i>
						PRE-CONSTRUCTION	CONSTRUCTION	OPERATION & MAINTENANCE	DECOMMISSIONING		LIKELIHOOD	EFFECT	RISK RATING	
					the required standards.					with the following: Made Ground – DS-1 AC-1s; Superficial Deposits – DS1 AC-1s; London Clay Formation – DS-1 AC-1s (if disturbed);				
4		X	Groundwater	Shallow groundwater.	Inundation of excavations with groundwater.		X			Ground investigation confirms presence of groundwater as shallow as 1.24 m bgl. Management of groundwater during construction if excavations	L	L	L	Ground Conditions Assessment Report

CATEGORY			RISK ASSESSMENT							CONTROL MEASURES				
REFERENCE No.	CDM – H&S	PROJECT	HAZARD <i>Record the nature of the hazard.</i>	CAUSE <i>Note the conditions that may lead to a hazard causing harm or disruption.</i>	CONSEQUENCE <i>List the consequences, should the hazard come into effect</i>	PROJECT STAGE				CONTROL MEASURES <i>List those measures that you consider may be put in place to</i>	RESIDUAL RISK RATING			METHOD OF COMMUNICATION <i>List risk communication media additional to this document</i>
						PRE-CONSTRUCTION	CONSTRUCTION	OPERATION & MAINTENANCE	DECOMMISSIONING		LIKELIHOOD	EFFECT	RISK RATING	
										extend below depths of 1m.				
5		X	Buried Services	Potential underground services.	Damage to services, plant and site personnel.		X			Obtain underground survey prior to construction.	L	M	L	Service drawings. Constraints plan.
6	X		Foundation failure – Ultimate Limit State (Bearing Capacity Failure)	Unknown loadings Degradation of concrete Insufficient depth of foundations	Building collapse/ need to rebuild			X		Determine strength of underlying soils in order to obtain bearing capacity. Additional ground investigation completed.	L	H	M	Foundation section of Ground Conditions Assessment Report
7	X		Serviceability limit state failure (settlement)	High Plasticity Clays and foundations placed on material types of contrasting	Cracking/deformation of slabs			X		PI testing of any clays. Additional Ground investigation to confirm variability of ground	M	M	M	Foundation section of Ground Conditions Assessment Report

CATEGORY			RISK ASSESSMENT							CONTROL MEASURES				
REFERENCE No.	CDM – H&S	PROJECT	HAZARD <i>Record the nature of the hazard.</i>	CAUSE <i>Note the conditions that may lead to a hazard causing harm or disruption.</i>	CONSEQUENCE <i>List the consequences, should the hazard come into effect</i>	PROJECT STAGE				CONTROL MEASURES <i>List those measures that you consider may be put in place to</i>	RESIDUAL RISK RATING			METHOD OF COMMUNICATION <i>List risk communication media additional to this document</i>
						PRE-CONSTRUCTION	CONSTRUCTION	OPERATION & MAINTENANCE	DECOMMISSIONING		LIKELIHOOD	EFFECT	RISK RATING	
				strength properties.						conditions and reduction of strength with depth. Larger loaded buildings to have foundations extending into underlying bedrock.				
8		X	Obstructions subsurface	Subsurface obstructions not anticipated	Unable to excavate through. Increased cost of disposal and earthworks. Material crushing required.		X			Determine ground model based on ground investigation results.	L	M	L	Excavations section of Ground Conditions Assessment Report. Allowance for locally slow excavations at shallow depth.
9	X		Ground Gases	Build-up of ground gasses in excavations and sub floor voids	Risk of explosion		X			Low risk of ground gas. Gas monitoring	L	L	L	Ground Conditions Assessment Report.

CATEGORY			RISK ASSESSMENT							CONTROL MEASURES				
REFERENCE No.	CDM – H&S	PROJECT	HAZARD <i>Record the nature of the hazard.</i>	CAUSE <i>Note the conditions that may lead to a hazard causing harm or disruption.</i>	CONSEQUENCE <i>List the consequences, should the hazard come into effect</i>	PROJECT STAGE				CONTROL MEASURES <i>List those measures that you consider may be put in place to</i>	RESIDUAL RISK RATING			METHOD OF COMMUNICATION <i>List risk communication media additional to this document</i>
						PRE-CONSTRUCTION	CONSTRUCTION	OPERATION & MAINTENANCE	DECOMMISSIONING		LIKELIHOOD	EFFECT	RISK RATING	
				from natural soils						results indicate low gas risk.				

APPENDIX G: GEG - FACTUAL GROUND INVESTIGATION REPORT

GEG | Geo Environmental Group
Geotechnical, Environmental & Ecological Consultants

GEG House, 17 Graham Road, Malvern, WR14 2HR
Tel. 01684 212526 Fax 01684 576917 www.g-eg.co.uk



FACTUAL GROUND INVESTIGATION



***BARTLETT ARBORETUM
WHITE HOUSE LANE
READING
RG7 1HR***

August 2023

Prepared for:



c/o Bartlett Tree Experts



Report Title:

**FACTUAL GROUND
INVESTIGATION**

Site Address:

Bartlett Arboretum
White House Lane
Spencers Wood
Reading
Berkshire
RG7 1HR

Performed By:

Geo Environmental Group
GEG House
17 Graham Road
Malvern
WR14 2HR

On Behalf Of:

Bartlett Tree Experts c/o
Jubb Consulting Engineers
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Project Reference:

GEG-23-795

Report Reference:

GEG-23-795/GI

Issue Status:

FINAL

Date:

25th August 2023



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1. INTRODUCTION

1.1 General

Geo Environmental Group (GEG) were commissioned by Jubb Consulting Engineers Ltd (Jubb) on behalf of Bartlett Tree Experts (the Client) to undertake a Factual Ground Investigation of a site known as 'Bartlett Arboretum, Reading,' in order to provide relevant information with respect to the development of the site for a proposed arboretum and associated ancillary structures.

This investigation has been undertaken without a Phase I Desk Study for the site and as such the findings within this report are based solely on material recovered from the exploratory holes.

1.2 Available Information

The following information was supplied by Jubb:

- 'Site Location Plan,' Jubb.
- 'Exploratory Hole Plan,' Jubb on behalf of Bartlett Tree Experts, Drawing No. 23192-GES01, Rev. B, dated 17th July 2023.
- 'Bartlett Arboretum. Ground Engineering Services - Ground Investigation Tender,' Jubb on behalf of Bartlett Tree Experts, dated 19th April 2023.

GEG also purchased various utility company service drawings for the site.

1.3 Proposed Site Development

The site is to be partly developed for a proposed Arboretum which will include research laboratories, maintenance buildings, car parking, and SUDs.

1.4 Scope

The works performed by GEG included:

- A ground investigation with associated chemical analysis and geotechnical testing, together with the installation of standpipes for subsequent gas and groundwater monitoring.

Limitations to the scope of the report are outlined in Section 4.

1.5 Site Setting

1.5.1 Site Location

The site is located adjacent to the south of the village of Spencers Wood approximately 7 km south of Reading town centre, at the approximate National Grid Reference 470889E, 165713N. It lies on land to the south of White House Lane, east



of Yew Tree Lane, and west of Beech Hill Road, and covers an area of approximately 8.6 ha.

A section of the 1:25,000 Ordnance Survey (OS) map identifying the site location is shown in Figure 1 of Appendix A and a photographic record is provided in Appendix B.

1.5.2 Site Description

The broadly triangular-shaped site currently comprises an agricultural field across the majority with a small wooded area in the north western corner and 2 No. residential dwellings and associated ancillary structures along the northern margins of the site, east of the woodland.

1.6 Ordnance

According to regional unexploded bomb risk maps provided by Zetica, the site falls within an area of low bomb risk and therefore no further action is required.

1.7 Geology, Hydrogeology And Hydrology

1.7.1 Published Geology

Reference to the 1:50,000 scale British Geological Survey digital mapping of the area (solid and drift) indicates that the solid geology beneath the site comprises the London Clay Formation of the Eocene period. It is described as *bioturbated or poorly laminated, blue-grey or grey-brown, slightly calcareous, silty to very silty clay, clayey silt and sometimes silt, with some layers of sandy clay.*

The solid geology across the western half section of the site is conjectured to be overlain by superficial deposits of River Terrace Deposits, 5, described generically as *sand and gravel, locally with lenses of silt, clay or peat.*

No significant faults are conjectured to intersect the site at the surface.

As previously stated, a Phase I Desk study has not been completed for the site and as such prior to further works potential geohazards should be considered.

1.7.2 Hydrogeology

1.7.2.1 Groundwater Designation

According to the MAGIC online viewer (supported by the Environment Agency), the solid geology beneath the site is designated as Unproductive Strata.

Unproductive Strata - are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

The superficial deposits are characterised as a Secondary A Aquifer.

Secondary A Aquifers are defined as permeable layers capable of supporting water supplies at a local rather than a strategic scale, and in some cases forming an important source of base flow to rivers.



1.7.2.2 Groundwater Source Protection Zone

According to the MAGIC online viewer (supported by the Environment Agency), the site does not lie within a currently defined Groundwater Source Protection Zone (GWSPZ).

1.7.3 Hydrology

1.7.3.1 Nearest Watercourse

Ordnance survey mapping indicates a drain approximately 70 m east of the site and the Foundry Brook approximately 330 west.

1.7.3.2 Surface Water Flooding

According to the Environment Agency online 'Flood Map for Planning', the site lies within Flood Zone 1, being land that lies outside the 1 in 1000 year (0.1%AEP) flood risk area and hence has a low probability of flooding.

2. INTRUSIVE INVESTIGATION

The following section outlines the scope of the intrusive investigation undertaken by GEG and details the ground conditions encountered and the chemical testing undertaken.

2.1 Site Works Overview

The following section outlines the scope of the intrusive investigation carried out by GEG in accordance with the Jubb specification and details the ground conditions encountered and the chemical testing undertaken.

All work was undertaken in general accordance with British Standard guidance (BS:5930:2015 and BS:10175) and the ICE UK Specification for Ground Investigation (2nd Edition 2012) guidelines.

Prior to commencement of the works, service plans were viewed to investigate the location of all major services and each exploratory hole location screened with a cable avoidance tool.

The exploratory holes were logged and sampled by an experienced geo-environmental engineer from GEG. The ground conditions encountered, sampling depths and details of the standpipes were recorded on the exploratory hole logs (Appendix C). Where the sample is disturbed but some guidance as to the in-situ consistency can be sensibly given, the consistency term is given in brackets, in accordance with BS:5930:2015.

The locations of the exploratory holes are shown on Figure 2 presented in Appendix A.



2.2 Site Works

2.2.1 General

The intrusive investigation was undertaken on 19th July 2023 and comprised a cable percussive borehole, window sample boreholes, machine-excavated trial pitting, infiltration testing and in-situ TRL DCP testing.

2.2.2 Cable Percussion Boreholes

1 No. 150mm diameter cable percussion boreholes (BH1) were drilled to a maximum depth of 10.00 m. Disturbed samples were taken at each major strata change and regular intervals in between.

Standard penetration testing SPT/SPT(C) testing was carried out at regular intervals in accordance with BS EN ISO 22476-3:2005+A1: 2011. A split barrel or a solid cone was used depending upon the materials encountered and the split barrel samples retained as small, disturbed samples. SPT results are summarised as uncorrected 'N' values on the borehole logs.

The uncorrected SPT 'N' Value has been used to assess the relative density in granular soils in accordance with BS5930:2015. The consistency of cohesive soils has been determined by hand pressures in accordance with Table 8 of BS5930:2015. The limitations of empirical relationships between SPT 'N' values and undrained shear strength of fine-grained soils (e.g. those determined by Stroud & Butler [1975] and Stroud [1989]) are acknowledged and as such are used for indicative purposes only.

BH01 was installed with a 50mm diameter standpipe for subsequent gas and groundwater monitoring.

2.2.3 Window Sample Holes

5 No. window sample boreholes (WS1-WS5) were drilled using an Archway Competitor Dart dynamic sampling rig to a maximum depth of 4.45 m.

Standard penetration testing SPT/SPT(C) was undertaken as for the cable percussive boreholes in Section 2.2.2.

WS1 and WS4 were installed with 50 mm diameter standpipes to depths detailed on the exploratory hole logs for subsequent gas and groundwater monitoring.

2.2.4 Trial Pits

5 No. trial pits (TP1-TP5) were excavated using a 360° tracked excavator to a maximum depth of 2.80 m to facilitate investigation of the near surface soils.

2.2.5 Dynamic Cone Penetrometer

6 No. DCP tests (TRL1-TRL5) were undertaken utilising a TRL dynamic cone penetrometer from surface level to depths of 1.17 m in order to provide an estimate of CBR values.



2.2.6 Infiltration Tests

3 No. infiltration tests were undertaken in 3 No. trial pits (TP1, TP2 & TP5) in general accordance with BRE Digest 365.

The trial pits were excavated to depths of 2.30 m, 2.40 m, and 2.30 m, respectively, and infiltration tests undertaken in the most permeable strata. Clean water was dispensed from a bowser at a rapid rate to fill each excavation as quickly as possible to the proposed depth of the invert levels and/or the most permeable strata. The excavations took less than 5 minutes to fill to the maximum capacity.

Measurements were then taken of the fall of water at suitable time increments to allow the infiltration rate to be calculated from the time taken for the water level to fall from 75% to 25% effective depth (where possible).

The infiltration test data and calculated infiltration rates are tabulated and graphically depicted on Figures D-1 to D-3 in Appendix D. The results are summarised in Table 1.

Table 1. Infiltration Test Results

Location (Depth Range of Test [m])	Test No.	Strata ^[1]	Effective Depth Reached	Time (mins)	Infiltration Rate (m/s)
TP1 (1.10 – 2.30 m)	1	LCF	95%	228	N/A
TP2 (1.30 – 2.40 m)	1	LCF	98%	279	N/A
TP5 (0.91 – 2.30 m)	1	LCF	97%	338	N/A

N/A=Not Applicable

[1] LCF=London Clay Formation.

As shown in Table 1, the water levels showed very little infiltration and consequently no infiltration rates could be calculated.

2.2.7 Reinstatement

The trial pits were backfilled with arisings and left slightly mounded to allow for future settlement. Boreholes were also backfilled with arisings or in the case of boreholes BH01, WS1 and WS4 installed with standpipes and lockable flush covers.

2.2.8 Sampling

Samples were taken from the exploratory holes for geotechnical and chemical testing, as described in Sections 2.4 and 2.5 respectively.



2.3 Gas Monitoring Programme

Gas and groundwater monitoring was undertaken on 3rd to 23th August 2023. The standpipes were monitored for methane, carbon dioxide, oxygen, hydrogen sulphide and the borehole gas flow rate using a GMF435 gas analyser. Atmospheric pressure and trend was also recorded.

Table 2. Gas Monitoring Results

Borehole	Date	Atmospheric Pressure	Atmospheric Pressure Trend	CH ₄	CO ₂	O ₂	H ₂ S	Borehole Flow
		mb		% Vol.			ppm	l/hr
BH1	03/08/23	994	Rising	0.0	2.2	14.7	0	0.0
	10/08/23	1012	Falling	0.0	2.3	14.5	0	0.0
	17/08/23	1013	Falling	0.0	1.9	16.3	0	0.0
	23/08/23	1013	Falling	0.0	1.7	17.2	0	0.0
WS1	03/08/23	995	Rising	0.0	1.1	19.6	0	0.0
	10/08/23	1012	Falling	0.0	1.0	19.3	0	0.0
	17/08/23	1013	Falling	0.0	1.1	19.9	0	0.0
	23/08/23	1013	Fallings	0.0	1.1	20.1	0	0.0
WS4	03/08/23	994	Rising	0.0	0.9	20.3	0	0.0
	10/08/23	1012	Falling	0.0	2.3	16.6	0	0.0
	17/08/23	1012	Falling	0.0	5.2	14.7	0	0.0
	23/08/23	1013	Falling	0.0	5.6	14.5	0	0.0

The water levels were monitored using a dip meter; results are presented in Section 2.6.5.

2.4 Geotechnical Laboratory Testing

Selected samples were despatched to Geo Site and Testing Services Limited and scheduled for geotechnical testing. The schedule of testing, which was in accordance with the Jubb specification, comprised:

- 11 No. natural moisture contents (BS1377: Part 2: 1990: 3.2).
- 8 No. liquid and plastic limits (BS1377: Part 2: 1990: 4.3 & 5.3).
- 4 No. particle size distribution wet sieve method (BS1377: Part 2: 1990: 9.2).
- 2 No. dry density/moisture content, 2.5 kg rammer method 1 litre mould (BS1377: Part 4: 1990: 3.5).
- 2 No. quick undrained triaxial compression test – single specimen at one confining pressure (100 mm diameter) (BS1377: 1990 Part 7: 8).
- 1 No. water soluble sulphate 2:1 extract.
- 1 No. pH value of soil.
- 2 No. reduced BRE suite (includes pH, water & acid soluble and total sulphur).



The results of the geotechnical testing are presented in Appendix G.

2.5 Chemical Laboratory Testing

7 No. soil samples were dispatched to I2 analytical for chemical analysis specified by Jubbs. All soil analysis was MCerts accredited where possible. The results of the chemical analysis are located in Appendix F.

Table 3. Chemical analysis suites

Suite Name	Determinants	No.	Sample Ref:
Suite 2	Arsenic, boron, cadmium, chromium, chromium - III, chromium, copper, lead, mercury, nickel, selenium, zinc, cyanide - total, cyanide - free. Organic matter, pH, sulphate (as SO ₄) - water soluble (2:1), sulphate (as SO ₄) – total sulphide. PAH - Speciated (EPA 16) INC Total. TPH band (C6 - C8), TPH band (C8 - C10), TPH band (C10 - C12), TPH band (C12 - C16), TPH band (C16 - C21), TPH band (C21 -C35), TPH band (C35 - C40), TPH Total (C6 - C40), phenols - total (monohydric).	1	WS04 (0.10 m)
Suite 3	Arsenic, boron , cadmium, chromium, chromium - III, chromium - hexavalent , copper, lead, mercury, nickel, selenium, zinc, cyanide - total, cyanide - free. Organic matter, pH, sulphate (as SO ₄) - water soluble (2:1), sulphate (as SO ₄) - total sulphide. PAH - speciated (EPA 16). Phenols - total (monohydric).	7	TP01 (0.10 m) TP02 (0.10 m) TP04 (0.50 m) WS01 (0.50 m) WS02 (0.10 m) WS03 (0.10 m) WS05 (0.10 m)
Asbestos ID	Asbestos	1	WS04 (0.10 m)

2.6 Ground Conditions Encountered

The ground conditions encountered are described below and broadly confirmed the published geology.

2.6.1 Made Ground

Made Ground comprising firm dark brown sandy gravelly CLAY with gravel consisting of flint, quartzite and rare brick was encountered in WS4 to a depth of 0.40 m.

2.6.2 Topsoil

Typically firm CLAY topsoil was encountered across the remainder of the site to depths of between 0.20 and 0.40 m.



2.6.3 River Terrace Deposits

River Terrace Deposits were encountered underlying the Made Ground and topsoil in all locations to depths of between >1.25 (WS4) and 4.00 m (BH1). It typically comprised firm to stiff sandy variably gravelly CLAY and medium dense to very dense variably clayey very gravelly SAND or slightly clayey sandy GRAVEL.

2.6.4 Weathered London Clay Formation

The weathered London Clay Formation was encountered underlying the River Terrace Deposits in 6 No. exploratory holes (BH1, WS1 & TP1-TP4) from depths of between 1.80 and 4.00 m to the base of the exploratory holes. These soils typically comprise firm to very stiff variably sandy gravelly CLAY with rare shell fragments.

2.6.5 Groundwater

No groundwater was encountered in any of the exploratory holes during the intrusive investigation.

Groundwater levels recorded during borehole monitoring visits to date are shown in Table 4 below:

Table 4. Groundwater Levels Recorded During the Monitoring Visits

Borehole	Date	Depth of Installation (m)	Groundwater Depth (m)
BH1	03/08/23	2.80	1.25
	10/08/23		1.24
	17/08/23		1.27
	23/08/23		1.26
WS1	03/08/23	4.00	1.50
	10/08/23		1.38
	17/08/23		1.40
	23/08/23		1.40
WS4	03/08/23	1.10	Dry
	10/08/23		Dry
	17/08/23		Dry
	23/08/23		Dry

2.6.6 Stability of Trial Pits

The sides of all trial pit excavations were stable.

2.6.7 Olfactory and Visual Evidence of Contamination

No sign of olfactory or visual evidence of contamination was noted during the investigation.



2.7 Geotechnical Parameters

2.7.1 Undrained Shear Strength

2.7.1.1 Pocket Penetrometer - Unconfined Compressive Strength

The results of the pocket penetrometer testing are presented in Graphs 1A and 1B of Appendix G for the various strata types. Undrained strength classifications are quoted in accordance with Table 9 of BS5930:2015 with the former terminology in brackets.

In-situ pocket penetrometer tests recorded unconfined compressive strengths (UCSs) of 95 to 350 kN/m² at 0.50 to 2.60 m in the cohesive strata of the River Terrace Deposits. This indicates estimated undrained shear strength of 48 to 175 kN/m² and an undrained strength classification of medium (firm) to very high (very stiff).

In-situ pocket penetrometer tests recorded unconfined compressive strengths (UCSs) of 250 to 350 kN/m² at 3.00 to 3.90 m in the cohesive strata of the London Clay Formation. This indicates estimated undrained shear strengths of 125 to 175 kN/m² and an undrained strength classification of high (stiff) to very high (very stiff).

2.7.1.2 Undrained Shear Strength (s_u) Derived from Hand Vane Measurements

The results of the hand shear vane tests are presented in Graph 2 of Appendix G for the various strata types. Undrained strength classifications are quoted in accordance with Table 9 of BS5930:2015 with the former terminology in brackets.

In-situ hand shear vane tests recorded undrained shear strengths of 160 to 230 kN/m² from 0.60 to 2.40 m in the cohesive strata of the River Terrace Deposits. This indicates an undrained strength classification of very high (very stiff).

In-situ hand shear vane tests recorded undrained shear strengths of 200 to 280 kN/m² from 1.80 to 2.60 m in the cohesive strata of the London Clay Formation. This indicates an undrained strength classification of very high (very stiff).

2.7.1.3 Standard Penetration Tests (SPT) 'N' Values – Shear Strength

The results of the SPTs are presented in Graph 3 of Appendix G of the various strata.

3 No. SPTs undertaken in the natural cohesive River Terrace Deposits recorded 'N' values of 12 to 14 at depths of 1.00 to 2.60 m, which based on the relationship: $s_u = f_1 \times N$ after Stroud 1974, where f_1 is assumed as 4.5, indicates undrained shear strengths (s_u) of 54 to 63 kN/m² respectively.

4 No. SPTs undertaken in the natural cohesive London Clay Formation recorded 'N' values of 13 to 27 at depths of 3.00 to 7.50 m, which based on the relationship: $s_u = f_1 \times N$ after Stroud 1974, where f_1 is assumed as 5, indicates undrained shear strengths (s_u) of 65 to 135 kN/m² respectively.

It is noted, however, that there can be high variability in the f_1 factors and as advised in BS EN 1997-2:2007 (Eurocode 7) use of the SPT in cohesive soils should be



restricted to a 'qualitative evaluation of the soil profile' as there is 'no general agreement on the use of SPT results in clayey soil'.

2.7.1.4 Geotechnical Laboratory Testing

Recorded undrained shear strength results from the 2 No. quick undrained triaxial compression tests were 74 kPa and 86 kPa at depths of 3.95 and 6.45 m, respectively.

2.7.2 Standard Penetration Tests: Solid Cone (SPT [C]) 'N' Values - Relative Density

5 No. SPT (C)'s were undertaken in the granular soils of the River Terrace Deposits, which recorded 'N' values >50 (BH1 at 1.50 m; WS2 at 1.00 m; WS3 at 1.00 m; WS4 at 1.00 m; & WS5 1.00 m). These have been interpreted as dense to very dense.

2.7.3 Plasticity Indices (PI)

The Modified Plasticity Indices and Volume Change Potential of the natural clay are presented in Table 5 below in accordance with NHBC Standards Chapter 4.2.

Table 5. Volume Change Potential

Location / Depth (m)	Strata ^[1]	Plasticity Index (Ip) (%)	Fraction <0.425mm (%)	Modified Plasticity Index (I'p) ^[2] (%)	Volume Change Potential
BH01 / 2.40	RTD	23	88	20	Medium
BH01 / 4.00	LCF	33	100	33	Medium
TP1 / 1.50	RTD	26	92	24	Medium
TP2 / 0.50	RTD	22	89	20	Medium
TP3 / 2.50	LCF	31	91	28	Medium
TP5 / 0.50	RTD	39	90	35	Medium
WS1 / 1.50	RTD	18	69	12	Low
WS1 / 3.50	LCF	34	100	34	Medium

[1] RTD=River Terrace Deposits; LCF=London Clay Formation.

[2] Modified Plasticity Index (I'p) = Plasticity Index (Ip) x (% <0.425mm/100)



3. REFERENCES

1. British Standard Institute (1990) BS: 1377 Parts 1-9. Methods of Tests for Soils for Civil Engineering Purposes.
2. British Standard Institute (1999) BS: 5930 Code of Practice for Site Investigations. BSI, London.
3. British Standard Institute (2001) BS: 10175 Code of Practice for Investigation of Potentially Contaminated Sites. BSI, London.

4. LIMITATIONS

As with all intrusive site investigations, there is a possibility that localised contamination 'hot spots'/geotechnical features remain undetected on the site. Therefore, as with standard practices, this report does not provide a warranty to cover limited localised contamination 'hot spots'/geotechnical features or any post-investigation importation of contamination.

In addition, groundwater levels may vary due to seasonal and other effects.

The conclusions and recommendations stated herein are based on information available at the time of production. These may not necessarily apply if the site is to be utilised for a more or less sensitive purpose in the future, or if operational procedures or management alter over time.

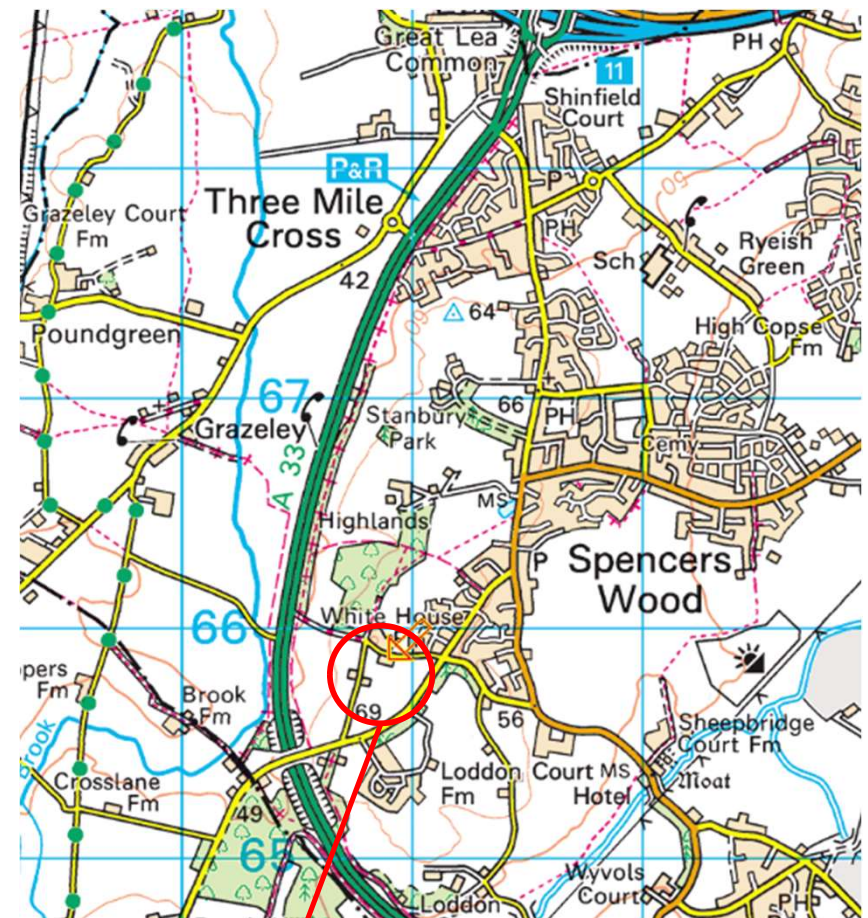
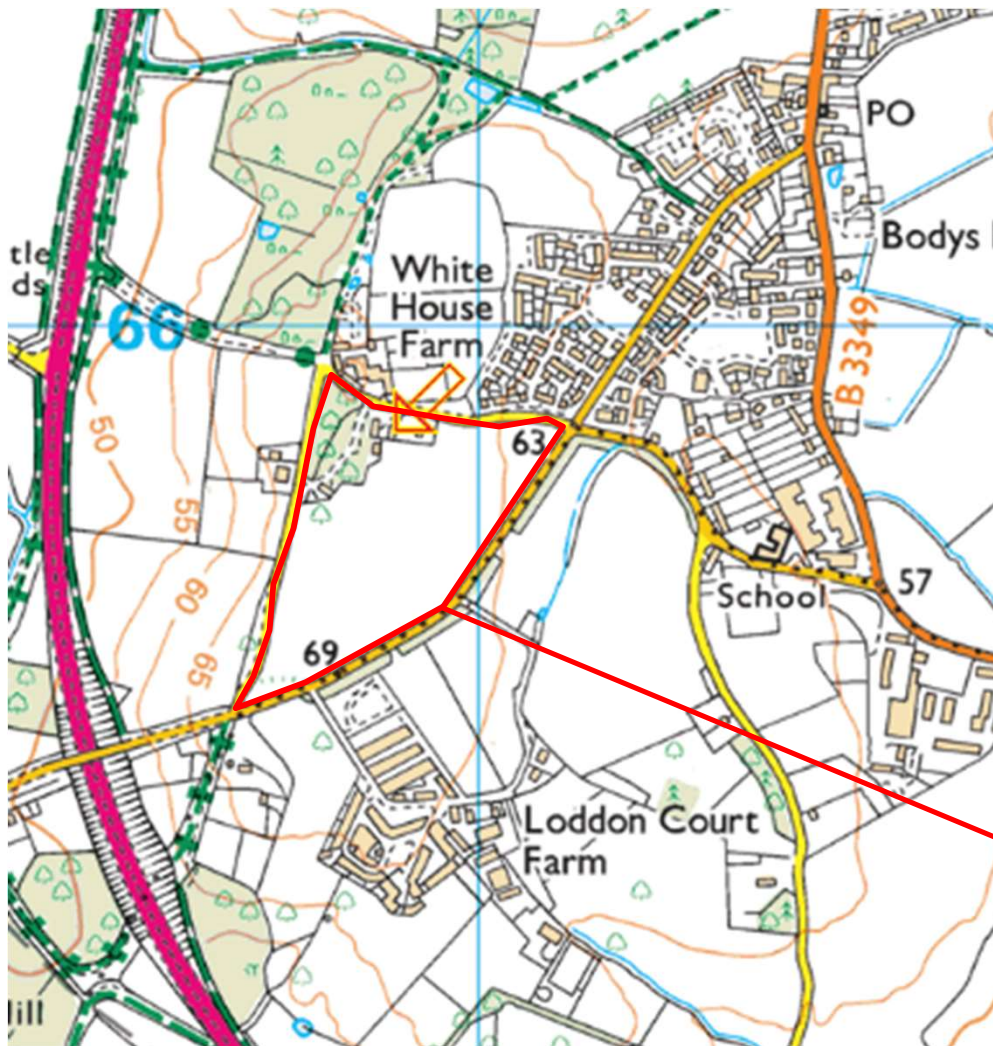
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APPENDIX A

FIGURES AND PLANS



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TITLE: FIGURE 1:
SITE LOCATION PLAN

CLIENT: BARTLETT TREE EXPERTS /
JUBB CONSULTING ENGINEERS LTD

DRAWN/CHECKED:
CM / MP

GEG House, 17 Graham Road
Malvern, WR14 2HR
Tel. 01684 212526
Fax 01684 576917
admin@g-eg.co.uk, www.g-eg.co.uk

**Geo
Environmental
Group**



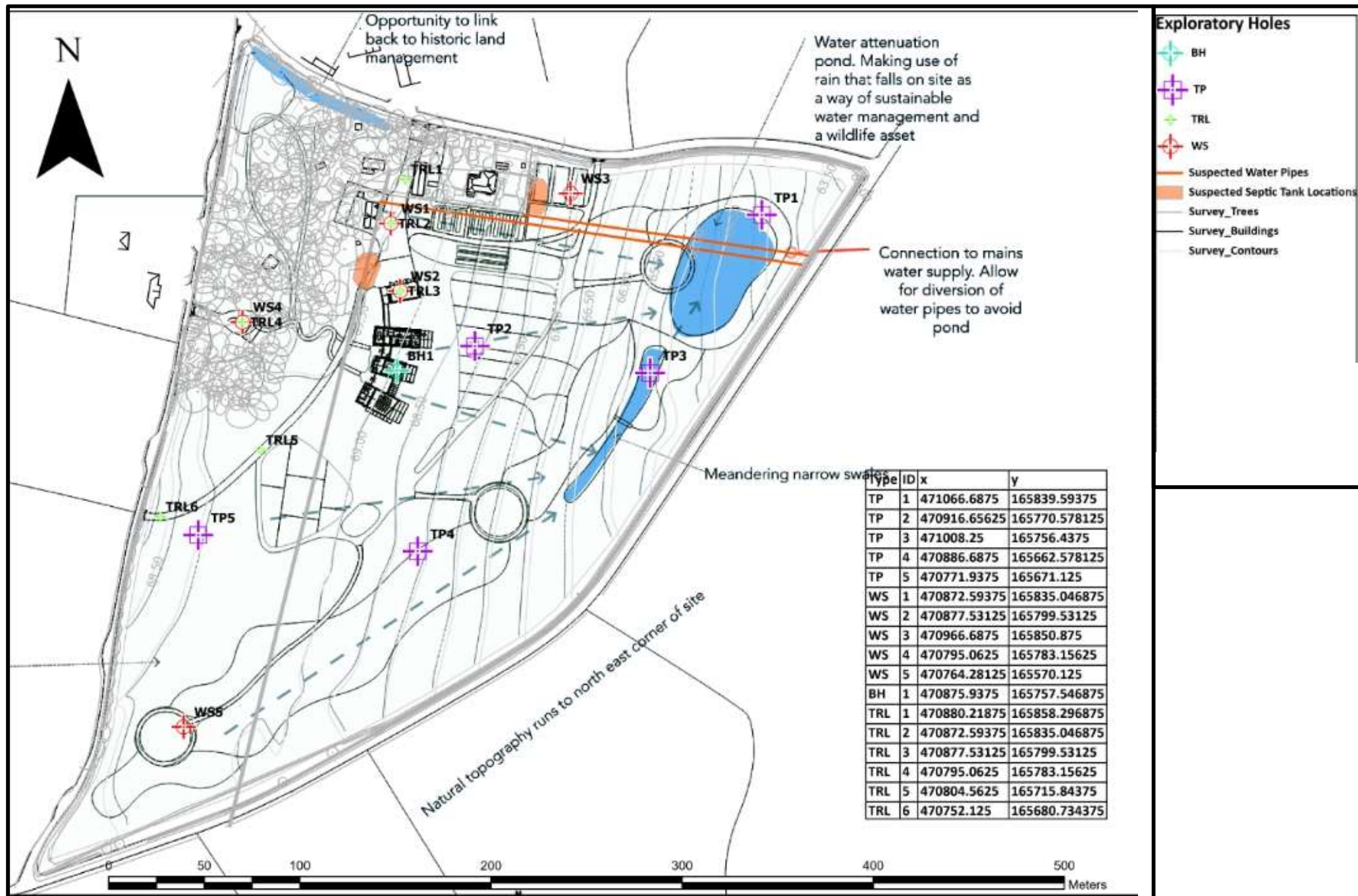
SITE:
BARTLETT ARBORETUM, READING

PROJECT No.:
GEG-23-795

SCALE:
NTS

DATE:
18/08/23

REVISION:
A



TITLE: FIGURE 2: EXPLORATORY HOLE LOCATION PLAN

CLIENT: BARTLETT TREE EXPERTS / JUBB CONSULTING ENGINEERS LTD

DRAWN/CHECKED: CM / MP

SITE: BARTLETT ARBORETUM, READING

PROJECT No.: GEG-23-795

SCALE: NTS

DATE: 18/08/23

REVISION: A

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Environmental
Group





APPENDIX B

PHOTOGRAPHIC RECORD



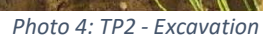
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Photo 1: TP1 - Arisings



Photo 2: TP1 - Excavation





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Photo 5: TP3 - Arisings



Photo 6: TP3 - Excavation



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Photo 7: TP4 - Arisings



Photo 8: TP4 - Excavation



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Photo 9: TP5 - Arisings



Photo 10: TP5 - Excavation



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Photo 11: WS1



Photo 12: WS2



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Photo 13: WS3



Photo 14: WS4





APPENDIX C

EXPLORATORY HOLE LOGS

EXPLORATORY HOLE LOG RECORDS:

Symbols & Abbreviations Legend



Sampling

B	Bulk disturbed sample.
BLK	Block sample.
C	Core run.
CR	Core cutter sample.
CS	Core sample taken from rotary core.
D	Small disturbed sample.
ES	Composite environmental soil sample.
EW	Environmental water sample.
L	Continuous percussive sample (plastic liner).
LB	Large disturbed sample.
U	Undisturbed driven tube sample (100 mm diameter, 450 mm long). No. of blows indicated in brackets.
W	Water sample.

In-situ Testing

HVP	Hand Vane Measurement. Value given as shear strength S_u (in kPa).
PP	Pocket Penetrometer (Unconfined Compressive Strength measured in kPa).
SPT	Standard Penetration Test using a split spoon sampler.
SPTC	Standard Penetration Test using a solid 60 degree cone.
N	The 'N' value is the No. of blows required to complete a test drive of 300 mm after a seating drive of 150 mm or 25 blows.
N = 50	Where the full test drive is not completed. A linearly extrapolated 'N' value can be derived.
PID	Photo Ionisation Detector reading in ppm.

Drilling Records

W	Water flush returns.
TCR	Total Core Recovery (%).
SCR	Solid Core Recovery (%).
RQD	Rock Quality Designation (% of intact core >100 mm).
FI	Fracture Index (Fractures/m).
NI	Non-intact core.
NR	No core recovery.

Water Column Symbols

	Standing groundwater strike
	Initial groundwater Level

Strata - Soil Legends

	MADE GROUND
	COBBLES & BOULDERS
	GRAVEL
	SAND
	SILT
	CLAY
	PEAT

Strata - Rock Legends

	CHALK
	LIMESTONE
	SANDSTONE
	COAL
	MUDSTONE
	SILTSTONE

	METAMORPHIC (Fine-grained)
	METAMORPHIC (Medium-grained)
	METAMORPHIC (Coarse-grained)

	IGNEOUS (Fine-grained)
	IGNEOUS (Medium-grained)
	IGNEOUS (Coarse-grained)

Instrumentation & Backfilling

	Plain standpipe.
	Slotted standpipe.
	Piezometer.
	Granular filter (response zone).
	Bentonite seal.
	Backfill (arising).
	Backfill (cement grout).
	Concrete.

NOTES:

- [1] The logging of soils and rocks has been carried out in general accordance with BS 5930:2015.
- [2] All lengths used to determine rock core mechanical properties taken along the centre line of the core. Obvious induced fractures have been ignored.
- [3] All logs are available in the AGS format.



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Borehole Log

Borehole No.

BH1

Sheet 1 of 1

Project Name: Bartlett Arboretum, Reading

Project No.
GEG-23-795

Co-ords: 470877E - 165754N

Hole Type
CP

Location: Bartlett Arboretum, Yew Tree Lane, Reading RG7 1HR

Level: 68.95 m AOD

Scale
1:61

Client: Jubb Consulting Engineers Ltd c/o Bartlett Tree Experts

Dates: 19/07/2023

Logged By
JM

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.10	ES		0.00			Firm friable brown sandy gravelly CLAY. Gravel is fine to medium rounded flint. (TOPSOIL)	
		0.40	B		0.30	68.95		Firm light brown very sandy gravelly CLAY. Gravel is fine to medium rounded flint. (RIVER TERRACE DEPOSITS)	0.5
		0.50	ES						
		0.70	B		0.70	68.65		Dense light brown slightly clayey sandy GRAVEL of fine to coarse flint. (RIVER TERRACE DEPOSITS)	1.0
		1.00	B						
		1.20	B						
		1.50	B						
		1.50	SPT	50 (3,9/50 for 205mm)					1.5
									2.0
		2.40	B		2.40	68.25		Firm brown slightly sandy slightly gravelly CLAY. Gravel is fine to medium rounded flint. (RIVER TERRACE DEPOSITS)	2.5
		2.60	D						
		2.60	SPT	N=12 (1,1/2,3,3,4)					
		3.00	B						3.0
		3.50	U					QUT= 74 kPa	3.5
		4.00	B		4.00	66.55		Firm brown slightly sandy CLAY. (LONDON CLAY FORMATION)	4.0
		4.00	D						
		4.50	D						4.5
		4.50	SPT	N=13 (2,3/3,3,3,4)					5.0
		5.50	B						5.5
		6.00	U					QUT= 86 kPa	6.0
		6.70	B		6.50	64.95		Firm to stiff grey and orangish brown slightly gravelly silty CLAY. Gravel is fine subangular shell fragments. (LONDON CLAY FORMATION)	6.5
		7.50	D						7.0
		7.50	SPT	N=22 (3,4/5,5,6,6)					7.5
		8.00	B						8.0
									8.5
		9.00	U		9.00	62.45		Stiff grey occasionally mottled brown slightly gravelly CLAY. Gravel is fine subangular shell fragments. (LONDON CLAY FORMATION)	9.0
		9.50	D						9.5
		10.00	B		10.00	59.95		End of Borehole at 10.000m	10.0
		10.00	D						10.5
									11.0
									11.5

Remarks

1. No groundwater encountered. 2. Borehole cased at 150mm to 2.70m. 3. 50mm standpipe installed to 2.70m, Response zone 2.70-1.00m, bentonite seal 1.00-0.20m, concrete flush cover 0.20-0.00m. 4. Approximate ground level taken from location plan provided.





Geo Environmental Group

Borehole Log

Borehole No.

WS1

Sheet 1 of 1

Project Name: Bartlett Arboretum, Reading

Project No.
GEG-23-795

Co-ords: 470877E - 165824N

Hole Type
WS

Location: Bartlett Arboretum, Yew Tree Lane, Reading RG7 1HR

Level: 69.50 m AOD

Scale
1:31

Client: Jubb Consulting Engineers Ltd c/o Bartlett Tree Experts

Dates: 19/07/2023

Logged By
JM

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.10	ES		0.00			Firm friable brown sandy slightly gravelly CLAY. Gravel is fine to coarse sub-angular and sub-rounded flint.	
					0.30	69.50		(TOPSOIL)	
		0.50	D					Dense light brown clayey very gravelly SAND. Gravel is fine to coarse sub-angular and sub-rounded flint.	0.5
		0.50	ES		0.60	69.20		(RIVER TERRACE DEPOSITS)	
		0.80	PP	200.00				Firm to stiff orangish brown sandy gravelly CLAY. Gravel is fine to coarse sub-angular and sub-rounded flint.	
		0.80	PP	220.00				(RIVER TERRACE DEPOSITS)	1.0
		0.80	PP	220.00					
		1.00	D						
		1.00	SPT	N=14 (3,2/4,4,3,3)					
		1.50	D						1.5
		2.00	D					2.00-2.40m Becoming firm.	2.0
		2.00	SPT	N=12 (4,3/2,3,3,4)					
					2.40	68.90		Very stiff brown and grey slightly sandy CLAY. (RIVER TERRACE DEPOSITS)	2.5
		2.50	D						
		2.60	PP	250.00					
		2.60	PP	250.00					
		2.60	PP	300.00					
					2.90	67.10		Stiff to very stiff brown and grey CLAY. (LONDON CLAY FORMATION)	3.0
		3.00	D						
		3.00	PP	250.00					
		3.00	PP	300.00					
		3.00	PP	300.00					
		3.00	SPT	N=21 (2,3/4,6,5,6)					
		3.50	D						3.5
		3.50	PP	325.00					
		3.50	PP	325.00					
		3.50	PP	350.00					
		3.90	PP	300.00					4.0
		3.90	PP	300.00					
		3.90	PP	350.00					
		4.00	D						
		4.00	SPT	N=27 (4,6/7,6,7,7)					
					4.45	66.60		End of Borehole at 4.450m	4.5
									5.0
									5.5

Remarks

1. No groundwater encountered. 2. Borehole terminated due to sand collapsing to 3.00m. 3. 50mm standpipe installed to 4.00m, Response zone 4.00-1.00m, bentonite seal 1.00-0.20m, concrete flush cover 0.20-0.00m. 4. Approximate ground level taken from location plan provided.





Borehole Log

Borehole No.

WS2

Sheet 1 of 1

Project Name: Bartlett Arboretum, Reading

Project No.
GEG-23-795

Co-ords: 470873E - 165782N

Hole Type
WS

Location: Bartlett Arboretum, Yew Tree Lane, Reading RG7 1HR

Level: 69.20 m AOD

Scale
1:31

Client: Jubb Consulting Engineers Ltd c/o Bartlett Tree Experts

Dates: 19/07/2023

Logged By
JM

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.10	ES		0.00			Firm friable brown sandy slightly gravelly CLAY. Gravel is fine to coarse sub-angular and sub-rounded flint.	
					0.20	69.20		(TOPSOIL)	
		0.50	D					Dense light brown clayey very gravelly SAND. Gravel is fine to coarse sub-angular and sub-rounded flint.	0.5
		0.50	ES					(RIVER TERRACE DEPOSITS)	
		1.00	D					Dense light grey and orangish brown very gravelly SAND. Gravel is fine to coarse sub-angular and sub-rounded flint.	1.0
		1.00	SPT	50 (7,7/50 for 180mm)				(RIVER TERRACE DEPOSITS)	
								<u>1.00-1.33m Becoming very dense.</u>	
					1.33	68.80		End of Borehole at 1.330m	1.5
									2.0
									2.5
									3.0
									3.5
									4.0
									4.5
									5.0
									5.5

Remarks

1. No groundwater encountered. 2. Borehole terminated due to SPT refusal at 1.00m. 3. On completion borehole backfilled with arisings. 4. Approximate ground level taken from location plan provided.





Borehole Log

Borehole No.

WS3

Sheet 1 of 1

Project Name: Bartlett Arboretum, Reading

Project No.
GEG-23-795

Co-ords: 470970E - 165861N

Hole Type
WS

Location: Bartlett Arboretum, Yew Tree Lane, Reading RG7 1HR

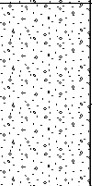
Level: 67.20 m AOD

Scale
1:31

Client: Jubb Consulting Engineers Ltd c/o Bartlett Tree Experts

Dates: 19/07/2023

Logged By
JM

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.10	ES	50 (10,14/50 for 175mm)	0.00	67.20		Firm friable brown sandy slightly gravelly CLAY. Gravel is fine to coarse sub-angular and sub-rounded flint. (TOPSOIL)	0.5
		0.50 0.50	D ES		0.30			Dense light brown clayey very gravelly SAND. Gravel is fine to coarse sub-angular and sub-rounded flint. (RIVER TERRACE DEPOSITS)	
		1.00 1.00	D SPT		0.60	66.90		Dense light grey and orangish brown very gravelly SAND. Gravel is fine to coarse sub-angular and sub-rounded flint. (RIVER TERRACE DEPOSITS)	1.0
					1.00 - 1.33 m: <i>Becoming very dense.</i>				
					1.33		66.60	End of Borehole at 1.325m	
								2.0	
								2.5	
								3.0	
								3.5	
								4.0	
								4.5	
								5.0	
								5.5	

Remarks

1. No groundwater encountered. 2. Borehole terminated due to SPT refusal at 1.00m. 3. On completion borehole backfilled with arisings. 4. Approximate ground level taken from location plan provided.





Borehole Log

Borehole No.

WS4

Sheet 1 of 1

Project Name: Bartlett Arboretum, Reading

Project No.
GEG-23-795

Co-ords: 470794E - 165783N

Hole Type
WS

Location: Bartlett Arboretum, Yew Tree Lane, Reading RG7 1HR

Level: 69.30 m AOD

Scale
1:31

Client: Jubb Consulting Engineers Ltd c/o Bartlett Tree Experts

Dates: 19/07/2023

Logged By
JM

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.10	ES		0.00			MADE GROUND - Firm dark brown sandy gravelly CLAY. Gravel is fine to coarse sub-rounded and sub-angular flint and quartzite with rare brick fragments.	
		0.50	D		0.40	69.30		Dense light brown clayey very sandy GRAVEL. Gravel is fine to coarse sub-angular and sub-rounded flint. (RIVER TERRACE DEPOSITS)	0.5
		0.50	ES		0.60	68.90		Dense light grey and orangish brown clayey slightly gravelly SAND. Gravel is fine to coarse sub-angular and sub-rounded flint. (RIVER TERRACE DEPOSITS)	
		0.90	D		0.80	68.70		Dense light grey SAND. (RIVER TERRACE DEPOSITS)	1.0
		1.00	SPT	50 (25 for 115mm/50 for 135mm)	0.90	68.50		Very dense light grey very gravelly SAND. Gravel is fine to coarse sub-angular and sub-rounded flint. (RIVER TERRACE DEPOSITS)	1.5
					1.25	68.40		End of Borehole at 1.250m	2.0
									2.5
									3.0
									3.5
									4.0
									4.5
									5.0
									5.5

Remarks

1. No groundwater encountered. 2. Borehole terminated due to SPT refusal at 1.00m. 3. 50mm standpipe installed to 1.00m, Response zone 1.00-0.50m, bentonite seal 0.50-0.20m, concrete flush cover 0.20-0.00m. 4. Approximate ground level taken from location plan provided.





Borehole Log

Borehole No.

WS5

Sheet 1 of 1

Project Name: Bartlett Arboretum, Reading

Project No.
GEG-23-795

Co-ords: 470759E - 165572N

Hole Type
WS

Location: Bartlett Arboretum, Yew Tree Lane, Reading RG7 1HR

Level: 69.00 m AOD

Scale
1:31

Client: Jubb Consulting Engineers Ltd c/o Bartlett Tree Experts

Dates: 19/07/2023

Logged By
JM

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.10	ES		0.00			Firm friable brown sandy slightly gravelly CLAY. Gravel is fine to coarse sub-angular and sub-rounded flint. (TOPSOIL)	
		0.20			0.20	69.00		Dense light brown clayey very gravelly SAND. Gravel is fine to coarse sub-angular and sub-rounded flint. (RIVER TERRACE DEPOSITS)	0.5
		0.50	D						
		0.50	ES						
		1.00	D						1.0
		1.00	SPT	40 (9,11/40 for 190mm)				1.00 - 1.34 m: Becoming very dense.,	
					1.34	68.80		End of Borehole at 1.340m	1.5
									2.0
									2.5
									3.0
									3.5
									4.0
									4.5
									5.0
									5.5

Remarks

1. No groundwater encountered. 2. Borehole terminated due to SPT refusal at 1.00m. 3. On completion borehole backfilled with arisings. 4. Approximate ground level taken from location plan provided.





Geo Environmental Group

Trial Pit Log

TrialPit No

TP1

Sheet 1 of 1

Project Name: Bartlett Arboretum, Reading

Project No.
GEG-23-795

Co-ords: 471070.00 - 165857.00
Level: 64.00

Date
19/07/2023

Location: Bartlett Arboretum, Yew Tree Lane, Reading RG7 1HR

Dimensions (m): 1.80

Depth
2.30

0.50

Scale
1:25

Logged
JM

Client: Jubb Consulting Engineers Ltd c/o Bartlett Tree Experts

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.10	ES		0.00			Firm friable brown slightly sandy slightly gravelly CLAY. Gravel is fine to coarse sub-angular and sub-rounded flint. (TOPSOIL)	
				0.20	63.80		Stiff orangish brown and grey slightly sandy slightly gravelly CLAY. Gravel is fine to coarse sub-angular and sub-rounded flint. (RIVER TERRACE DEPOSITS)	0.5
	0.50	ES						
	0.60	D		0.60	63.40		Stiff orangish brown and grey slightly sandy slightly gravelly CLAY. (RIVER TERRACE DEPOSITS)	1.0
	0.70	HVP	160					
	0.70	HVP	170					
	0.70	HVP	180					
	1.00	D						
	1.40	HVP	192					
	1.40	HVP	200					1.5
	1.40	HVP	204					
	1.50	D						
	2.00	B					Band of clayey sand and flint gravel.	2.0
	2.10	HVP	216	2.10	61.90		Very stiff brown and grey CLAY. (LONDON CLAY FORMATION)	
	2.10	HVP	240					
	2.10	HVP	256					
	2.30	D		2.30	61.70		End of Pit at 2.300m	2.5
								3.0
								3.5
								4.0
								4.5

Remarks: 1. No groundwater encountered. 2. Infiltration test carried out in pit. 3. On completion trial pit backfilled with arisings. 4. Equipment used: 8t 360 Excavator. 5. Approximate ground level taken from location plan provided.

Stability: Stable





Geo Environmental Group

Trial Pit Log

TrialPit No

TP2

Sheet 1 of 1

Project Name: Bartlett Arboretum, Reading

Project No.
GEG-23-795

Co-ords: 470921.00 - 165770.00
Level: 68.20

Date
19/07/2023

Location: Bartlett Arboretum, Yew Tree Lane, Reading RG7 1HR

Dimensions (m): 1.80

Depth
2.40

0.50



Scale
1:25

Logged
JM

Client: Jubb Consulting Engineers Ltd c/o Bartlett Tree Experts

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.10	ES		0.00			Firm very friable brown sandy gravelly CLAY. Gravel is fine to coarse sub-angular and sub-rounded flint. (TOPSOIL)	
				0.30	67.90		Stiff orangish brown slightly sandy slightly gravelly CLAY. Gravel is fine to coarse sub-angular and sub-rounded flint. (RIVER TERRACE DEPOSITS)	0.5
	0.50	D						
	0.50	ES						
	0.60	HVP	180					
	0.60	HVP	180					
	0.60	HVP	190					
	1.00	HVP	190					1.0
	1.00	HVP	190					
	1.00	HVP	196					
	1.50	B						1.5
	1.50	D						
	1.80	HVP	200	1.80	66.40		Stiff orangish brown and grey CLAY with gravel size pockets of clayey fine sand. (LONDON CLAY FORMATION)	2.0
	1.80	HVP	200					
	1.80	HVP	260					
	2.00	D						
	2.20	HVP	220					
	2.20	HVP	232					
	2.20	HVP	236					
	2.40	D		2.40	65.80		End of Pit at 2.400m	2.5
								3.0
								3.5
								4.0
								4.5

Remarks: 1. No groundwater encountered. 2. Infiltration test carried out in pit. 3. On completion trial pit backfilled with arisings. 4. Equipment used: 8t 360 Excavator. 5. Approximate ground level taken from location plan provided.

Stability: Stable





Geo Environmental Group

Trial Pit Log

Trial Pit No

TP3

Sheet 1 of 1

Project Name: Bartlett Arboretum, Reading

Project No.
GEG-23-795

Co-ords: 470998.00 - 165758.00
Level: 65.25

Date
19/07/2023

Location: Bartlett Arboretum, Yew Tree Lane, Reading RG7 1HR

Dimensions (m): 2.00

Depth
2.75

0.50



Scale
1:25

Logged
JM

Client: Jubb Consulting Engineers Ltd c/o Bartlett Tree Experts

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.20	ES		0.00			Firm friable brown slightly sandy slightly gravelly CLAY. Gravel is fine to coarse sub-angular and sub-rounded flint. (TOPSOIL)	
				0.25	65.00		Stiff friable yellowish brown sandy gravelly CLAY. Gravel is fine to coarse sub-angular and sub-rounded flint. (RIVER TERRACE DEPOSITS)	
				0.40	64.85		Stiff orangish brown and grey slightly sandy slightly gravelly CLAY. Gravel is fine to coarse sub-angular and sub-rounded flint. (RIVER TERRACE DEPOSITS)	0.5
	0.50	D						
	0.50	ES						
	0.60	HVP	216					
	0.60	HVP	220					
	0.60	HVP	230					
	1.00	B						1.0
	1.50	D						1.5
	1.90	B						2.0
	2.00	D					Dense gravel band in north of pit.	
	2.40	HVP	200					
	2.40	HVP	200				Becoming gravelly.	
	2.50	B		2.50	62.75		Very stiff brown CLAY. (LONDON CLAY FORMATION)	2.5
	2.60	HVP	280					
	2.60	HVP	280					
	2.60	HVP	280	2.75	62.50		End of Pit at 2.750m	3.0
	2.70	B						3.5
								4.0
								4.5

Remarks: 1. No groundwater encountered. 2. On completion trial pit backfilled with arisings. 3. Equipment used: 8t 360 Excavator. 4. Approximate ground level taken from location plan provided.

Stability: Stable





Geo Environmental Group

Trial Pit Log

TrialPit No

TP4

Sheet 1 of 1

Project Name: Bartlett Arboretum, Reading

Project No.
GEG-23-795

Co-ords: 470873.00 - 165654.00
Level: 68.20

Date
19/07/2023

Location: Bartlett Arboretum, Yew Tree Lane, Reading RG7 1HR

Dimensions (m):

2.00

Scale
1:25

Client: Jubb Consulting Engineers Ltd c/o Bartlett Tree Experts

Depth
2.80

0.50

Logged
JM

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.10	ES		0.00			Firm friable brown sandy slightly gravelly CLAY. Gravel is fine to coarse sub-angular and sub-rounded flint. (TOPSOIL)	
	0.50	D		0.40	67.80		Stiff friable brown slightly sandy CLAY. (RIVER TERRACE DEPOSITS)	0.5
	0.50	ES		0.60	67.60		Stiff brown and grey CLAY. (RIVER TERRACE DEPOSITS)	
	1.00	D						1.0
	1.30	HVP	208					
	1.30	HVP	224					
	1.30	HVP	224					
	1.50	B						1.5
				1.60	66.60		Stiff orangish brown sandy gravelly CLAY with boulder sized pockets of gravelly sand. Gravel is fine to coarse sub-angular and sub-rounded flint. (RIVER TERRACE DEPOSITS)	
	1.90	B		1.90	66.30		Medium dense orangish brown clayey gravelly SAND. Gravel is fine to coarse sub-angular and sub-rounded flint. (RIVER TERRACE DEPOSITS)	2.0
				2.10	66.10		Stiff orangish brown sandy gravelly CLAY. Gravel is fine to coarse sub-angular and sub-rounded flint. (RIVER TERRACE DEPOSITS)	
	2.50	D		2.50	65.70		Stiff brown and grey CLAY. Gravelly in north end until base. Gravel is fine to coarse sub-angular and sub-rounded flint. (LONDON CLAY FORMATION)	2.5
	2.80	D		2.80	65.40		End of Pit at 2.800m	3.0
								3.5
								4.0
								4.5

Remarks: 1. No groundwater encountered. 2. On completion trial pit backfilled with arisings. 3. Equipment used: 8t 360 Excavator. 4. Approximate ground level taken from location plan provided.

Stability: Stable





Trial Pit Log

Trial Pit No
TP5
Sheet 1 of 1

Project Name: Bartlett Arboretum, Reading

Project No.
GEG-23-795

Co-ords: 470778.00 - 165668.00
Level: 69.00

Date
19/07/2023

Location: Bartlett Arboretum, Yew Tree Lane, Reading RG7 1HR

Dimensions (m): 1.90

Depth
2.30

0.50

Scale
1:25

Logged
JM

Client: Jubb Consulting Engineers Ltd c/o Bartlett Tree Experts

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.10	ES		0.00			Firm friable brown sandy gravelly CLAY. Gravel is fine to coarse sub-angular and sub-rounded flint. (TOPSOIL)	
				0.30	68.70		Stiff slightly friable orangish brown slightly sandy gravelly clay. Gravel is fine to coarse sub-angular and sub-rounded flint. (RIVER TERRACE DEPOSITS)	0.5
	0.50	D						
	0.50	ES						
	0.50	PP	PP=300					
	0.50	PP	PP=300					
	0.50	PP	PP=310					
	0.80	PP	PP=320	0.80	68.20		Stiff slightly friable grey and orangish brown gravelly CLAY. Gravel is fine to coarse sub-angular and sub-rounded flint. (RIVER TERRACE DEPOSITS)	1.0
	0.80	PP	PP=350					
	0.80	PP	PP=350	1.00	68.00		Medium dense orangish brown and grey very clayey very sandy GRAVEL. Gravel is fine to coarse sub-angular and sub-rounded flint. (RIVER TERRACE DEPOSITS)	1.5
	1.00	D						
	1.50	D						
	1.50	PP	PP=106					
	1.50	PP	PP=108					
	1.50	PP	PP=110	1.70	67.30		Stiff orangish brown very sandy gravelly CLAY. Gravel is fine to coarse sub-angular and sub-rounded flint. (RIVER TERRACE DEPOSITS)	2.0
	2.00	B						
	2.00	PP	PP=100					
	2.00	PP	PP=95					
	2.00	PP	PP=98					
				2.30	66.70		End of Pit at 2.300m	2.5
								3.0
								3.5
								4.0
								4.5

Remarks: 1. No groundwater encountered. 2. Infiltration test carried out in pit. 3. On completion trial pit backfilled with arisings. 4. Equipment used: 8t 360 Excavator. 5. Approximate ground level taken from location plan provided.

Stability: Stable





APPENDIX D

INFILTRATION TEST DATA

Infiltration Test

Project Name: Bartlett Arboretum, Reading
Project Ref.: GEG-23-795
Trial Pit: TP1
Test No.: Test 1 of 1

Depth of Pit (cm):	230.00
Depth of Water at Start of Depth (cm):	110.00
Date of Test:	19 July 2023

[illegible]

Parameter	Symbol	Calculation	Units	TP1
Effective Depth of Trial Pit	d_p		m	1.20
Width of Trial Pit	w		m	0.50
Length of Trial Pit	l		m	1.80
Volume of Trial Pit	V	$= d_p \times w \times l$	m^3	1.08
Volume of Trial Pit at 50% Effective Depth	$V_{50\%}$	$= V \times 0.5$	m^3	0.54
Internal Surface Area of Trial Pit*	$a_{p50\%}$	$= l \times w + d_p \times (w + l)$	m^2	3.66
Time to reach 75% Effective Depth	$T_{p75\%}$		min	N/A
Time to reach 25% Effective Depth	$T_{p25\%}$		min	N/A
Time 25% - 75%	$T_{p75\%-25\%}$	$= T_{p25\%} - T_{p75\%}$	min	N/A
Infiltration Rate	f	$= V_{50\%} / a_{p50\%} \times (T_{p75\%-25\%})$	m/s	N/A

*To 50% Effective Depth (including base)

End of Test

With Reference to: **Graph D-1**

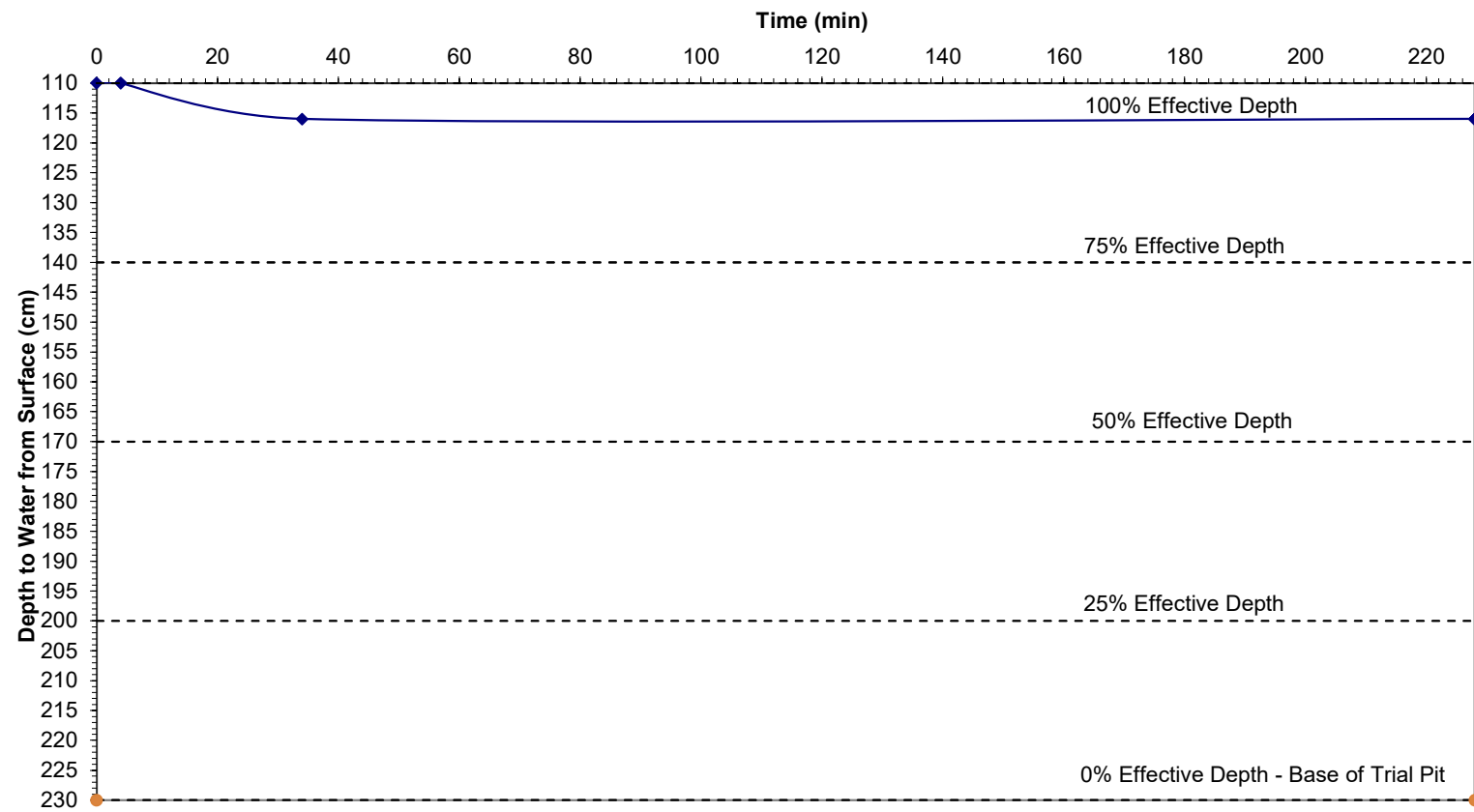
Site Engineer: JM
Drafted by: JM
Checked by: CM/MP

Graph D-1

GEG-23-795

Bartlett Arboretum, Reading

TP1



Infiltration Test

Project Name: Bartlett Arboretum, Reading
Project Ref.: GEG-23-795
Trial Pit: TP2
Test No.: Test 1 of 1

Depth of Pit (cm):	240.00
Depth of Water at Start of Depth (cm):	130.00
Date of Test:	19 July 2023

[illegible]

Parameter	Symbol	Calculation	Units	TP2
Effective Depth of Trial Pit	d_p		m	1.10
Width of Trial Pit	w		m	0.50
Length of Trial Pit	l		m	1.80
Volume of Trial Pit	V	$= d_p \times w \times l$	m^3	0.99
Volume of Trial Pit at 50% Effective Depth	$V_{50\%}$	$= V \times 0.5$	m^3	0.495
Internal Surface Area of Trial Pit*	$a_{p50\%}$	$= l \times w + d_p \times (w + l)$	m^2	3.43
Time to reach 75% Effective Depth	$T_{p75\%}$		min	N/A
Time to reach 25% Effective Depth	$T_{p25\%}$		min	N/A
Time 25% - 75%	$T_{p75\%-25\%}$	$= T_{p25\%} - T_{p75\%}$	min	N/A
Infiltration Rate	f	$= V_{50\%} / a_{p50\%} \times (T_{p75\%-25\%})$	m/s	N/A

*To 50% Effective Depth (including base)

End of Test

With Reference to: **Graph D-2**

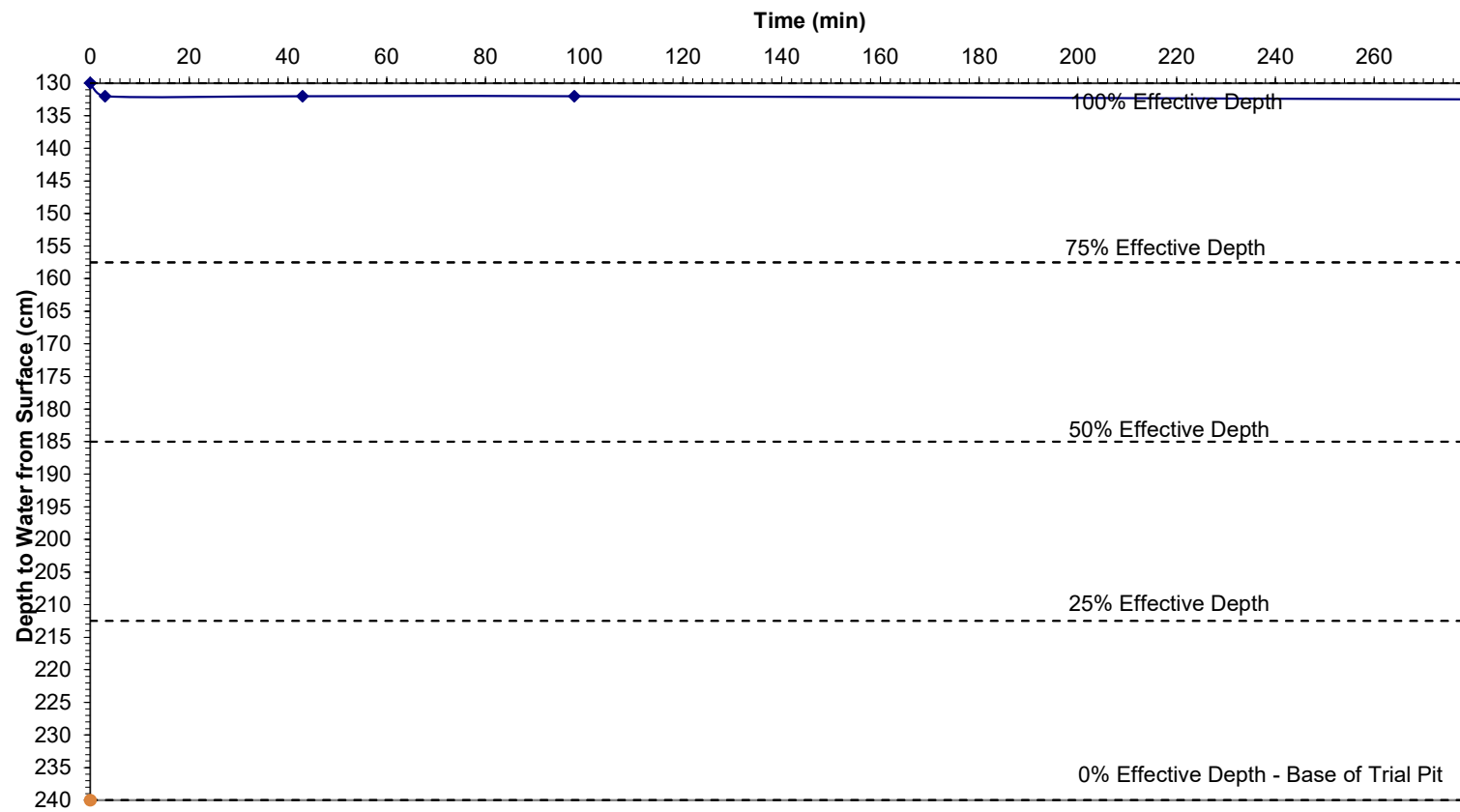
Site Engineer: JM
Drafted by: JM
Checked by: CM/MP

Graph D-2

GEG-23-795

Bartlett Arboretum, Reading

TP2



Infiltration Test

Project Name: Bartlett Arboretum, Reading
Project Ref.: GEG-23-795
Trial Pit: TP5
Test No.: Test 1 of 1

Depth of Pit (cm):	230.00
Depth of Water at Start of Depth (cm):	91.00
Date of Test:	19 July 2023

[illegible]

Parameter	Symbol	Calculation	Units	TP5
Effective Depth of Trial Pit	d_p		m	1.39
Width of Trial Pit	w		m	0.50
Length of Trial Pit	l		m	1.90
Volume of Trial Pit	V	$= d_p \times w \times l$	m^3	1.32
Volume of Trial Pit at 50% Effective Depth	$V_{50\%}$	$= V \times 0.5$	m^3	0.66025
Internal Surface Area of Trial Pit*	$a_{p50\%}$	$= l \times w + d_p \times (w + l)$	m^2	4.29
Time to reach 75% Effective Depth	$T_{p75\%}$		min	N/A
Time to reach 25% Effective Depth	$T_{p25\%}$		min	N/A
Time 25% - 75%	$T_{p75\%-25\%}$	$= T_{p25\%} - T_{p75\%}$	min	N/A
Infiltration Rate	f	$= V_{50\%} / a_{p50\%} \times (T_{p75\%-25\%})$	m/s	N/A

*To 50% Effective Depth (including base)

End of Test

With Reference to: **Graph D-3**

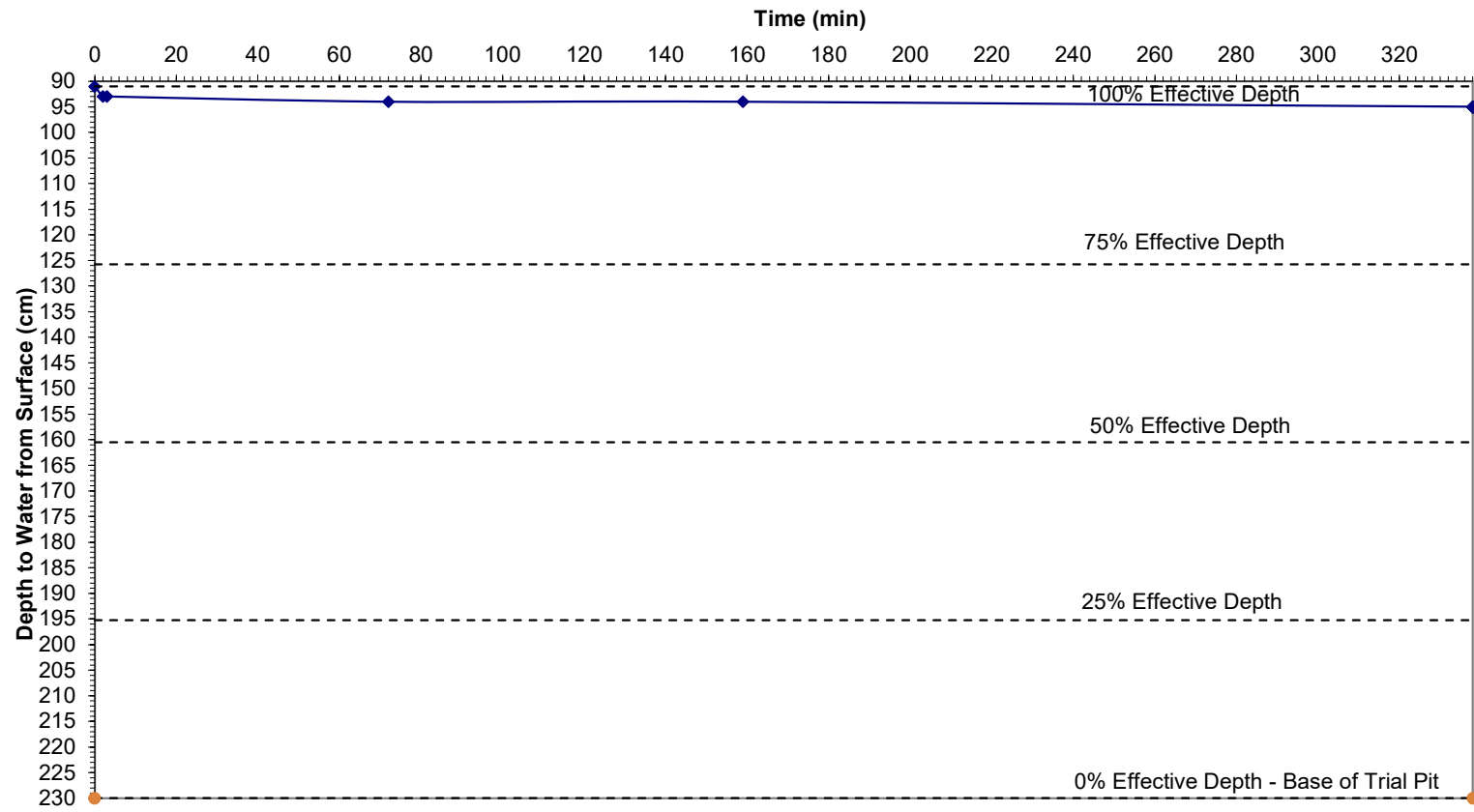
Site Engineer: JM
Drafted by: JM
Checked by: CM/MP

Graph D-3

GEG-23-795

Bartlett Arboretum, Reading

TP5

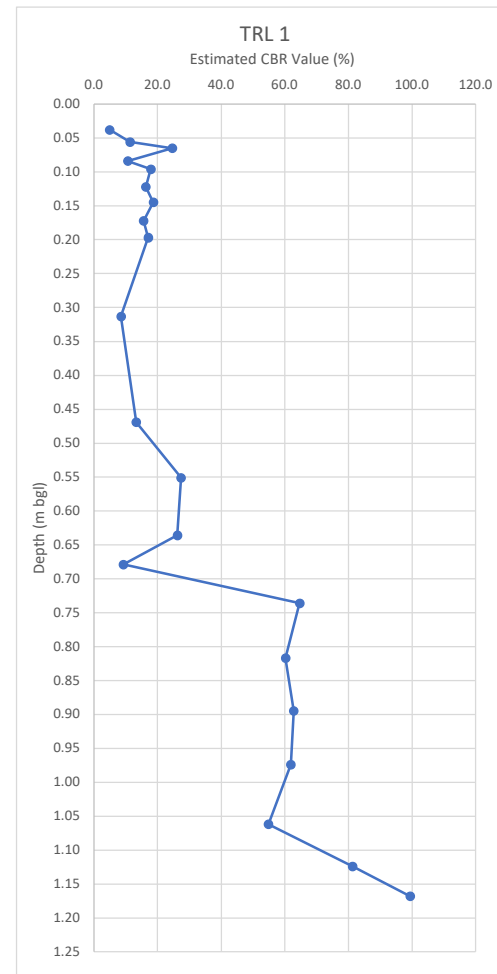




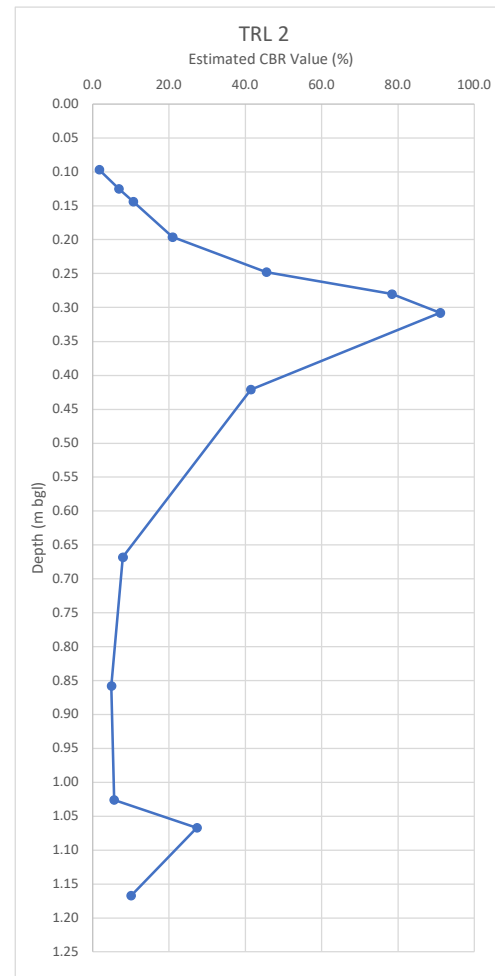
APPENDIX E

TRL DCP RESULTS

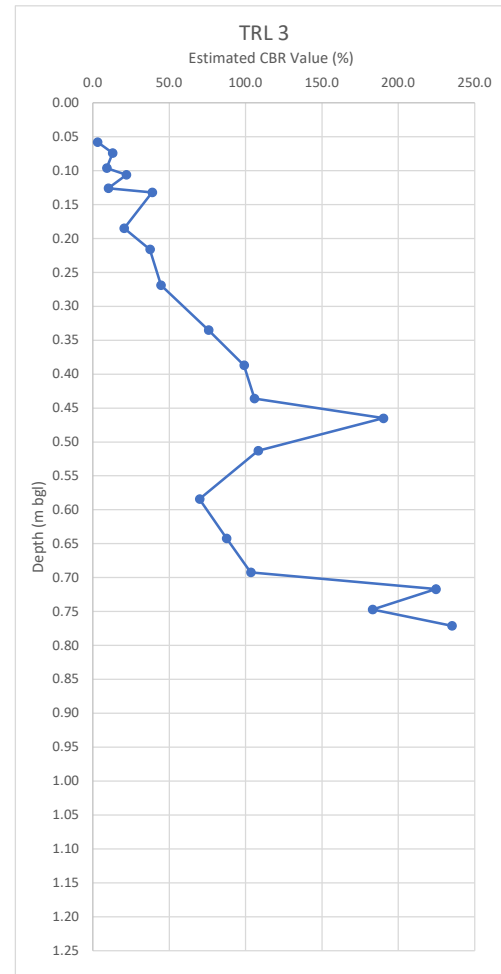
* $\log \text{CBR} = 2.46 - 1.12 \log \text{DPI}$ (after US Army Engineers Waterways Experiment Station (1992))



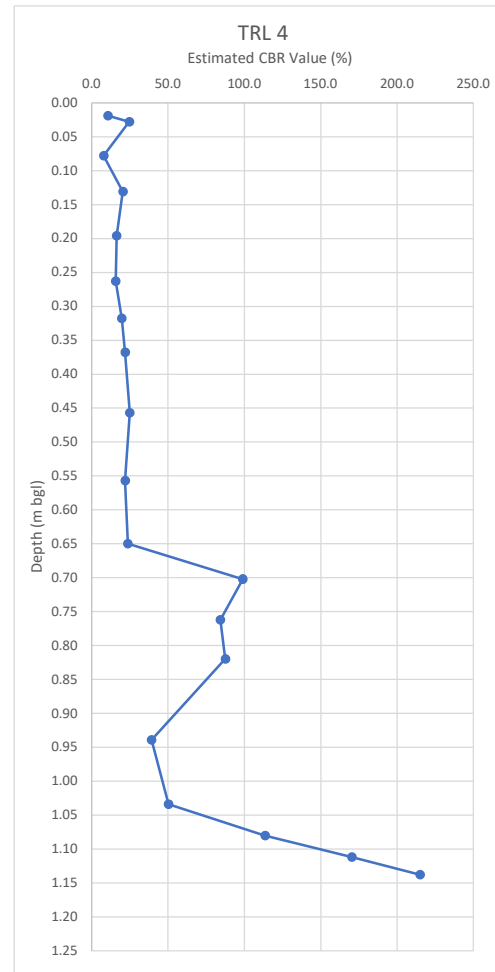
* $\log \text{CBR} = 2.46 - 1.12 \log \text{DPI}$ (after US Army Engineers Waterways Experiment Station (1992))



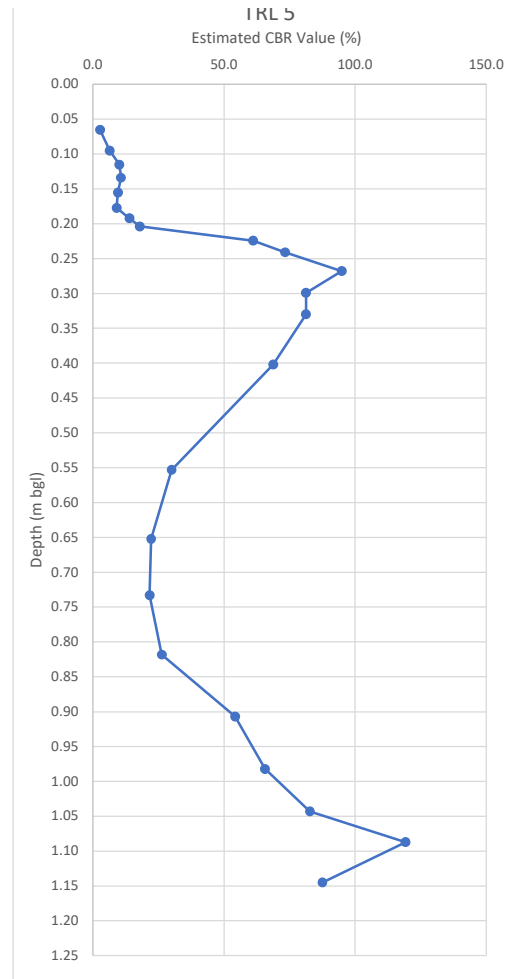
* $\log \text{CBR} = 2.46 - 1.12 \log \text{DPI}$ (after US Army Engineers Waterways Experiment Station (1992))



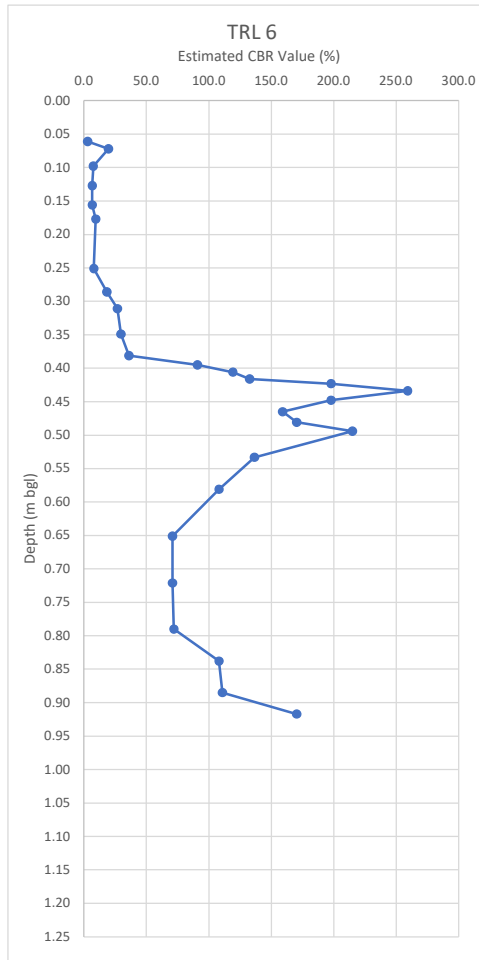
* $\log \text{CBR} = 2.46 - 1.12 \log \text{DPI}$ (after US Army Engineers Waterways Experiment Station (1992))



* $\log \text{CBR} = 2.46 - 1.12 \log \text{DPI}$ (after US Army Engineers Waterways Experiment Station (1992))



* $\log \text{CBR} = 2.46 - 1.12 \log \text{DPI}$ (after US Army Engineers Waterways Experiment Station (1992))





APPENDIX F

CHEMICAL ANALYSIS RESULTS



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e: reception@i2analytical.com

Analytical Report Number : 23-47085

Project / Site name: Barlett Arboretum - Reading

Samples received on: 24/07/2023

Your job number: GEG-23-795

**Samples instructed on/
Analysis started on:** 26/07/2023

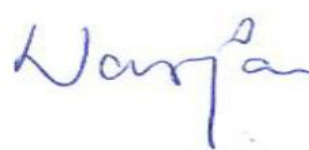
Your order number: 4725

Analysis completed by: 02/08/2023

Report Issue Number: 1

Report issued on: 02/08/2023

Samples Analysed: 7 soil samples



Signed:
Dominika Warjan
Reporting 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: 23-47085
Project / Site name: Barlett Arboretum - Reading
Your Order No: 4725

Lab Sample Number				2760139	2760140	2760141	2760142	2760143
Sample Reference				TP4	WS1	WS1	WS2	WS2
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.50	0.50	3.00	0.10	0.50
Date Sampled				19/07/2023	19/07/2023	19/07/2023	19/07/2023	19/07/2023
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	92
Moisture Content	%	0.01	NONE	9.8	12	14	4.4	1.2
Total mass of sample received	kg	0.001	NONE	1.5	1.5	1	1.5	1.5

Asbestos in Soil	Type	N/A	ISO 17025	-	-	-	-	-
Asbestos Analyst ID	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

General Inorganics

pH - Automated	pH Units	N/A	MCERTS	8	7.4	7.7	7.4	8.2
Total Cyanide	mg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	-
Free Cyanide	mg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	-
Total Sulphate as SO4	mg/kg	50	MCERTS	220	200	-	690	-
Total Sulphate as SO4	%	0.005	MCERTS	-	-	0.055	-	-
Water Soluble Sulphate as SO4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	17	13	-	340	1100
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.0085	0.0067	0.091	0.17	0.55
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	8.5	6.7	90.6	168	548
Sulphide	mg/kg	1	MCERTS	< 1.0	< 1.0	-	1.2	-
Water Soluble Chloride (2:1) (leachate equivalent)	mg/l	0.5	MCERTS	-	-	61	-	-
Total Sulphur	%	0.005	MCERTS	-	-	0.026	-	-
Ammoniacal Nitrogen as NH4	mg/kg	0.5	MCERTS	-	-	< 0.5	-	-
Ammonium as NH4 (10:1 leachate equivalent)	mg/l	0.05	MCERTS	-	-	< 0.05	-	-
Organic Matter (automated)	%	0.1	MCERTS	0.5	0.7	-	3.2	-
Water Soluble Nitrate (2:1) as N (leachate equivalent)	mg/l	2	NONE	-	-	< 2.0	-	-

Total Phenols

Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	-
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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	< 0.05	-	< 0.05	-
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	-
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	0.09	-
Pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	0.08	-
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	-
Chrysene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	0.05	-
Benzo(b)fluoranthene	mg/kg	0.05	ISO 17025	< 0.05	< 0.05	-	0.06	-
Benzo(k)fluoranthene	mg/kg	0.05	ISO 17025	< 0.05	< 0.05	-	< 0.05	-
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	0.05	-
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	-
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	-
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	-

Total PAH

Speciated Total EPA-16 PAHs	mg/kg	0.8	ISO 17025	< 0.80	< 0.80	-	< 0.80	-
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Analytical Report Number: 23-47085
Project / Site name: Barlett Arboretum - Reading
Your Order No: 4725

Lab Sample Number				2760139	2760140	2760141	2760142	2760143
Sample Reference				TP4	WS1	WS1	WS2	WS2
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.50	0.50	3.00	0.10	0.50
Date Sampled				19/07/2023	19/07/2023	19/07/2023	19/07/2023	19/07/2023
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					

Heavy Metals / Metalloids

Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	11	20	-	6.2	-
Boron (water soluble)	mg/kg	0.2	MCERTS	0.3	0.4	-	0.5	-
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	-	0.3	-
Chromium (hexavalent)	mg/kg	1.2	NONE	< 1.2	< 1.2	-	< 1.2	-
Chromium (III)	mg/kg	1	NONE	33	53	-	15	-
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	34	53	-	15	-
Copper (aqua regia extractable)	mg/kg	1	MCERTS	13	24	-	14	-
Lead (aqua regia extractable)	mg/kg	1	MCERTS	11	16	-	30	-
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	-	< 0.3	-
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	13	14	-	5.2	-
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	-
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	33	48	-	54	-

Magnesium (water soluble)	mg/kg	5	NONE	-	-	30	-	-
Magnesium (leachate equivalent)	mg/l	2.5	NONE	-	-	15	-	-

Petroleum Hydrocarbons

TPH (C21 - C35) EH_CU_1D_TOTAL	mg/kg	10	MCERTS	-	-	-	-	-
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TPH Texas (C6 - C8) HS_1D_TOTAL	mg/kg	0.1	NONE	-	-	-	-	-
TPH Texas (C8 - C10) HS_1D_TOTAL	mg/kg	0.1	NONE	-	-	-	-	-
TPH Texas (C10 - C12) EH_CU_1D_TOTAL	mg/kg	1	MCERTS	-	-	-	-	-
TPH Texas (C12 - C16) EH_CU_1D_TOTAL	mg/kg	4	MCERTS	-	-	-	-	-
TPH Texas (C16 - C21) EH_CU_1D_TOTAL	mg/kg	10	MCERTS	-	-	-	-	-
TPH Texas (C21 - C40) EH_CU_1D_TOTAL	mg/kg	10	MCERTS	-	-	-	-	-
TPH Texas (C6 - C40) EH_CU+HS_1D_TOTAL	mg/kg	10	NONE	-	-	-	-	-

U/S = Unsuitable Sample I/S = Insufficient Sample ND = Not detected

Analytical Report Number: 23-47085
Project / Site name: Barlett Arboretum - Reading
Your Order No: 4725

Lab Sample Number				2760144	2760145
Sample Reference				WS3	WS4
Sample Number				None Supplied	None Supplied
Depth (m)				0.10	0.10
Date Sampled				19/07/2023	19/07/2023
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	%	0.01	NONE	8.4	5.3
Total mass of sample received	kg	0.001	NONE	1.5	1.3

Asbestos in Soil	Type	N/A	ISO 17025	-	Not-detected
Asbestos Analyst ID	N/A	N/A	N/A	N/A	IZJ

General Inorganics

pH - Automated	pH Units	N/A	MCERTS	8.4	7.1
Total Cyanide	mg/kg	1	MCERTS	< 1.0	< 1.0
Free Cyanide	mg/kg	1	MCERTS	< 1.0	< 1.0
Total Sulphate as SO4	mg/kg	50	MCERTS	5800	-
Total Sulphate as SO4	%	0.005	MCERTS	-	0.02
Water Soluble Sulphate as SO4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	3400	71
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	1.7	0.036
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	1690	35.6
Sulphide	mg/kg	1	MCERTS	29	< 1.0
Water Soluble Chloride (2:1) (leachate equivalent)	mg/l	0.5	MCERTS	-	-
Total Sulphur	%	0.005	MCERTS	-	-
Ammoniacal Nitrogen as NH4	mg/kg	0.5	MCERTS	-	-
Ammonium as NH4 (10:1 leachate equivalent)	mg/l	0.05	MCERTS	-	-
Organic Matter (automated)	%	0.1	MCERTS	3.4	1
Water Soluble Nitrate (2:1) as N (leachate equivalent)	mg/l	2	NONE	-	-

Total Phenols

Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0
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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	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	0.07	< 0.05
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	0.24	0.13
Pyrene	mg/kg	0.05	MCERTS	0.22	0.12
Benzo(a)anthracene	mg/kg	0.05	MCERTS	0.11	0.06
Chrysene	mg/kg	0.05	MCERTS	0.14	0.07
Benzo(b)fluoranthene	mg/kg	0.05	ISO 17025	0.17	0.08
Benzo(k)fluoranthene	mg/kg	0.05	ISO 17025	0.08	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	0.13	0.07
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	0.08	0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	0.09	0.05

Total PAH

Speciated Total EPA-16 PAHs	mg/kg	0.8	ISO 17025	1.33	< 0.80
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Analytical Report Number: 23-47085
Project / Site name: Barlett Arboretum - Reading
Your Order No: 4725

Lab Sample Number				2760144	2760145
Sample Reference				WS3	WS4
Sample Number				None Supplied	None Supplied
Depth (m)				0.10	0.10
Date Sampled				19/07/2023	19/07/2023
Time Taken				None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status		
Heavy Metals / Metalloids					
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	6.3	5.8
Boron (water soluble)	mg/kg	0.2	MCERTS	9.5	0.4
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	2.4	< 0.2
Chromium (hexavalent)	mg/kg	1.2	NONE	< 1.2	< 1.2
Chromium (III)	mg/kg	1	NONE	14	12
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	14	12
Copper (aqua regia extractable)	mg/kg	1	MCERTS	18	12
Lead (aqua regia extractable)	mg/kg	1	MCERTS	62	17
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	5.8	6.6
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	260	39

Magnesium (water soluble)	mg/kg	5	NONE	-	-
Magnesium (leachate equivalent)	mg/l	2.5	NONE	-	-

Petroleum Hydrocarbons

TPH (C21 - C35) EH_CU_1D_TOTAL	mg/kg	10	MCERTS	-	11
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TPH Texas (C6 - C8) HS_1D_TOTAL	mg/kg	0.1	NONE	-	< 0.1
TPH Texas (C8 - C10) HS_1D_TOTAL	mg/kg	0.1	NONE	-	< 0.1
TPH Texas (C10 - C12) EH_CU_1D_TOTAL	mg/kg	1	MCERTS	-	< 1.0
TPH Texas (C12 - C16) EH_CU_1D_TOTAL	mg/kg	4	MCERTS	-	< 4.0
TPH Texas (C16 - C21) EH_CU_1D_TOTAL	mg/kg	10	MCERTS	-	< 10
TPH Texas (C21 - C40) EH_CU_1D_TOTAL	mg/kg	10	MCERTS	-	21
TPH Texas (C6 - C40) EH_CU+HS_1D_TOTAL	mg/kg	10	NONE	-	22

U/S = Unsuitable Sample I/S = Insufficient Sample ND = Not detected



Analytical Report Number : 23-47085
Project / Site name: Barlett Arboretum - Reading

* 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 *
2760139	TP4	None Supplied	0.5	Brown clay and sand with gravel.
2760140	WS1	None Supplied	0.5	Brown clay and sand with gravel and vegetation.
2760141	WS1	None Supplied	3	Brown clay with vegetation.
2760142	WS2	None Supplied	0.1	Brown sand with gravel and vegetation.
2760143	WS2	None Supplied	0.5	Brown sand with gravel and stones.
2760144	WS3	None Supplied	0.1	Brown sand with gravel and vegetation.
2760145	WS4	None Supplied	0.1	Brown sand with gravel and vegetation.

Analytical Report Number : 23-47085
Project / Site name: Barlett Arboretum - Reading

Water matrix abbreviations:

Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters (PrW) Final Sewage Effluent (FSE) Landfill Leachate (LL)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
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
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 dispersion 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
Free cyanide in soil	Determination of free 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
Magnesium, water soluble, in soil	Determination of water soluble magnesium by extraction with water followed by ICP-OES.	In-house method based on TRL 447	L038-PL	D	NONE
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
Speciated EPA-16 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	L064-PL	D	MCERTS
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
Sulphide in soil	Determination of sulphide in soil by acidification and heating to liberate hydrogen sulphide, trapped in an alkaline solution then assayed by ion selective electrode.	In-house method	L010-PL	D	MCERTS
Total sulphate (as SO ₄ in soil)	Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES.	In house method.	L038-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
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
TPH Texas (Soil)	TPH Texas bands C6-C10 by HS/GC-MS & C10-C40 by GC-FID	In-house method	L088/L076	D	MCERTS
Ammonium as NH ₄ in soil	Determination of Ammonium/Ammonia/ Ammoniacal Nitrogen by the colorimetric salicylate/nitroprusside method, 10:1 water extraction.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L082-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

Analytical Report Number : 23-47085
Project / Site name: Barlett Arboretum - Reading

Water matrix abbreviations:
Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters (PrW) Final Sewage Effluent (FSE) Landfill Leachate (LL)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
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
Hexavalent chromium in soil (Lower Level)	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazine followed by colorimetry.	In-house method	L080-PL	W	NONE
Total Sulphate in soil as %	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 as %	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
TPH 8 Band (Soil)	Determination of extractable petroleum hydrocarbons in soil.	In-house method with silica gel split/clean up.	L076PL	D	MCERTS
Water Soluble Nitrate (2:1) as N in soil	Determination of nitrate by reaction with sodium salicylate and colorimetry.	In-house method based on Examination of Water and Wastewater & Polish Standard Method PN-82/C-04579.08, 2:1 extraction.	L078-PL	W	NONE
Chloride, water soluble, in soil	Determination of Chloride colorimetrically by discrete analyser.	In house method.	L082-PL	D	MCERTS
Sulphate, water soluble, in soil	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

For method numbers ending in 'UK or A' analysis have been carried out in our laboratory in the United Kingdom (WATFORD).

For method numbers ending in 'F' analysis have been carried out in our laboratory in the United Kingdom (East Kilbride).

For method numbers ending in 'PL or B' 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.

Unless otherwise indicated, site information, order number, project number, sampling date, time, sample reference and depth are provided by the client. The instructed on date indicates the date on which this information was provided to the laboratory.

Information in Support of Analytical Results

List of HWOL Acronyms and Operators

Acronym	Descriptions
HS	Headspace Analysis
MS	Mass spectrometry
FID	Flame Ionisation Detector
GC	Gas Chromatography
EH	Extractable Hydrocarbons (i.e. everything extracted by the solvent(s))
CU	Clean-up - e.g. by Florisil®, silica gel
1D	GC - Single coil/column gas chromatography
2D	GC-GC - Double coil/column gas chromatography
Total	Aliphatics & Aromatics
AL	Aliphatics
AR	Aromatics
#1	EH_2D_Total but with humics mathematically subtracted
#2	EH_2D_Total but with fatty acids mathematically subtracted
_	Operator - understore to separate acronyms (exception for +)
+	Operator to indicate cumulative e.g. EH+HS_Total or EH_CU+HS_Total



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e: reception@i2analytical.com

Analytical Report Number : 23-50947

Project / Site name:	Barlett Arboretum - Reading	Samples received on:	24/07/2023
Your job number:	GEG-23-795	Samples instructed on/ Analysis started on:	15/08/2023
Your order number:	4725	Analysis completed by:	21/08/2023
Report Issue Number:	1	Report issued on:	21/08/2023
Samples Analysed:	5 soil samples		


Signed:

Joanna Szwagrak
Junior Reporting 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: 23-50947
Project / Site name: Barlett Arboretum - Reading
Your Order No: 4725

Lab Sample Number				2781128	2781129	2781130	2781131	2781132
Sample Reference				TP1	TP1	TP2	TP3	WS5
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.10	1.00	0.10	0.50	0.10
Date Sampled				19/07/2023	19/07/2023	19/07/2023	19/07/2023	19/07/2023
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	55	45	44
Moisture Content	%	0.01	NONE	13	15	4.1	6	4.6
Total mass of sample received	kg	0.001	NONE	1	1	1	1	1

General Inorganics

pH - Automated	pH Units	N/A	MCERTS	6.8	5.6	6.6	6.6	6.8
Total Cyanide	mg/kg	1	MCERTS	< 1.0	-	< 1.0	-	< 1.0
Free Cyanide	mg/kg	1	MCERTS	< 1.0	-	< 1.0	-	< 1.0
Total Sulphate as SO ₄	mg/kg	50	MCERTS	340	-	320	-	440
Water Soluble Sulphate as SO ₄ 16hr extraction (2:1)	mg/kg	2.5	MCERTS	22	72	24	14	41
Water Soluble SO ₄ 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.0109	0.036	0.0118	0.0072	0.0206
Water Soluble SO ₄ 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	10.9	36	11.8	7.2	20.6
Sulphide	mg/kg	1	MCERTS	< 1.0	-	< 1.0	-	< 1.0
Organic Matter (automated)	%	0.1	MCERTS	4.1	-	1.8	-	2.7

Total Phenols

Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	-	< 1.0	-	< 1.0
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Speciated PAHs

Naphthalene	mg/kg	0.05	MCERTS	0.15	-	0.4	-	0.29
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	0.08	-	0.07	-	0.07
Anthracene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	0.22	-	0.11	-	0.16
Pyrene	mg/kg	0.05	MCERTS	0.2	-	0.11	-	0.14
Benzo(a)anthracene	mg/kg	0.05	MCERTS	0.11	-	0.06	-	0.08
Chrysene	mg/kg	0.05	MCERTS	0.12	-	0.07	-	0.08
Benzo(b)fluoranthene	mg/kg	0.05	ISO 17025	0.18	-	0.11	-	0.14
Benzo(k)fluoranthene	mg/kg	0.05	ISO 17025	0.07	-	0.05	-	0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	0.13	-	0.08	-	0.1
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	0.09	-	< 0.05	-	0.07
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	0.11	-	0.06	-	0.07

Total PAH

Speciated Total EPA-16 PAHs	mg/kg	0.8	ISO 17025	1.46	-	1.12	-	1.25
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Heavy Metals / Metalloids

Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	6.4	-	9.1	-	6.2
Boron (water soluble)	mg/kg	0.2	MCERTS	0.5	-	0.5	-	0.7
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	-	< 0.2	-	< 0.2
Chromium (hexavalent)	mg/kg	1.2	NONE	< 1.2	-	< 1.2	-	< 1.2
Chromium (III)	mg/kg	1	NONE	20	-	20	-	13
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	20	-	20	-	13
Copper (aqua regia extractable)	mg/kg	1	MCERTS	14	-	14	-	11
Lead (aqua regia extractable)	mg/kg	1	MCERTS	33	-	32	-	22
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	-	< 0.3	-	< 0.3

Analytical Report Number: 23-50947

Project / Site name: Barlett Arboretum - Reading

Your Order No: 4725

Lab Sample Number				2781128	2781129	2781130	2781131	2781132
Sample Reference				TP1	TP1	TP2	TP3	WS5
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.10	1.00	0.10	0.50	0.10
Date Sampled				19/07/2023	19/07/2023	19/07/2023	19/07/2023	19/07/2023
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	7	-	7.2	-	5.2
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	-	< 1.0	-	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	53	-	51	-	27

U/S = Unsuitable Sample I/S = Insufficient Sample ND = Not detected

Analytical Report Number : 23-50947
Project / Site name: Barlett Arboretum - Reading

* 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 *
2781128	TP1	None Supplied	0.1	Brown loam and clay with vegetation.
2781129	TP1	None Supplied	1	Brown clay and sand with vegetation.
2781130	TP2	None Supplied	0.1	Brown sandy loam with vegetation and stones.
2781131	TP3	None Supplied	0.5	Brown sandy loam with vegetation and stones.
2781132	WS5	None Supplied	0.1	Brown sandy loam with vegetation and stones.

Analytical Report Number : 23-50947

Project / Site name: Barlett Arboretum - Reading

Water matrix abbreviations:

Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters (PrW) Final Sewage Effluent (FSE) Landfill Leachate (LL)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
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
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
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
Free cyanide in soil	Determination of free 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
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
Speciated EPA-16 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	L064-PL	D	MCERTS
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
Sulphide in soil	Determination of sulphide in soil by acidification and heating to liberate hydrogen sulphide, trapped in an alkaline solution then assayed by ion selective electrode.	In-house method	L010-PL	D	MCERTS
Total sulphate (as SO ₄ in soil)	Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES.	In house method.	L038-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
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
Cr (III) in soil	In-house method by calculation from total Cr and Cr VI.	In-house method by calculation	L080-PL	W	NONE
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
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	NONE
Sulphate, water soluble, in soil	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

Analytical Report Number : 23-50947

Project / Site name: Barlett Arboretum - Reading

Water matrix abbreviations:

Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters (PrW) Final Sewage Effluent (FSE) Landfill Leachate (LL)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
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For method numbers ending in 'UK or A' analysis have been carried out in our laboratory in the United Kingdom (WATFORD).

For method numbers ending in 'F' analysis have been carried out in our laboratory in the United Kingdom (East Kilbride).

For method numbers ending in 'PL or B' 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.

Unless otherwise indicated, site information, order number, project number, sampling date, time, sample reference and depth are provided by the client. The instructed on date indicates the date on which this information was provided to the laboratory.



APPENDIX G

GEOTECHNICAL TESTING

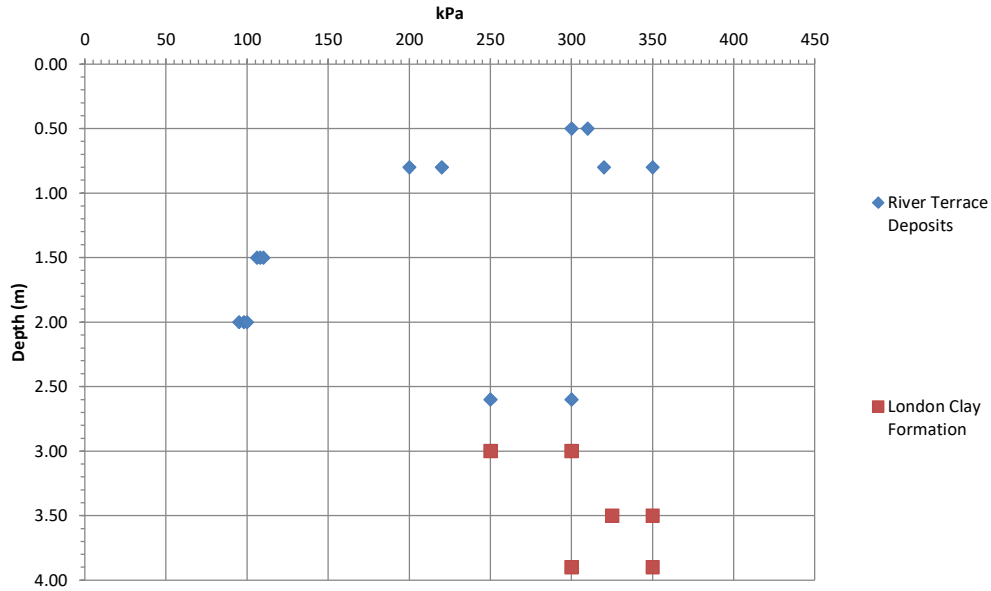
Pocket Penetrometer Measurements

Project No.: GEG-23-795

Project: Bartlett Arboretum, Reading



Graph 1A. Pocket Penetrometer Unconfined Compressive Strength vs Depth



Graph 1B. Pocket Penetrometer Derived Undrained Shear Strength vs Depth

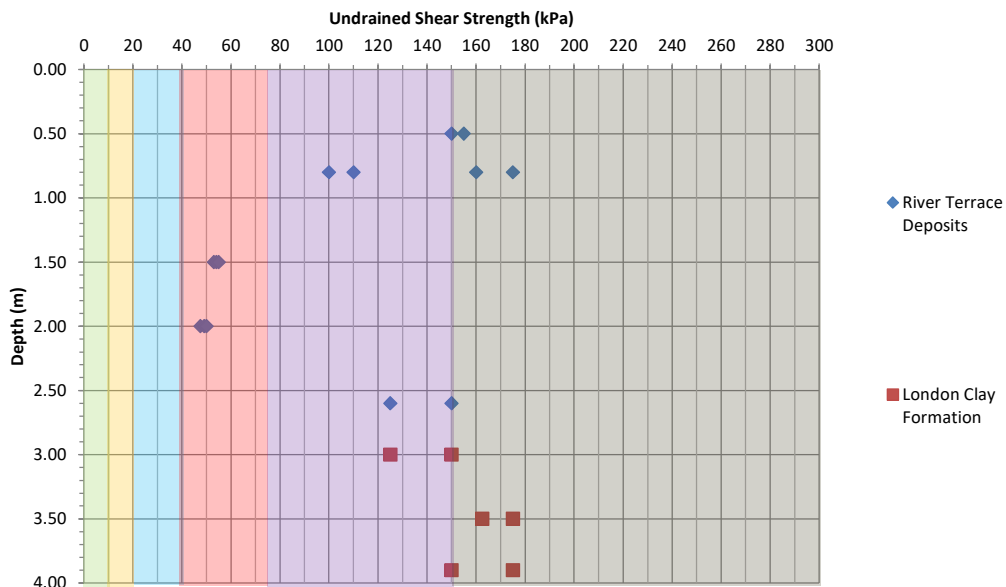


Table 9 Terms for classification of strength

Term based on measurement	Undrained strength classification definition, s_u , in kPa [from BS EN ISO 14688-2:2004, 5.3, Table 5]
Extremely low strength	<10
Very low strength	10 – 20
Low strength	20 – 40
Medium strength	40 – 75
High strength	75 – 150
Very high strength	150 – 300

Hand Vane Measurements

Project No.: GEG-23-795

Project: Bartlett Arboretum, Reading



Graph 2. Hand Shear Vane Undrained Strength vs Depth

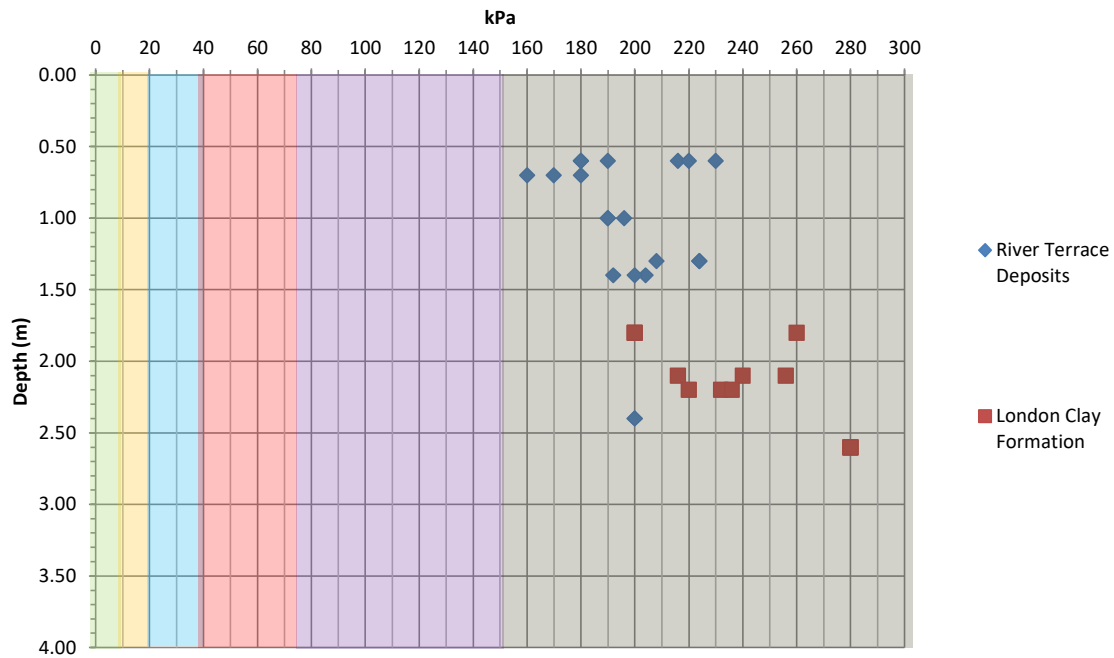


Table 9 Terms for classification of strength

Term based on measurement	Undrained strength classification definition, s_{uv} in kPa [from BS EN ISO 14688-2:2004, 5.3, Table 5]
Extremely low strength	<10
Very low strength	10 – 20
Low strength	20 – 40
Medium strength	40 – 75
High strength	75 – 150
Very high strength	150 – 300

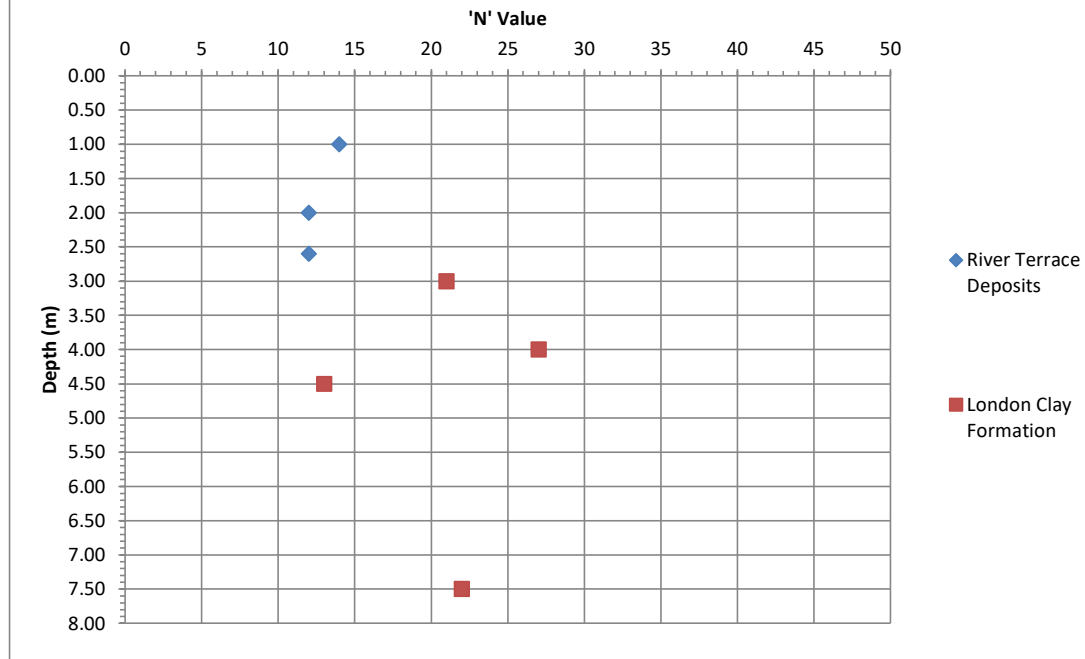
Standard Penetration Tests (SPT) 'N' Values

Project No.: GEG-23-795

Project: Bartlett Arboretum, Reading



Graph 3. SPT 'N' Value vs Depth





Laboratory Report



Contract Number: 67781

Client Ref: **GEG-23-795**

Client PO: **4729**

Date Received: **28-07-2023**

Date Completed: **10-08-2023**

Report Date: **10-08-2023**

Client: **GEG Limited**
17 Graham Road
Malvern
Worcestershire
WR14 2HR

This report has been checked and approved by:

Brendan Evans
Office Administrator

Contract Title: **Bartlett Arboretum**

For the attention of: **Alan Taylor**

Test Description	Qty
Moisture Content BS 1377:1990 - Part 2 : 3.2 - * UKAS	11
4 Point Liquid & Plastic Limit BS 1377:1990 - Part 2 : 4.3 & 5.3 - * UKAS	8
PSD Wet Sieve method BS 1377:1990 - Part 2 : 9.2 - * UKAS	3
Quick Undrained Triaxial Compression test - single specimen at one confining pressure (100mm or 38mm diameter) BS 1377:1990 - Part 7 : 8 - * UKAS	2
BRE Reduced Suite includes pH, water & acid soluble sulphate and total sulphur Sub-contracted Test	2
Water Soluble Sulphate 2:1 extract Sub-contracted Test	1
pH value of soil Sub-contracted Test	1

Notes: **Observations and Interpretations are outside the UKAS Accreditation**

* - denotes test included in laboratory scope of accreditation

- denotes test carried out by approved contractor

@ - denotes non accredited tests

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Approved Signatories:

Brendan Evans (Office Administrator) - Darren Bourne (Quality Senior Technician) - Paul Evans (Director)
Richard John (Quality/Technical Manager) - Shaun Jones (Laboratory manager) - Shaun Thomas (Site Manager)
Wayne Honey (Human Resources/ Health and Safety Manager)



Laboratory Report



Contract Number: 67781

Test Description	Qty
Dry Den/MC (2.5kg Rammer Method 1 litre mould/CBR Mould) BS 1377:1990 - Part 4 : 3.4 - * UKAS	2
Disposal of samples for job	1

Notes: Observations and Interpretations are outside the UKAS Accreditation

* - denotes test included in laboratory scope of accreditation

- denotes test carried out by approved contractor

@ - denotes non accredited tests

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Richard John (Quality/Technical Manager) - Shaun Jones (Laboratory manager) - Shaun Thomas (Site Manager)
Wayne Honey (Human Resources/ Health and Safety Manager)



DESCRIPTIONS

Contract Number	67781	
Site Name	Bartlett Arboretum	
Date Tested	07/08/2023	

[illegible]

Operators			
Clayton Jenkins			

Contract Number	67781	
Project Name	Bartlett Arboretum	
Date Tested	07/08/2023	

[illegible]

Operator

Clayton Jenkins

**PARTICLE SIZE DISTRIBUTION
BS 1377 Part 2:1990
Wet Sieve, Clause 9.2**

Contract Number 67781

Borehole/Pit No. BH01

Project Name Bartlett Arboretum

Sample No.

Soil Description

Brown slightly silty/ clayey fine to coarse sandy fine to coarse
GRAVEL

Depth Top

1.20

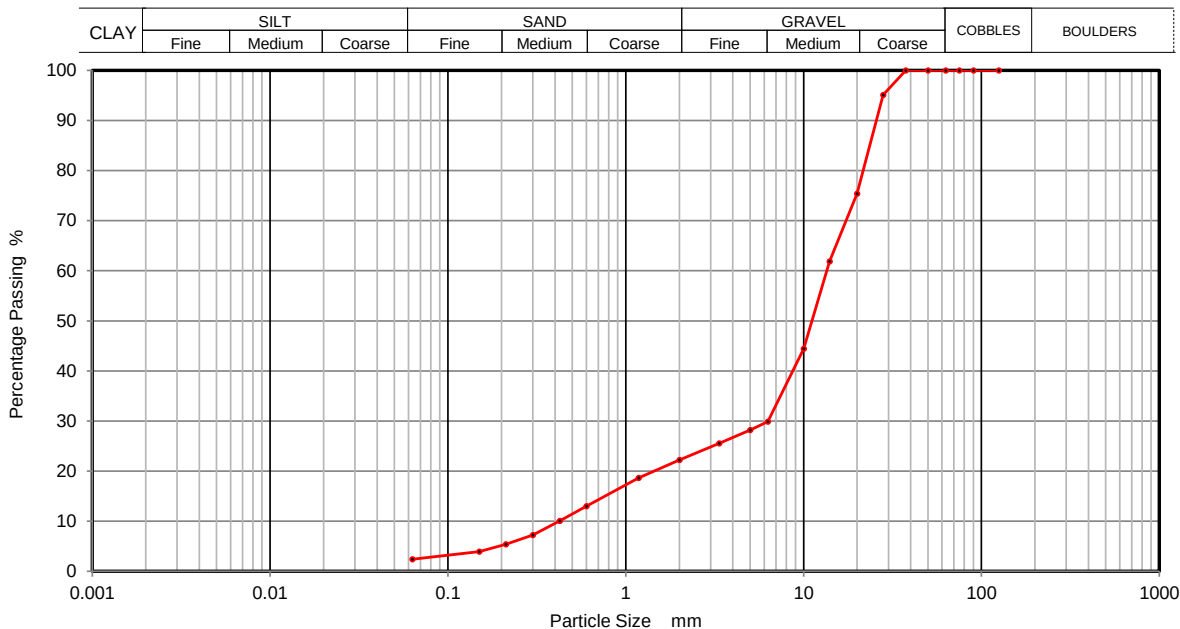
Depth Base

Date Tested

07/08/2023

Sample Type

B



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	95		
20	75		
14	62		
10	44		
6.3	30		
5	28		
3.35	26		
2	22		
1.18	19		
0.6	13		
0.425	10		
0.3	7		
0.212	5		
0.15	4		
0.063	2		

Sample Proportions	% dry mass
Cobbles	0
Gravel	78
Sand	20
Silt and Clay	2

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator

David Edwards

PARTICLE SIZE DISTRIBUTION
BS 1377 Part 2:1990
Wet Sieve, Clause 9.2

Contract Number 67781

Borehole/Pit No. TP1

Project Name Bartlett Arboretum

Sample No.

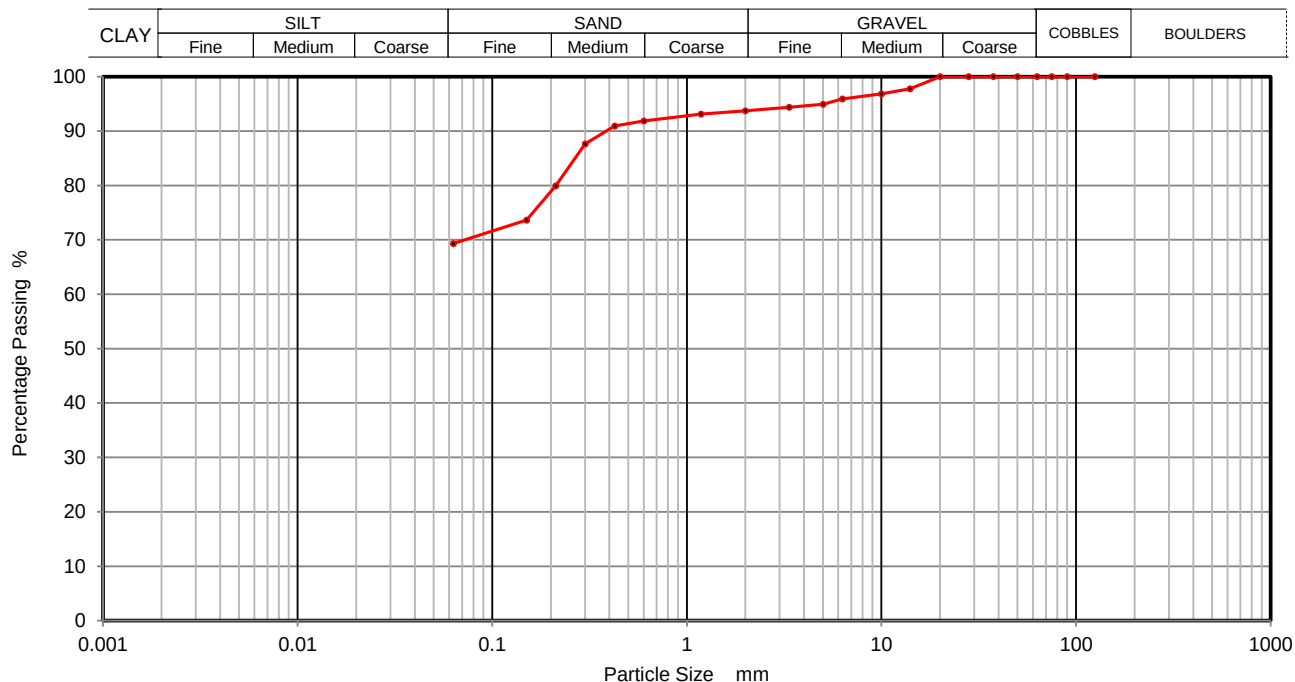
Soil Description Brown slightly gravelly fine to coarse sandy SILT/ CLAY

Depth Top 0.60

Depth Base

Date Tested 07/08/2023

Sample Type D



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	98		
10	97		
6.3	96		
5	95		
3.35	94		
2	94		
1.18	93		
0.6	92		
0.425	91		
0.3	88		
0.212	80		
0.15	74		
0.063	69		

Sample Proportions	% dry mass
Cobbles	0
Gravel	6
Sand	25
Silt and Clay	69

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator

David Edwards

PARTICLE SIZE DISTRIBUTION
BS 1377 Part 2:1990
Wet Sieve, Clause 9.2

Contract Number 67781

Borehole/Pit No. TP5

Project Name Bartlett Arboretum

Sample No.

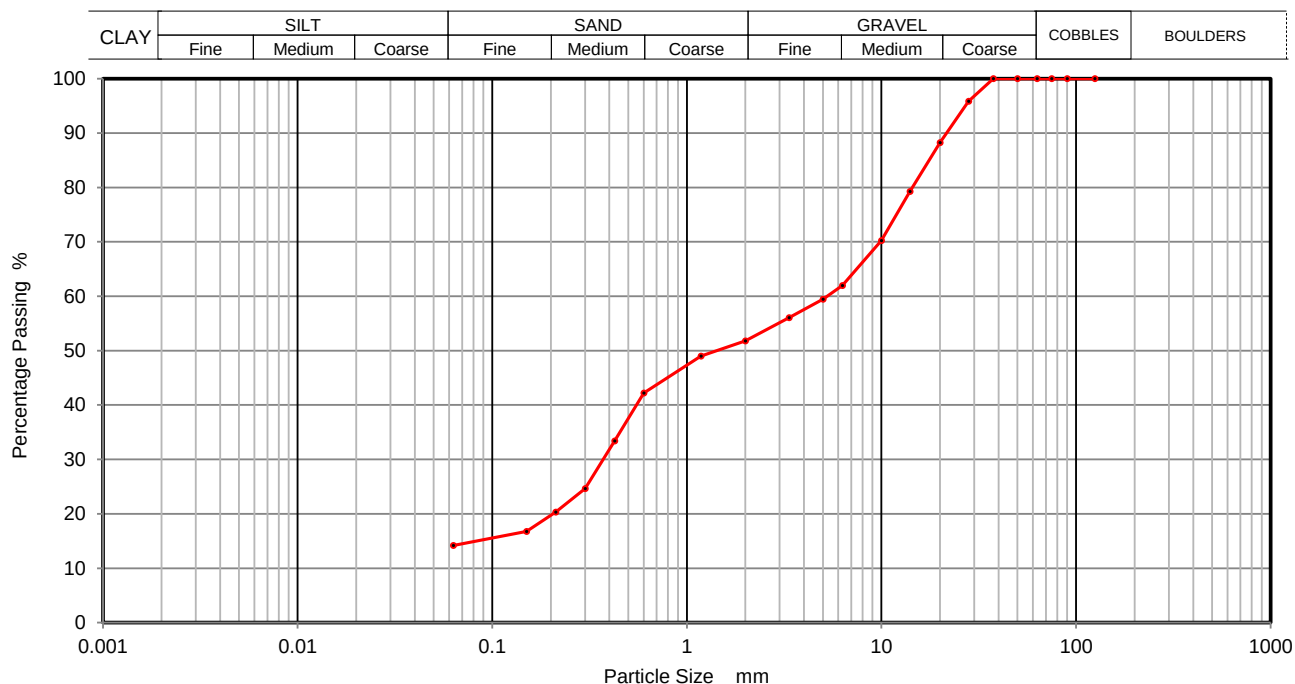
Soil Description Brown silty/ clayey fine to coarse sandy fine to coarse GRAVEL

Depth Top 1.50

Depth Base

Date Tested 07/08/2023

Sample Type D



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	96		
20	88		
14	79		
10	70		
6.3	62		
5	59		
3.35	56		
2	52		
1.18	49		
0.6	42		
0.425	33		
0.3	25		
0.212	20		
0.15	17		
0.063	14		

Sample Proportions	% dry mass
Cobbles	0
Gravel	48
Sand	38
Silt and Clay	14

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator

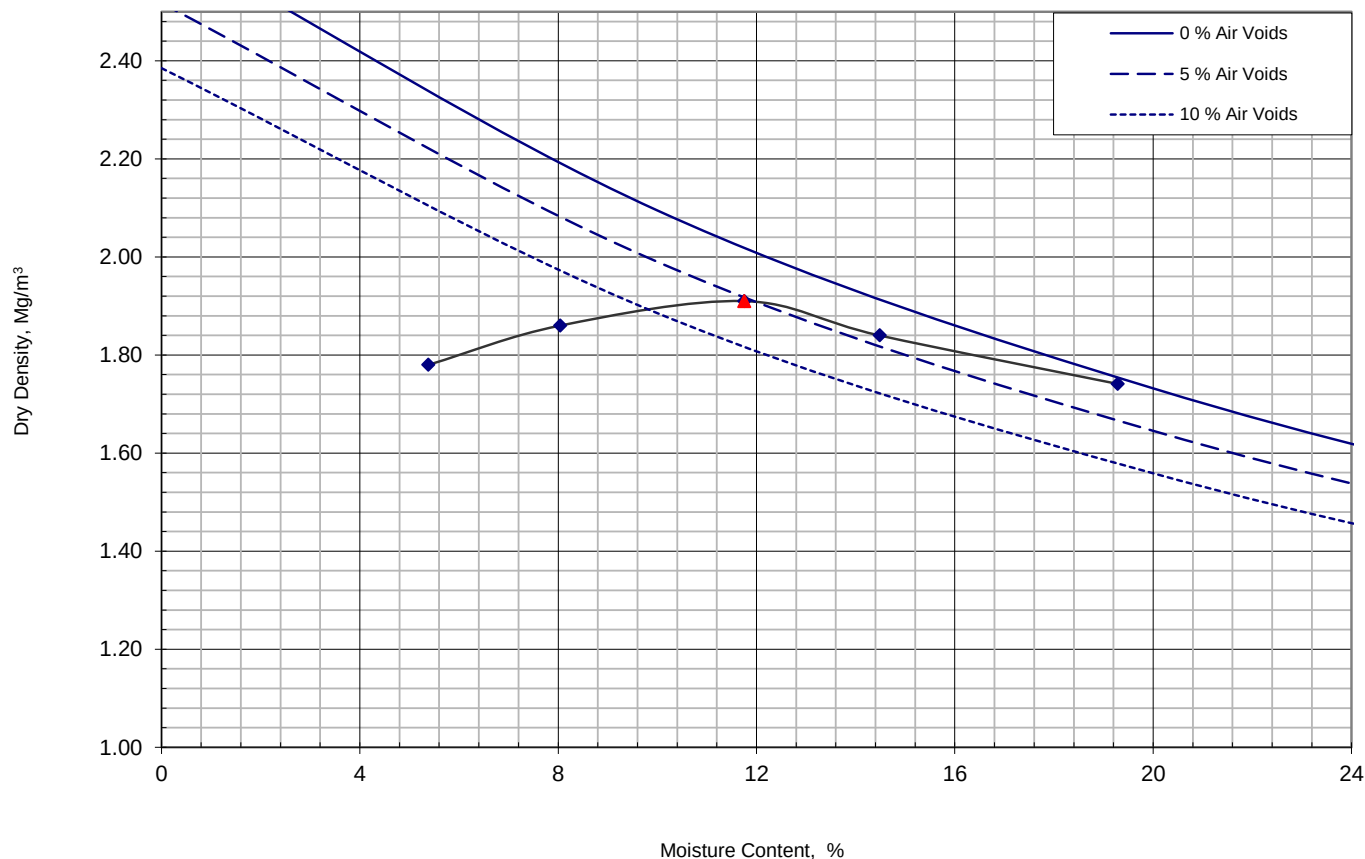
David Edwards

**Dry Density / Moisture Content Relationship
BS 1377:Part 4:1990**

Contract Number 67781

Borehole / Pit No TP1

Project Name	Bartlett Arboretum	Sample No	
Date Tested	06/08/2023	Depth Top	1.50 + 2.00
Compaction Method	2.5 Kg Rammer	Depth Base	
Compaction Clause	BS1377:Part 4:1990, Clause 3.3	Sample Type	D
Sample Description	Brown fine to medium gravelly sandy silty CLAY	Single or Separate Sample Used	Single



Compaction Point	1	2	3	4	5						
Moisture Content	5.4	8.0	12	14	19						
Bulk Density	1.88	2.01	2.13	2.11	2.08						
Dry Density	1.78	1.86	1.91	1.84	1.74						

Initial Moisture Content	19	%
Maximum Dry Density	1.91	Mg/m ³
Optimum Moisture Content	12	%
Particle Density	2.65 Assumed	Mg/m ³
Material Retained 37.5mm	0	%
Material Retained 20mm	0	%

Operator

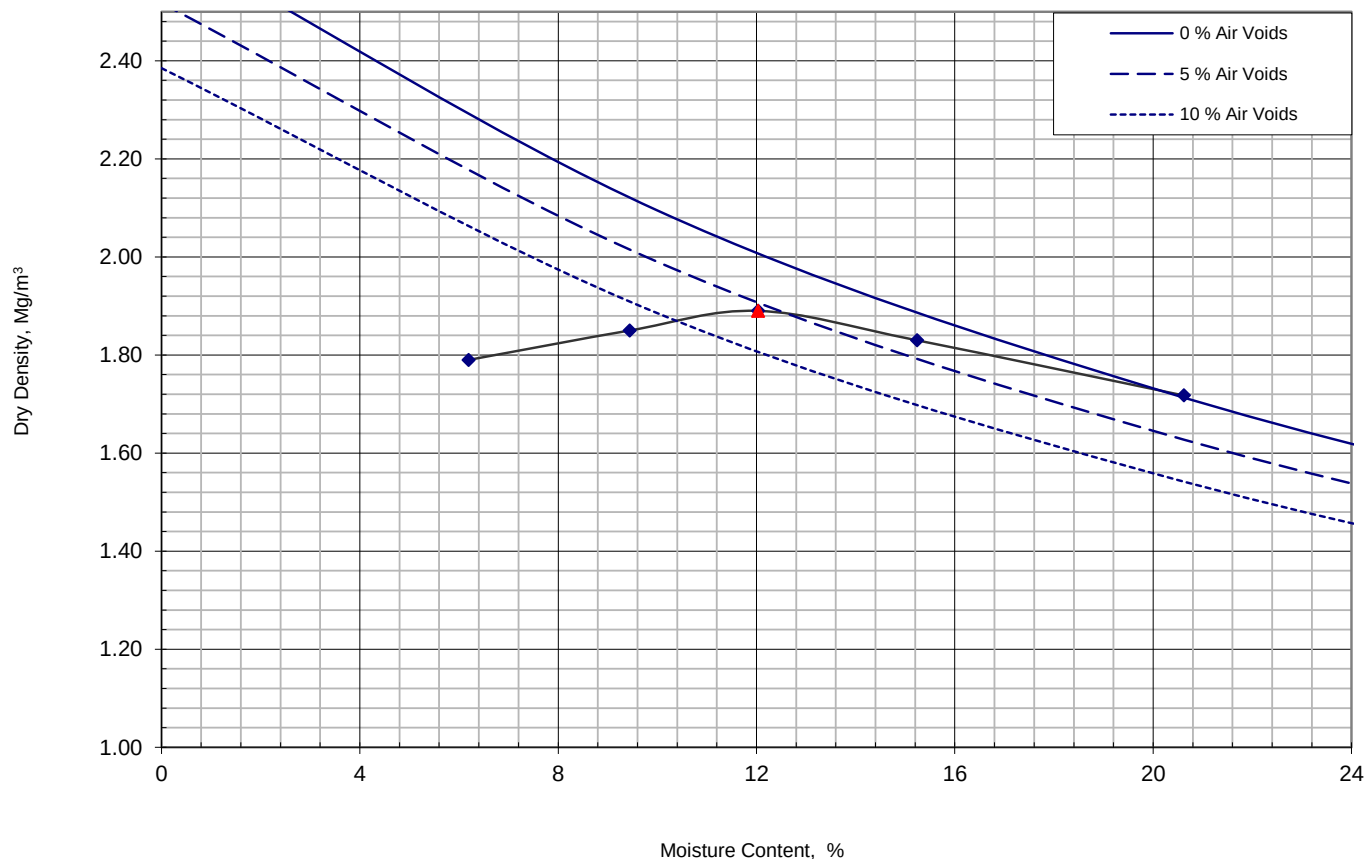
Conor

**Dry Density / Moisture Content Relationship
BS 1377:Part 4:1990**

Contract Number 67781

Borehole / Pit No TP2

Project Name	Bartlett Arboretum	Sample No	
Date Tested	06/08/2023	Depth Top	1.50 + 0.50
Compaction Method	2.5 Kg Rammer	Depth Base	
Compaction Clause	BS1377:Part 4:1990, Clause 3.3	Sample Type	B/D
Sample Description	Brown fine to medium gravelly sandy silty CLAY	Single or Separate Sample Used	Single



Compaction Point	1	2	3	4	5						
Moisture Content	6.2	9.4	12	15	21						
Bulk Density	1.90	2.02	2.12	2.11	2.07						
Dry Density	1.79	1.85	1.89	1.83	1.72						

Initial Moisture Content	21	%
Maximum Dry Density	1.89	Mg/m3
Optimum Moisture Content	12	%
Particle Density	2.65 Assumed	Mg/m3
Material Retained 37.5mm	0	%
Material Retained 20mm	0	%

Operator

Conor

Single Stage Unconsolidated-Undrained Triaxial Test
BS 1377 : 1990 Part 7 : 8

Contract Number 67781

Borehole/Pit No. BH01

Project Name Bartlett Arboretum

Sample No.

Soil Description Brown silty CLAY

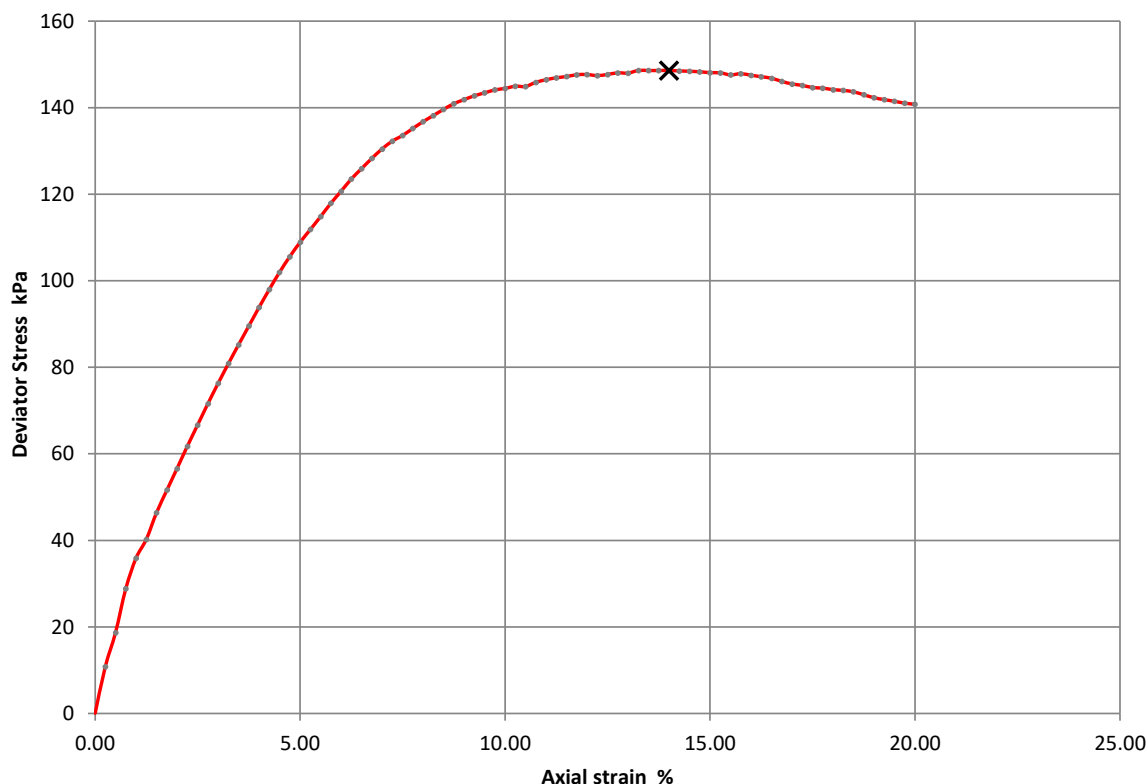
Depth Top (m) 3.50

Depth Base (m) 3.95

Date Tested 08/08/2023

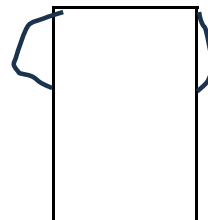
Sample Type U

Operator Jordan



Moisture Content (%)	24
Bulk Density (Mg/m ³)	2.00
Dry Density (Mg/m ³)	1.61
Specimen Length (mm)	206.81
Specimen Diameter (mm)	105.07
Cell Pressure (kPa)	70
Deviator Stress (kPa)	149
Undrained Shear Strength (kPa)	74
Failure Strain (%)	14
Mode Of Failure	Plastic
Membrane Used/Thickness	Rubber/0.2mm
Rate of Strain (%/min)	1.33

Notes.



Failure Sketch.



Single Stage Unconsolidated-Undrained Triaxial Test
BS 1377 : 1990 Part 7 : 8

Contract Number 67781

Borehole/Pit No. BH01

Project Name Bartlett Arboretum

Sample No.

Soil Description Brown silty CLAY

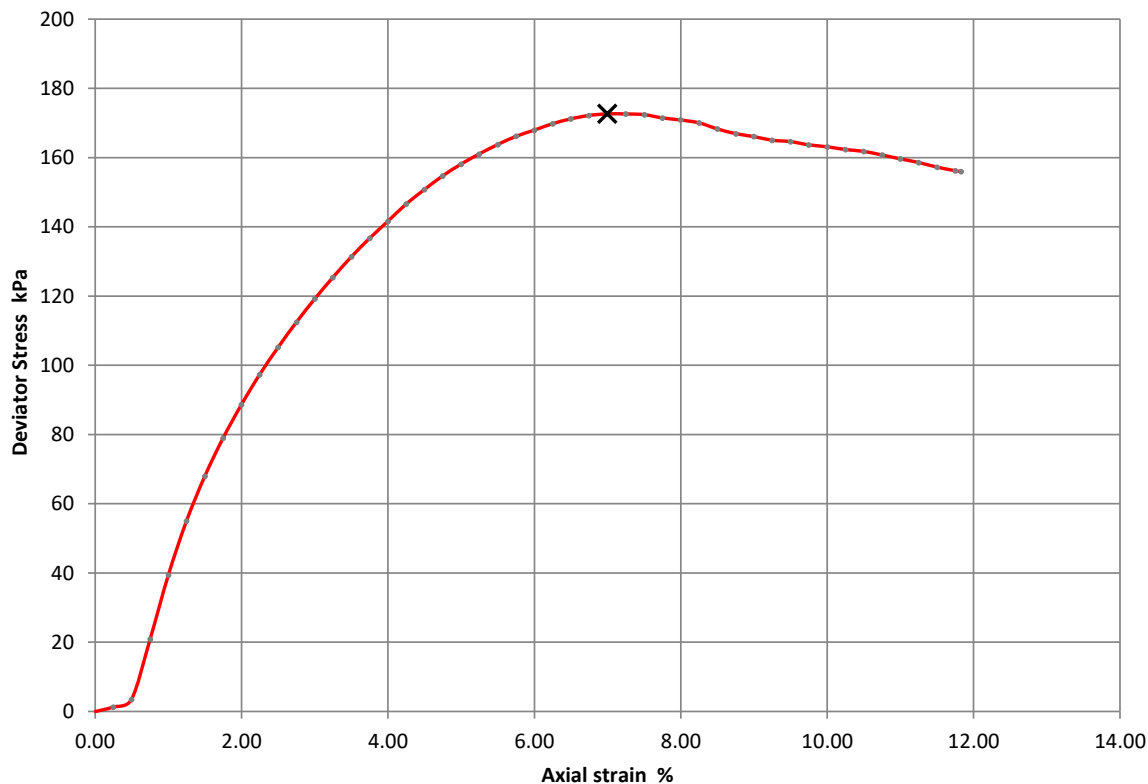
Depth Top (m) 6.00

Depth Base (m) 6.45

Date Tested 08/08/2023

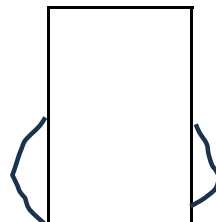
Sample Type U

Operator Jordan



Moisture Content (%)	26
Bulk Density (Mg/m ³)	2.00
Dry Density (Mg/m ³)	1.59
Specimen Length (mm)	207.83
Specimen Diameter (mm)	104.57
Cell Pressure (kPa)	120
Deviator Stress (kPa)	173
Undrained Shear Strength (kPa)	86
Failure Strain (%)	7
Mode Of Failure	Plastic
Membrane Used/Thickness	Rubber/0.2mm
Rate of Strain (%/min)	1.32

Notes.



Failure Sketch.



2788



ANALYTICAL TEST REPORT

Contract no: 125536(1)

Contract name: Bartlett Arboretum

Client reference: GEG-23-795

Clients name: Geo Site and Testing Services

Clients address: Unit 3 and 4 Heol Aur
Dafen Industrial Estate, Dafen
Llanelli, Carmarthenshire
SA14 8QN

Samples received: 07 August 2023

Analysis started: 07 August 2023

Analysis completed: 10 August 2023

Report issued: 10 August 2023

This is a supplementary report to report number 125536 issued 09 August.

Key

U	UKAS accredited test
M	MCERTS & UKAS accredited test
\$	Test carried out by an approved subcontractor
I/S	Insufficient sample to carry out test
N/S	Sample not suitable for testing

Approved by:

Samantha Rogerson
Reporting Manager

Chemtech Environmental Limited

SOILS

Lab number			125536-1	125536-2	125536-3
Sample id			BH01	BH01	TP3
Depth (m)			3.00	5.50	2.70
Sample Type			Soil	Soil	Soil
Date sampled			19/07/2023	19/07/2023	-
Test	Method	Units			
pH	CE004 ^U	units	8.1	8.0	7.9
Sulphate (2:1 water soluble)	CE061 ^U	mg/l SO ₄	25	39	16
Sulphate (acid extractable)	CE062 ^U	mg/kg SO ₄	-	985	113
Sulphate (acid extractable)	CE062 ^U	% w/w SO ₄	-	0.10	0.01
Sulphur (total)	CE119	mg/kg S	-	138	<100
Sulphur (total)	CE119	% w/w S	-	0.01	<0.01

Chemtech Environmental Limited

METHOD DETAILS

METHOD	SOILS	METHOD SUMMARY	SAMPLE	STATUS	LOD	UNITS
CE004	pH	Based on BS 1377, pH Meter	As received	U	-	units
CE061	Sulphate (2:1 water soluble)	Aqueous extraction, ICP-OES	Dry	U	10	mg/l SO ₄
CE062	Sulphate (acid extractable)	HCl extract, analysed by ICP-OES	Dry	U	100	mg/kg SO ₄
CE062	Sulphate (acid extractable)	HCl extract, analysed by ICP-OES	Dry	U	0.01	% w/w SO ₄
CE119	Sulphur (total)	Aqua regia digest, analysed by ICP-OES	Dry		100	mg/kg S
CE119	Sulphur (total)	Aqua regia digest, analysed by ICP-OES	Dry		0.01	% w/w S

DEVIATING SAMPLE INFORMATION

Chemtech Environmental Ltd cannot be held responsible for the integrity of sample(s) received if Chemtech Environmental Ltd did not undertake the sampling. Such samples may be deviating.

N	No (not deviating sample)
Y	Yes (deviating sample)
NSD	Sampling date not provided
NST	Sampling time not provided (waters only)
EHT	Sample exceeded holding time(s)
IC	Sample not received in appropriate containers
HP	Headspace present in sample container
NCF	Sample not chemically fixed (where appropriate)
OR	Other (specify)

[illegible]

Chemtech Environmental Limited

ADDITIONAL INFORMATION

Notes

Opinions and interpretations expressed herein are outside the UKAS accreditation scope.

Unless otherwise stated, Chemtech Environmental Ltd was not responsible for sampling.

All testing carried out at Unit 6 Parkhead, Stanley, DH9 7YB, except for subcontracted testing.

Methods, procedures and performance data are available on request.

Results reported herein relate only to the material supplied to the laboratory.

This report shall not be reproduced except in full, without prior written approval.

Samples will be disposed of 4 weeks from initial receipt unless otherwise instructed.

For soils and solids, all results are reported on a dry basis. Samples dried at no more than 30°C in a drying cabinet.

Analytical results are inclusive of stones, where applicable.

Chemtech Environmental Limited

TEST REPORT REVISIONS

The table below identifies amendments that have been made to this test report for each revision.

Test Report Reference	Details of amendments to test report	Issue Date
125536	Original report issued	09 August 2023
125536(1)	Result transcription error corrected	10 August 2023



TEST CERTIFICATE

DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Tested in Accordance with: BS 1377-2: 1990

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



Environmental Science

4041

Client: Geo Environmental Group
Client Address: 17 Graham Road, Malvern,
Worcestershire, WR14 2HR

Contact: Charlotte Mason
Site Address: Barlett Arboretum

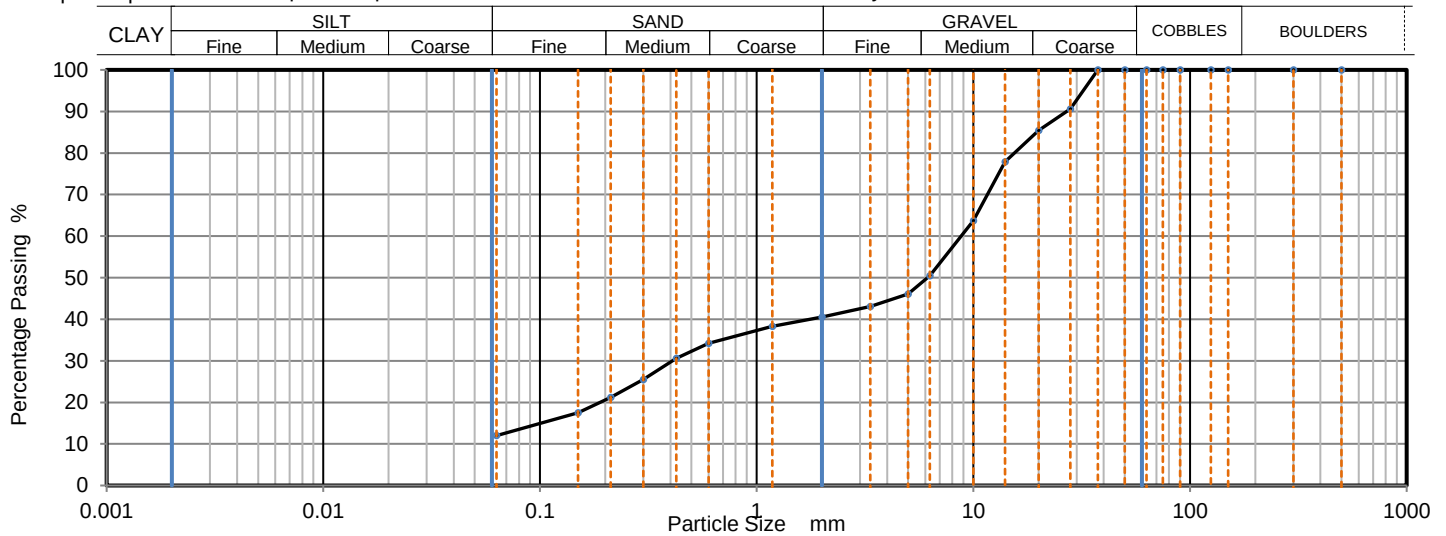
Client Reference: GEG-23-795
Job Number: 23-48601-1
Date Sampled: Not Given
Date Received: 02/08/2023
Date Tested: 16/08/2023
Sampled By: Not Given

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

Test Results:

Laboratory Reference: 2768399
Hole No.: WS04
Sample Reference: Not Given
Sample Description: Brown sandy GRAVEL
Sample Preparation: Sample was quartered, oven dried at 106.4 °C and broken down by hand.

Depth Top [m]: 0.50
Depth Base [m]: Not Given
Sample Type: D



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
500	100		
300	100		
150	100		
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	91		
20	85		
14	78		
10	64		
6.3	51		
5	46		
3.35	43		
2	41		
1.18	38		
0.6	34		
0.425	31		
0.3	26		
0.212	21		
0.15	18		
0.063	13		

Sample Proportions	% dry mass
Very coarse	0
Gravel	59
Sand	28
Fines <0.063mm	13

Grading Analysis	
D100	mm 37.5
D60	mm 8.79
D30	mm 0.408
D10	mm
Uniformity Coefficient	> 140
Curvature Coefficient	

Uniformity and Curvature Coefficient calculated in accordance with BS EN ISO 14688-2:2018

Note: Tested in Accordance with BS1377:Part 2:1990, clause 9.2

Remarks:

Signed:

Katarzyna Koziel

Katarzyna Koziel
Reporting Specialist
for and on behalf of i2 Analytical Ltd

Opinions and interpretations expressed herein are outside of the scope of the UKAS Accreditation. This report may not be reproduced other than in full without the prior written approval of the issuing laboratory. The results included within the report relate only to the sample(s) submitted for testing.

APPENDIX H: LIMITATIONS AND EXCEPTIONS

Limitations and Exceptions

1. The advice given in this report is based on the guidelines available at the time of writing.
2. This investigation was conducted so as to generally comply with the relevant principles and requirements of BS10175: 2011 "Investigation of potentially contaminated sites - Code of Practice" and BS 5930:2015 "Code of Practice for Site Investigations".
3. The Client is advised that the conditions observed on site by Jubb Consulting Engineers Ltd (JCE) at the time of the investigation or assessment are subject to change. Certain indicators of the presence of hazardous substances may have been latent at the time of the most recent site reconnaissance or investigation and they may subsequently have become observable. Ground conditions, including geotechnical properties may vary between points of observation, sampling and testing.
4. Certain areas of site had restricted access or were inaccessible due to the presence of in-use buildings, facilities and live services, as identified in this report. These may require further investigation outside the scope of this present investigation.
5. Comments made relating to land gas or groundwater conditions are based on observations made at the time of an investigation unless otherwise stated. Land gas and groundwater conditions may vary as a result of seasonal or other effects.
6. Ground contamination often exists as small discrete areas of contamination and there can be no certainty that any or all such areas have been located, sampled and/or identified.
7. The findings and opinions conveyed in this report are based on information obtained from a variety of sources, including that from previous site investigations and chemical and geotechnical testing laboratories, and which JCE has assumed are correct. Nevertheless, JCE cannot and does not guarantee the authenticity or reliability of the information it has used or cited. JCE can accept no responsibility for inaccuracies within the data supplied by other parties.
8. This report is written in the context of an agreed scope of work between JCE and the Client and should not be used in a different context. In the light of additional information becoming available, improved practices and changes in legislation, amendment or re-interpretation of the assessment or report in whole or part may be necessary after its original submission.
9. This report is provided for sole use by the Client and is confidential to them. No responsibility whatsoever for the contents of the report will be accepted to anyone other than the Client.
10. This report is not a specification for works.
11. JCE believes that providing information about limitations is essential to help the Client identify and thereby manage risks.
12. JCE does not provide legal advice and the advice of the Clients' legal advisors may also be required.
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