

Citylabs 4.0 Ltd.

Citylabs 4.0

Ground Investigation Report

GEO-REP-002

Issue 2 | 13 April 2022

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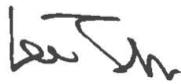
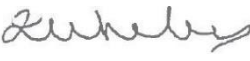
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Detailed Unexploded Ordnance (UXO) Risk Assessment

Executive Summary

Citylabs 4.0 Ltd. is proposing to develop a site on Hathersage Road, Manchester as a seven storey laboratory and office building.

In order to inform the design process and reduce the ground related risks identified in an earlier desk study exercise, a phase of intrusive ground investigation was conducted by contractor CC Geotechnical. The work included boreholes (cable percussion with rotary follow on) and mechanical trial pitting, with associated in situ and geotechnical and geochemical testing.

The ground conditions were found to comprise a relatively thin (average 1.6m thick) and generally granular layer of made ground overlying generally cohesive glacial till deposits which in turn overlies a weathered sandstone bedrock. The depth to the weathered sandstone bedrock is generally consistent across the site and was recorded to be 12-12.5m bgl (26.8 to 28.0mAOD).

Walls and structures with residual voids were encountered within the made ground deposits, these possibly being related to cellars within the former buildings on the site.

The investigation has provided in-situ and laboratory geotechnical testing which allows the derivation of typical soil parameters. The data obtained will inform the future foundation design.

Monitoring of borehole installations indicates the presence of some localised perched groundwater, with the main water table being within the underlying sandstone.

Much of the granular made ground material on site is potentially suitable for reuse after screening and crushing to form a suitable site fill if required.

At this stage CFA bored piled foundations are recommended. These are to be installed through glacial till and socketed in to the sandstone layer. The CFA solution would require the removal of obstructions within the made ground.

Due to the variable nature of the made ground and voiding encountered it is not recommended that a floor slab is founded directly on the existing made ground layer. However, if this layer is excavated and replaced with engineered granular material and validated, then a ground bearing slab should be suitable.

The soil risk assessment has identified that the existing made ground is unlikely to pose a risk to human health if reused within the final development. Exposure of construction workers to contaminated soils should be controlled to be as low as reasonably practicable (ALARP). No soil remediation is likely to be necessary to protect the health of future site users. If soils are to be reused as part of the development, they will need to be subject to validation testing to prove that they are suitable for reuse. A validated clean cover system will be required in areas of soft landscaping.

Limited perched shallow groundwater was recorded within the made ground beneath the site and risks to controlled waters are considered to be low. Where

piled foundations are to extend to bedrock (principal aquifer) a foundation works risk assessment will be required by the regulators.

The ground gas risk assessment suggests that the gassing regime within the site conforms to Characteristic Situation 1 and therefore gas protection measures in new buildings will not be required.

It is considered that all buried concrete at the development site should be designed in accordance with DS-1 and AC-1.

1 Introduction

1.1 Context

Ove Arup and Partners Ltd (Arup) has been commissioned by Citylabs 4.0 Ltd to prepare a Ground Investigation Report (GIR) to support the detailed design and accompany a planning application for the proposed Citylabs 4.0 scheme on Hathersage Road, Manchester. The project consists of the demolition and removal of the diabetes centre building and the construction of a new seven storey steel framed office structure.

1.2 Objectives

A number of ground related uncertainties were identified in an earlier desk study report [1] and an intrusive ground investigation was recommended. The purpose of this report is to summarise the findings of this intrusive ground investigation and evaluate the potential impact on the future development by:

- establishing the general ground profile and condition;
- providing an overview on the ground water levels below the site;
- characterising the existing geoenvironmental conditions of the site;

The report includes guidance on the ground related risks which should be considered within subsequent design and construction phases.

1.3 Use of report and limitations

This report was prepared by Arup on behalf of Citylabs 4.0 Ltd. It takes into account our Client's particular instructions and requirements. This report was not intended for, and should not be relied on by, any third party and no responsibility is undertaken to any third party in relation to it.

All reasonable skill, care and diligence have been exercised within the timescale available and in accordance with the technical requirements of the brief. Notwithstanding the efforts made by the professional team in preparing the report, it is possible that other ground contamination or ground conditions, as yet undetected, may exist and consequently reliance on this report must be limited accordingly.

2 The Site

2.1 Site description

The site is located to the south of Manchester City Centre approximately 1.5km south of the A57(M) Mancunian Way. The site area is approximately 0.3ha and centred on National Grid Reference SJ851958 (385166, 395814). The site is generally flat, with the level in the range 39-40mOD, with levels sloping gently to the south eastern corner.

2.2 Existing land use

The majority of the site is currently occupied by a surface car park in the eastern part and associated Manchester Royal Infirmary Diabetes Centre building in the western part which was constructed circa 2004. This is a two-storey portacabin structure which was constructed in circa 2004.

2.3 Historical site use

The site history is presented in Section 2.5 of the Arup Geotechnical and Geo-Environmental Desk Study (May 2019) [1]. The site was formerly occupied by ten residential properties. Six appear to have been demolished during the war, potentially due to bomb damage, and the remainder of the properties were demolished in the 1970s.

2.4 Published geology

The published geology is detailed in Section 2.6 of the Geotechnical and Geo-Environmental Desk Study and is summarised as follows:

Based on the British Geological Society (BGS) 1:50,000 scale solid geological map, the bedrock present beneath the western edge of the site is the Sherwood Sandstone formation, while the Manchester Marl formation is present beneath the remainder of the site. The published Manchester geological maps (SJ89NE, 1:10,000) show the superficial geology at the site to comprise glacial till.

Made ground is expected due to the developed nature of the site.

The West Manchester Fault is shown trending north-west to south-east approximately 500m north-east of the site. The Manchester Marl is shown to sub-crop beneath the site. The Sherwood Sandstone is shown to sub-crop at the western edge of the site.

2.5 Hydrogeology

The glacial till beneath the site is classified by the Environment Agency (EA) as an Unproductive stratum.

The Manchester Marl is classified by the EA as a Secondary (B) Aquifer. The EA defines Secondary (B) Aquifers as strata with predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. The Sherwood Sandstone is classified as a Principal Aquifer.

The western edge of the site is located within a Source Protection Zone (SPZ) 3 (total catchment). The EA defines this as an area around a source within which all groundwater recharge is presumed to be discharged at the source.

The Groundsure report states there are no active groundwater abstraction licences within 1,000m of the site.

The information on the hydrogeology has been taken from the Groundsure Enviro-insight report which is presented in **Appendix A** of the Arup desk study [2].

2.6 Unexploded ordnance

Before the ground investigation took place a UXO risk assessment was undertaken by 1st Line Defence with the results presented in a report [3]. The Detailed UXO Risk Assessment Report is presented in **Appendix D** of this report. This report complies with the guidelines outlined in CIRIA C681, 'Unexploded Ordnance (UXO) A Guide for the Construction Industry'.

The recommended risk mitigation methodology given in the report is:

- Site specific UXO awareness briefings to all personnel conducting intrusive works. This will include briefing on the identification of UXO and what to do in the event of encountering a suspect item to be given by a UXO Specialist.
- Unexploded Ordnance (UXO) Specialist presence on site to support shallow intrusive works. The role of the UXO would include:
 - Monitoring of works using visual recognition and instrumentation and providing an immediate response to suspected items recovered on site.
 - Providing UXO awareness briefing and advising staff on modifying work practices to take into account ordnance risk.
 - To aid incident management should ordnance be identified as a hazard.
- Intrusive Magnetometer survey of all borehole and pile locations down to a maximum bomb penetration depth.

Site attendance by UXO specialist and magnetometer screening was undertaken as part of the intrusive ground investigation.

2.7 Drainage

A drainage and SUDs Statement was prepared for the site in November 2019 by Arup [4].

There is evidence of a culvert beneath the site which runs along the southern border. It is understood to be a UU or EA asset and there is likely to be an easement and potential restrictions on building on or adjacent to it.

A survey of this has been undertaken in a separate study with results being reviewed and processed at the time of writing.

2.8 Other ground related issues

Issues relating to the following aspects of the site are presented in the indicated sections in Arup Geotechnical and Geo-Environmental Desk Study 36[1]:

- Hydrology (Section 2.8)
- Mining (Section 2.11)

3 Proposed development

The development will involve the demolition of the existing temporary Diabetes Centre building and construction of a seven storey new build steel framed office with associated bin and cycle space to the south. The proposed site layout is illustrated in **Figure 1**.

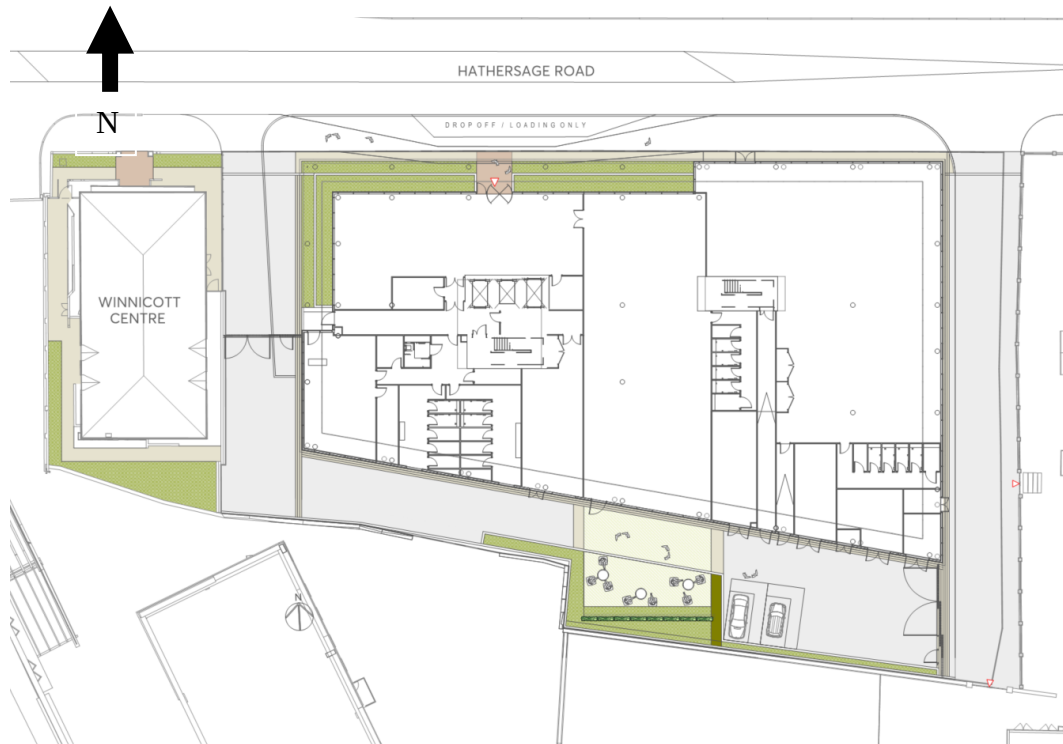


Figure 1: The proposed building.

4 Ground investigations

A ground investigation scope was designed and specified by Arup and implemented by CC Geotechnical Ltd. The works were supervised by CC Geotechnical with occasional site visits from Arup.

The fieldwork comprised the following:

- Three cable percussion boreholes with follow on rotary coring (BH01, BH02 and BH03);
- Eight mechanically excavated trial pits (TP101 to TP110);
- Three mechanically excavated pits (SA01 to SA03) to conduct BRE infiltration/soakaway testing.

The factual findings of the investigations were reported in a Factual report produced by CC Geotechnical [5].

The as constructed ground investigation locations are shown in **Appendix A1**.

As recommended in the detailed UXO risk assessment, the intrusive exploratory holes were supervised by a UXO engineer for the duration of the works in accordance with the monitoring plan.

In addition to the above, selected boreholes were fitted with installations to permit gas and ground water monitoring.

Following completion of fieldwork, six rounds of gas and groundwater monitoring was undertaken. Monitoring records are presented in the factual report and described in subsequent sections of this report.

A programme of laboratory testing was undertaken to establish the geotechnical and geoenvironmental properties of the ground.

5 Ground summary and properties

The recent ground investigation has confirmed the stratigraphy on the site, which is summarised in **Table 1**. A drawing indicating the location of the investigation points is presented in **Appendix A1**.

5.1 Stratigraphy

Stratum	Top of stratum (mOD) where proven	Thickness (m) where proven	Description
Made Ground	39.34-40.02	0.8– 2.3	Predominantly granular material comprising sandy GRAVEL or gravelly SAND with high cobble content. Gravel and cobble is fine to coarse subangular to subrounded comprising brick, ash and occasional concrete ceramic and sandstone. Surface hard standing comprises tarmac of circa 0.1m thickness.
Glacial Till	37.89 – 38.72	10.1-11.7	Firm to stiff slightly sandy slightly gravelly silty CLAY. Gravel is subrounded to subangular sandstone. Occasional sand bands/lenses in clay. Layer of medium dense gravelly fine to medium SAND at base of till.
Chester Pebble Beds	26.84 – 28.02	Unproven (9.5m proven)	Red weathered SANDSTONE. Reddish brown very weak fine to medium grained thickly laminated SANDSTONE. Recovered locally as sandy gravel or gravelly sand. Upper 0.5-2.0m is described as weathered and was recovered as sand.

Table 1: Summary of the stratigraphy encountered at the site.

A series of geological cross sections have been generated through the site and are presented in **Figures A2.1 to 2.3** of this report.

Plots of the main in-situ and laboratory geotechnical test results are presented in **Figures A3 – A7** of this report. The groundwater levels for the ground water monitoring is summarised in **Table 2**.

5.2 Made ground

5.2.1 Extent and description

Made ground thickness generally ranged between 0.8 and 2.3m, with an average thickness where fully penetrated of circa 1.6m.

The made ground is composed of predominantly granular material comprising sandy gravel or gravelly sand with high cobble content. Gravel and cobble is fine to coarse subangular to subrounded brick (often fully intact bricks), ash and occasional concrete ceramic and sandstone. The made ground appears to be more sandy in the south western part of the site. In TP02 and TP05 a layer of soft to firm slightly sandy slightly gravelly silty clay was present at the base of the made ground. A concrete slab of 0.15m thickness was encountered at the base of the made ground in TP01.

Hard standing comprising tarmac was encountered in all exploratory hole locations.

Intact brick walls were found in TP01, TP03, TP05 and T10 which are thought to be remnants cellars/basements of previously existing houses on the site. Most of the space between these walls had been backfilled with made ground however voids were evident in some of the trial pits.

5.2.2 Geotechnical in-situ and laboratory testing

Standard Penetration Tests (SPTs) performed within the made ground indicated typical SPT N values of between 9 and 33 (see **Appendix A6**). This is indicative of a loose to dense condition and an angle of shearing resistance of about 29 to 36 degrees. Only two SPT tests were undertaken in the made ground which reduces their reliability for use in design.

Seven particle size distribution (PSD) analyses were carried out on made ground samples. The grading curves are indicated in **Appendix A3a**.

The results suggest the made ground comprises varying proportions of sand and gravel. The gravel content is between 7 and 50% with the remainder being about 30 to 50% sand. The PSD results suggest that typically 10-30% of the made ground is a silt or clay.

5.3 Glacial Till

5.3.1 Extent and description

Glacial till was encountered beneath the made ground in all borehole locations and confirmed in seven trial pits. The material was fully proven to rockhead in the three borehole locations; the depth to the base of glacial till in BH01 was 12mbgl, in BH02 was 12mbgl and in BH03 was 12.5mbgl.

The glacial till was typically described as firm to stiff slightly sandy slightly gravelly silty clay. Gravel is subrounded to subangular sandstone. Inclusions of granular material were encountered, which comprised medium dense gravelly fine to medium sand at base of till. Sands beds/lenses were also found within the granular glacial till layer.

5.3.2 Geotechnical in-situ and laboratory testing

SPT testing was conducted in the glacial till at a range of depths, totalling 16 tests. SPT 'N' values in the layer were between 9 and 50, typically increasing with depth. Based on $c_u = 5 \times N$ (after Stroud, 1975 for a typical plasticity index of 20%)[6], this indicates an undrained shear strength (c_u) of around 45 to 250kN/m², indicative of a firm to very stiff clay which broadly corresponds to the soil descriptions. One high SPT N value of 500 was present. This is possibly attributable to obstructions in the glacial till such as cobbles.

SPT 'N' values on the five samples taken in the granular material in the glacial till were 26 and 31 indicate a dense to very dense material and an angle of shearing resistance of approximately 35 degrees (after Peck et al, 1967)[7][6].

Two unconsolidated undrained triaxial tests were carried out on U100 samples, taken at 2-9.5m bgl. The measured shear strengths were 82kPa to 305kPa which were typically higher than the values derived from SPTs and hand shear vane tests at samples at similar depths. 57 hand shear vane tests were performed on samples obtained at 0.5-3.7m bgl from the trial pits with a typical shear strength of 30-110kPa (this being the upper limit of equipment) which generally agrees with SPT and hand shear vane derived strengths at corresponding depths, albeit with a larger spread of values. Shear Strength values for the glacial till derived from all testing methods are shown in **Appendix A5**. A design shear strength profile of $c_u = 40 + 11.6z$ (where z is the depth below top of the glacial till) is proposed.

Thirteen Atterberg limit tests and twelve moisture content samples were conducted on the glacial till as shown in **Appendix A4**.

The natural moisture content typically ranged from 11% to 23%. The Atterberg limits indicated a typical liquid limit of around 23 to 50% and plasticity index of around 10 to 29%, indicating a clay of generally 'low to 'intermediate' plasticity.

Thirteen particle size distribution tests were undertaken on samples of glacial till. Of the layer described primarily as a clay, the clay content ranged from 18% to 46% and silt content of 23 to 43%, whilst sand ranged from 11 to 53% and gravel typically 1 to 6%. Of the layers described as sand or gravel, the content of clay

ranged from 2 to 6% and silt 17%, while the sand content was 28 to 51% and the gravel content was in the range of 16 to 71%.

5.4 Sandstone bedrock (Chester Pebble Beds formation)

5.4.1 Extent and description

The underlying bedrock was encountered in three boreholes at elevations of 27.79 mAOD at BH101, 28.02 mAOD at BH102 and 26.84 mAOD at BH103. This indicates a relatively consistent level of the rock underneath the site.

The sandstone is described as very weak to extremely weak fine to medium grained thickly laminated sandstone which is moderately weathered. Core recovery was poor in several core runs and elsewhere the material was recovered as sandy gravel or gravelly sand. Discontinuities were close to medium spaced. BH101 extended 0.5m into the rock which was described as a red weathered sandstone that was recovered as slightly gravelly sand. In BH102A it was described similarly but was recovered as a very sandy fine to coarse gravel with particles of sandstone being recovered after 13.3mbgl. The coring in BH103 had zero recovery for the first 6m, which suggests that the rock is highly weathered in the top 6m. Core recoveries towards the base of each borehole improved and was typically between 80-100%.

The Manchester Marl has not been encountered within this investigation.

5.4.2 Geotechnical in-situ and laboratory testing

SPT 'N' values in the bedrock, shown in **Appendix A6** were measured at depths of 0-8.8m below the rock surface and vary greatly from 90 to 750, with no apparent trend in SPT value with depth. This corresponds to an extremely weak to a weak rock with a UCS of 0.9-7.5Mpa. This matches the available rock descriptions at this depth of an extremely weak to very weak rock.

Ultimate compressive strength values derived from point load tests vary between 2-18MPa with no apparent trend in depth. These are shown in **Appendix A7**. This corresponds to a very weak to moderately weak rock which is higher than the strength derived from SPTs. When point load tests are undertaken, the strength of intact rock is typically taken, whereas SPTs will be affected by discontinuities in the rock which exist in-situ which may explain why SPT values are lower.

Given the discrepancy between the SPT derived UCS values and the point load test derived UCS values, it is recommended to use a cautious value for the rock strength. A value of 2.5MPa, corresponding to very weak to very weak rock is appropriate, but should be reviewed during the design.

5.5 Groundwater

5.5.1 Groundwater encountered during fieldworks

Seepage occurred in both BH02 and BH03 at depths of 10.40mbgl and 10.5mbgl. Both of these seepages occurred in granular glacial till deposits. The piezometer monitoring shows the water level to be at the level of these granular layers. The sandstone is fully saturated and it is likely that the granular layers are in hydraulic continuity with the underlying rock, with the phreatic surface within this granular layer.

Seepage occurred in TP05, TP06 and TP09 at depths of 1.2-2.7m bgl in the made ground and top of the glacial till which indicates perched water is present in some locations.

5.5.2 Groundwater monitoring

All three boreholes were installed with a single 50 mm combined gas and groundwater monitoring standpipe. The standpipes have been monitored on six occasions.

The installation details and the range of depths to groundwater recorded during monitoring are summarised in **Table 2**.

Location	Response zone (mbgl)	Response zone stratum	Groundwater depth range (mbgl)	Groundwater level range (mAOD)
BH01	0.9-1.9	Made ground	Dry to 1.84	Dry (<37.89) to 39.95
BH02	10.5-20.5	Glacial Till/Sandstone	11.4 to 11.95	28.07 to 28.62
BH03	15-22	Sandstone	11.0 to 11.4	27.94 to 28.34

Table 2: Summary of borehole installation and groundwater details

6 Geoenvironmental screening assessment

6.1 Conceptual site model

6.1.1 Introduction

A conceptual model describes the scenario in which the risks to human health and the environment posed by contaminated land are assessed. It describes the ground and surface conditions, the proposed ground works and the final form of the development. In particular, the model identifies and describes the sources of the potential contamination, the behaviour of the contamination in environmental media such as soil and groundwater, surface water and air. It also identifies and characterises potential human health and environmental receptors, and plausible pathways.

The potential risks to human health and the environment have been considered in the context of a conceptual source-pathway-receptor model of the site, identifying:

- The principal pollutant hazards associated with the site (the sources);
- The principal receptors at risk from the identified hazards; and
- The existence, or absence, of plausible pathways which may exist between the identified hazards and receptor.

For risks to be present at the site, all three elements (source-pathway-receptor) of a plausible pollutant linkage must be present. Potential source-pathway-receptor linkages are described below based on the assumption that the site will be redeveloped for residential uses in the form of a hotel.

6.1.2 Potential sources

The site area was historically developed for residential purposes. More recently, the site has been used for car parking and diabetes centre (in a temporary portacabin structure).

Historic adjacent uses include a hospital, laboratories, clothing works, motor repair garage, and various industrial works.

The historic activity on site and adjacent areas will contribute to the potential sources of contamination that may be present on site. A summary of potential contaminants that could be associated with historic activity on site and in the vicinity, are provided in **Table 3**.

Potential source	Potentially contaminative materials	Comments
Made ground (demolition material)	Asbestos Ground gases (methane, carbon dioxide)	Made ground deriving from building demolition of buildings on site could contain asbestos. The generation of ground gas will depend on the thickness and organic content of made ground.
Offsite sources (laboratories, clothing works, motor repair garage, St Mary's Hospital, industrial works, brickworks, slaughter works and brewery)	Heavy metals Petroleum hydrocarbons Polycyclic aromatic hydrocarbons (PAHs) Acids/alkalis Chlorinated and non-chlorinated solvents	St Mary's Hospital previously housed maternity, gynaecology and paediatrics units. Potential contamination may have derived from use of fuels in hospital boilers. Nothing from available information suggests hospital waste disposal occurred within the site. However, practices at old hospitals were generally not as rigorous as today. Note that recent demolition of the offsite sources including St Mary's Hospital and subsequent redevelopment involved remediation.

Table 3: Summary of potential contaminants

6.1.3 Potential receptors

Receptors both during construction and after completion of the development include:

- Construction workers, site workers/visitors and site neighbours during construction;
- Site workers/visitors post construction;
- Groundwater within the Sherwood Sandstone (principal aquifer) and Manchester Marl (secondary B aquifer); and
- Rush Brook and Gore Brook.

6.1.4 Potential pathways

Potential pathways that may be present during redevelopment and operation include:

- Human health - ingestion of soils or dust;
- Human health - inhalation of dust, vapour or ground gas;
- Human health - dermal contact with soils or groundwater;

- Controlled waters - migration of dissolved phase contamination within groundwater;
- Controlled waters (and human health by vapours) – transport of non-aqueous phase contaminants;
- Ground gas - ingress of ground gas into buildings.

6.1.5 Summary of potential pollutant linkages

The conceptual site model for the site was presented in Section 6.1 of the Desk Study [1]. The conceptual site model has been revised based on the findings from the ground investigation. A summary of the potential pollutant linkages in relation to the site is presented in **Table 9**.

Sources	Pathways	Receptors	Comments
Potentially impacted made ground soils	Dermal contact with soils Inhalation of dust or vapour Ingestion of dust, soil	Construction workers	No significant contamination identified in soils beneath site. Standard good health and safety practices to be applied. Hardstanding will prevent exposure to dust. Vapours if present, may present a risk. Areas of soft landscaping will require a clean cover system.
Ground gases	Accumulation of gases in confined spaces producing an asphyxiation and explosion risk	Future site user	No significant sources of ground gas expected on site. Ground gas monitoring undertaken to date indicates that the risk from ground gas to site end users is negligible.
Leachable contaminants in the made ground	Vertical infiltration of leachate	Groundwater	Limited localised pocket of perched groundwater were recorded during the ground investigation. Lack of perched groundwater indicates that the risk to controlled waters beneath the site is negligible. Hardstanding/ building slab will limit infiltration and leachate production. It is understood that there will be minimal areas of soft landscaping at the proposed development limiting the potential for vertical infiltration of leachate.
	Lateral movement along service pipe/trenches		

Table 4 - Summary of potential pollutant linkages

6.2 Data screening

6.2.1 Introduction

The laboratory analysis results and field data collected during the ground investigation have been screened against current published or internal guideline values in order to provide an initial assessment of the potential contamination status of the site. The data for soil, groundwater and ground gas have been assessed separately, as presented below.

6.2.2 Soil screening assessment

6.2.2.1 Methodology

To simplify the assessment of ground contamination risks, the statutory guidance suggests that generic soil quality guideline values may be used for the initial screening of soil contamination testing results. Generic assessment criteria (GAC) and site-specific assessment criteria (SSAC) can be calculated using the software version of the Contaminated Land Exposure Assessment (CLEA) model [4]. The model estimates human exposure (children and adults) to soil contaminants for those potentially living, working and/or playing on contaminated sites over long time periods (chronic exposure). The CLEA model does not consider short-term (acute) risks to humans, such as those which may arise during construction activities, or the risks posed by contaminated groundwater.

Soil guideline values (SGVs) generated using the CLEA software and accompanying toxicological reports have been issued by the Environment Agency (EA) for eleven contaminants. Arup has produced GAC using risk assessment software (CLEA v1.06) in accordance with the CLEA assessment framework for the four standard CLEA end uses (residential with plant uptake, residential without plant uptake, allotments, and commercial) and for soil organic matter (SOM) values of 1%, 2.5% and 6%.

6.2.2.2 Soil assessment criteria – commercial end use

The soil results have been compared against screening criteria for a commercial end use. The key input parameters are summarised in **Table 5**. Full details on the input parameters and background research can be provided upon request. The GACs have been developed using a Soil Organic Matter (SOM) value of 6%, which has been selected based on the average SOM content of the soils sampled on site.

Parameter	Unit	Commercial
Age Range (critical receptor)	Years	16-65 (Female)
Exposure Frequency	days/yr	230
Exposure duration outdoor	hr/day	1
Soil to skin adherence factor	mg cm ⁻² day ⁻¹	0.14
Maximum exposed skin fraction	m ² /m ²	0.08
Soil and dust ingestion rate	mg/day	50
Inhalation rate	m ³ /day	13.4

Table 5 - Summary of key input parameters

6.2.2.3 Soil screening results

The results of the human health screening assessment are presented in **Appendix B1**. A total of twenty two soil samples were screened and a small number of

contaminants which exceed the screening criteria were identified and these are summarised in **Table 6**.

Determinand	Screening criteria	No. of samples	Exceedances	
			Number	Location
Lead	2,300 mg/kg	20	4	BH02 0.2m (2,750 mg/kg) BH02 0.5m (4,490 mg/kg) TP07 1m (11,200 mg/kg) TP10 1.5m (2,930 mg/kg)
Asbestos	Presence	20	1	TP10 1.5m (Chrysotile weathered damp proof course 0.193%, free fibre analysis <0.001%)

Table 6 - Summary of testing suites and number of tests undertaken

All contaminants have been reported below their respective screening criteria for a commercial end use with the exception of lead and asbestos.

Four exceedances of lead were identified in the made ground. Lead is not a volatile and therefore risks to future site users are not deemed to be present where soils are located beneath hardstanding. If soft landscaping areas are proposed then a risk to future site users could arise from exposure to soils.

There is a potential risk to construction workers who may come into direct contact with contaminated soils, particularly during earthworks. However, exposure periods are generally shorter than those experienced by long term site users and can usually be reduced to an acceptable level through adoption of adequate health and safety procedures.

Asbestos was identified in one sample of made ground soils tested and comprised chrysotile in weathered damp proof course material. The asbestos quantification for the sample reported a concentration of 0.193%.

The presence of asbestos poses potential risks during earthwork and construction works where soils are disturbed, as this may allow fibres to be released into ambient air. Appropriate mitigation measures should be applied to protect construction workers and site neighbours and should be designed and implemented by a competent contractor. Mitigation measures should include as a minimum dust suppression and appropriate PPE.

The results indicate that the existing soils within the site may be suitable for reuse as part of the development and that no specific remediation is likely to be required with respect to the protection of human health. This is discussed further in **Section 8.4**.

6.2.3 Controlled waters screening assessment

6.2.3.1 Controlled waters assessment criteria

Groundwater test results have been screened against criteria based on the lowest published value of freshwater Environmental Quality Standards (EQS) and UK

drinking water standards (DWS) to identify potential contaminants of concern. Where no EQS values are available the results have been compared against EU drinking water standards (DWS) or World Health Organisation standards (WHO).

6.2.3.2 Groundwater screening results

No shallow perched groundwater was encountered in the monitoring well installed within the made ground on site (BH01). Groundwater within the sandstone aquifer was sampled from two wells (BH02 and BH03) on one occasion. The contaminants which exceed the screening criteria are summarised in **Table 7**.

Determinand	Screening criteria (µg/l)	Exceedances
Manganese	50	BH02 (887 µg/l) BH03 (1,020 µg/l)
Ammoniacal nitrogen	390	BH02 (600 µg/l)

Table 7 - Summary of groundwater exceedances of water screening criteria

In general, the groundwater testing indicates low levels of contamination with the majority of contaminants recorded below their screening criteria. Elevated concentrations of manganese have been identified within the groundwater in BH02 and BH03 and elevated ammoniacal nitrogen has been recorded in BH03.

Manganese and ammoniacal nitrogen are known to be present within groundwater in the Sherwood Sandstone in the Manchester region. Due to the lack of the significant contamination identified in the made ground it is considered unlikely that the site is the source of the elevated groundwater concentrations.

Upon completion of the ground investigation, no plausible pollutant linkage was identified relating to a risk to controlled waters at the site. Groundwater where encountered during the ground investigation was encountered at a considerable depth below the ground and was not found to be in contact with made ground materials. The glacial till is at least 10m thick beneath the site and will limit any infiltration of contaminants into the underlying principal aquifer.

Due to the lack of shallow perched groundwater and layer of glacial till between made ground and bedrock any risk posed from soil contamination is considered to be negligible.

6.2.4 Ground gas monitoring

Made ground beneath the site has been identified as a potential source of ground gases. A plausible pollutant linkage between site users and ground gases accumulating in buildings to asphyxiating or explosive concentrations was identified in the conceptual site model. Ground gas monitoring was undertaken upon completion of the recent ground investigation and a generic risk assessment has been undertaken following the guidance outlined in CIRIA C665.

6.2.4.1 Methodology

The risk posed to buildings by hazardous ground gases has been assessed in accordance with CIRIA C665 [10] and British Standard guidance [11] and follows the source-pathway-receptor model.

6.2.4.2 Gas monitoring results

Six rounds of gas monitoring have been completed in three standpipes installed within the site as part of the 2019 ground investigation. Atmospheric pressures during the monitoring have ranged from 994 to 1006 mb.

The results of the gas monitoring are summarised in **Table 8**. Gas flows recorded were negligible (<0.1%).

Monitoring well	No. visits	Methane		Carbon dioxide		Peak gas flow (l/hr)
		Range %v/v	No. >1%v/v	Range %v/v	No. >5%v/v	
Response zone in made ground						
BH01	6	<0.1	0	0.4 – 0.8	0	<0.1
Response zone in sandstone						
BH02	6	<0.1	0	4.0 – 5.7	3	<0.1
BH03*	6	<0.1	0	0.1 – 0.3	0	<0.1
* The response zone of BH03 is below the groundwater table and therefore the results have not been used in the gas risk assessment						

Table 8 - Gas monitoring results

Gas Screening Values (GSV) have been calculated for methane and carbon dioxide, in line with current CIRIA guidance. The GSVs mainly indicate that the gassing regime within the site conforms to Characteristic Situation 1.

6.3 Building materials

6.3.1 Concrete

Contaminants such as sulphate and acidic conditions generally present a low risk to human health but can result in the degradation of buried concrete. The chemical environment for concrete has been assessed following the guidance outlined in BRE Special Digest 1 [13].

The design sulphate (DS) and aggressive chemical environment for concrete (ACEC) classes were assessed assuming that the site was classified as non-pyritic brownfield with mobile groundwater. A summary of the assessment results provided in **Table 9**.

Strata	Characteristic pH	Characteristic sulphate (mg/l)	Design sulphate class	ACEC class
Made ground	7.7	120	DS-1	AC-1
Glacial till	8.0	200	DS-1	AC-1

Table 9 - Summary of aggressive ground testing

Based on the above, it is considered that all buried concrete at the development site should be designed in accordance with DS-1 and AC-1.

7 Geoenvironmental risk assessment

7.1 Introduction

The screening assessments for the receptors identified in the conceptual site model have identified residual risks at the proposed site. Based on the proposed redevelopment and the plausible pollutant linkages identified in the conceptual site model, these residual risks have been assessed. The risk classifications of Very Low, Low, Moderate or High risk have been based on the CIRIA guidance C552 [9] A brief description of each is provided below:

- High Risk - There is a high probability that severe harm could arise or is occurring to a designated receptor from an identified hazard. Urgent investigation (if not undertaken already) is required and remedial works may be necessary;
- 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, or if any harm were to occur it is more likely that the harm would be relatively mild. Investigation (if not already undertaken) is normally required to clarify the risk. Some remedial works may be required in the longer term;
- Low Risk - It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild;
- Very Low Risk - There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be significant.

In addition to the risk classifications within the CIRIA guidance, a Negligible risk rating has also been used within the assessment where no plausible pollutant linkage exists.

7.2 Human health

7.2.1 Construction phase

The concentrations of all contaminants measured during the ground investigation in soil were below values that might be regarded as posing an acute risk to construction workers.

This would present a **Low** risk to health during construction, however it is recommended that specific precautions are taken during any future earthworks to reduce potential exposure in accordance with the principle of ‘as low as reasonably practical’ (ALARP), particularly with regards to asbestos in soils. This would include appropriate briefings and protective equipment (PPE). The level of mitigation required will need to be determined by the Principal Contractor.

If appropriate mitigation procedures are implemented during construction it is assessed that the risk of harm to construction workers and neighbours can be reduced to **Very Low**.

7.2.2 Operational phase

The following plausible pollutant linkages may pose a risk to future site users during the operational phase of the site:

- dermal contact with made ground soils;
- ingestion of site made ground;
- inhalation of made ground soil dust; and
- inhalation of soil vapours / soil gases.

In line with the UK contaminated land framework, these linkages require further assessment to understand the risk posed to the receptors. The proposed development will comprise an office building that will cover most of the site area. This proposed site use means that there is little potential that site users will come into contact with the soils on site. If soft landscaping areas are proposed then a validated clean cover system will be required. Vapours arising from contaminated soils may present a risk to the residents of the development, but no soil contamination has been identified to date which would pose a vapour inhalation risk.

Consequently, the risks from dermal contact with made ground soils, ingestion of site made ground and inhalation of made ground soil dust or vapour to future site users is **Very Low**.

7.3 Controlled waters

Limited shallow perched groundwater was identified during the ground investigation, within the made ground beneath the site, however no perched groundwater was recorded during subsequent monitoring.

Groundwater where encountered within the sandstone bedrock beneath the site was at a considerable depth and was not found to be in contact with made ground materials.

The glacial till was proven to be of significant thickness and is likely to be acting as a physical barrier to any leaching from the made ground into the principal aquifer of the Chester Pebble Beds formation. Therefore, risk to controlled waters is considered to be **Very Low**.

It is considered that a pathway between the made ground and the principal aquifer may be established through piling operations. Due to the limited presence of perched groundwater being encountered within the made ground, the risk of piling operations creating a pathway to the principal aquifer is deemed to be **Low**. Where piled foundations are proposed to penetrate the entire thickness of the glacial till, a foundation works risk assessment may be required by the

environmental regulators to justify the proposed piling technique and ensure protection of the sandstone aquifer.

7.4 Ground gas

A potential pollutant linkage exists between ground gas generating soils and future site users, if gas can flow or permeate through building envelopes and accumulate within enclosed spaces. Gas monitoring undertaken at the site indicates that the gas regime would be classified as Characteristic Situation 1 and therefore ground gas protection measures in new buildings on the site will not be required. The risk from ground gases based on the monitoring results is therefore assessed to be **Very Low**.

7.5 Construction materials

The BRE assessment did not identify any elevated sulphate concentrations within made ground on site which could pose a potential risk to buried concrete. It is considered that all buried concrete at the development site should be designed in accordance with DS-1 and AC-1.

8 Remediation strategy

This section presents the remediation strategy for the proposed works. Detailed contractor's method statements will need to be prepared prior to commencing works on site. An options appraisal has not been undertaken as the mitigation measures are intrinsic to the development design or relate to site management, as described below.

8.1 Excavated materials management

The most sustainable approach to the development is to reuse materials onsite during the development and minimise offsite disposal. This includes materials resulting from the demolition of the existing buildings and excavated soils.

The risk assessments indicate excavated soils are likely to be suitable for reuse as part of the development, provided that they are encapsulated beneath buildings or hardstanding. A Materials Management Plan (MMP) prepared in accordance with the CL:AIRE Definition of Waste Code of Practice would enable excavated materials to be reused within the development and avoid the material being considered as waste.

Where site-won soils are to be reused within the site, soils should be validated to demonstrate that the soils are suitable for use and quantities recorded in a validation report. No visibly contaminated or odorous material should be reused. Soil validation samples should be taken at a frequency of 1 per 500m³ and tested for asbestos, metals and PAHs and compared against the screening criteria defined in Appendix B1.

If excavated material cannot be reused on site (for example geotechnically unsuitable or surplus to requirements) it may be possible to treat the soil to achieve the reuse criteria, reuse the material on another project (with consideration of waste regulatory requirements) or as a least preferred option, offsite disposal to soil treatment facility or landfill.

8.2 Imported material

If any import of soils is proposed the material must be confirmed as suitable for its proposed use and meet waste regulatory requirements (e.g. a CL:AIRE Definition of Waste Code of Practice MMP may be required). If the imported material is potentially a waste the regulatory mechanism for the material import must be clearly defined.

The testing regime for imported material must be defined. Typically imported materials from brownfield sites should be tested at a frequency of 1 sample in 50m³. If the source desk study confirms a greenfield source, and no environmental incidents on the site of origin, then it is considered that the testing frequency for imported material can be lowered.

8.3 Contamination risk associated with piling

Where piled foundations are proposed, which are to penetrate the entire thickness of the glacial till, a foundation works risk assessment will be required by the regulators to justify the proposed piling technique and ensure protection of the sandstone aquifer.

8.4 Unforeseen contamination

Grossly contaminated materials are not expected to be encountered at the site. However, on any brownfield site there is the possibility that unforeseen contaminated material may be encountered during excavation works. Care should be taken during ground works and excavations should be supervised to ensure any previously unforeseen contamination is appropriately managed.

Any material which is identified as potentially contaminated (for example by visual appearance or odour) should be delineated and samples taken for chemical analysis by an Environmental Scientist. The samples should be compared to the soil assessment criteria to determine the suitability of this material for use within the development.

Asbestos was detected in one sample of made ground. Measures to control the release of dust or asbestos fibres will need to be taken. Due to the age and nature of the site and previous developments, there remains a possibility that more asbestos may be encountered during construction. A competent contractor should be appointed to design and implement appropriate measures to ensure protection of construction workers and site neighbours during construction and comply with Control of Asbestos Regulations 2012.

8.5 Buried structural concrete

It is recommended that buried concrete is specified to meet design sulphate class DS-1 and ACEC AC-1.

8.6 Liaison with regulatory authorities

A contaminated land planning condition has been applied to the planning consent, requiring investigation, risk assessment and remediation strategy to be approved prior to the commencement of development. This report has been produced to satisfy this such a condition. The planning consent also includes a condition requiring the works be implemented in accordance with the remediation strategy and a validation report to be approved prior to occupation of the development (see validation below).

The need for regulator consultation and decision should be considered in the programme and sufficient time allowed.

8.7 Remediation implementation

Detailed contractor's method statements should be prepared prior to commencing works on site in accordance with this Remediation Strategy and including the following content:

- Environmental protection measures (including water management and dust suppression)
- Health and safety management
- Stockpile management
- Material reuse proposals (if required, with reference to CL:AIRE DoWCoP)
- Confirm material reuse validation criteria and testing frequency (if required)
- Waste management proposals (off site soil disposal, if required)
- Imported soil proposals (if required)
- Proposals for addressing unforeseen contamination
- Buried concrete classification
- Potable water supply pipe requirements
- Validation plan (see below).

8.8 Validation and reporting

Evidence that the works have been undertaken in accordance with this Remediation Strategy and the method statements should be collected by the contractor during the works. A validation report should be prepared including the following, as a minimum:

- Photographic records and details of any below ground infrastructure removed
- Records of environmental protection measures implemented
- Results of validation testing compared to validation criteria
- Records of earthworks and piling including photographs
- Details of any unexpected contamination encountered
- Material reuse records
- Offsite surplus soil disposal records
- Environmental regulator communications

This information should be compiled into a validation report by a suitably qualified environmental scientist at the end of the works.

9 Key development considerations

9.1 General ground and groundwater conditions

The ground conditions comprise a relatively thin (average 1.6m thick) and generally granular made ground overlying generally cohesive glacial deposits which in turn overlie weathered sandstone bedrock.

The bedrock was encountered within three boreholes. The bedrock was found at a depth of 12m bgl at BH01 and BH02 and at 12.5m bgl at BH03. This indicates that the rock level is consistent beneath the site, however it must be considered that no boreholes were undertaken in the west of the site due to the presence of the building there.

Deep groundwater was encountered within two boreholes within the granular material at the base of the glacial till layer (10.4m and 10.5m bgl) during the ground investigation. Groundwater monitoring in the sandstone shows the water level to be similar to that seen during the investigation (11.0m bgl and 11.95m bgl). The sandstone is therefore fully saturated and assuming that the granular glacial till is in hydraulic continuity with the sandstone, the groundwater will be under hydrostatic conditions.

Shallow perched groundwater was encountered as a slight seepage in TP05, TP06 and TP09. Subsequent groundwater monitoring in BH01 did not show any ground water to be present. Perched groundwater is therefore likely to be localised, dependant on the presence of obstructions in the ground in to which rain water can infiltrate and collect.

It should be noted that the remnant basements in the made ground and their associated voids will pose a constraint for site development and will have to be removed where found close to the new structural footprints or in the proposed service corridors. This is the case for both the part of the site that was investigated and the uninvestigated part of the site currently beneath the existing building.

9.2 Earthworks and site preparation

Site preparation works are recommended to mitigate the impacts of the ground risks and prepare a platform for development. This work could be undertaken either as a separate activity prior to the main construction work or as an early activity within the main construction. The elements of work which could form part of this site preparation works are as follows:

- Disconnection and removal of redundant drainage and utilities;
- Demolition of existing buildings to ground level;
- Remove existing surface pavements and underlying concrete slabs;
- Remove trees (and grub out their roots), surface vegetation and topsoil;

- Grub out the existing remnant basements and foundations to the existing building (plot wide or local to foundations);
- Subject to quantities developed, crush and process the hard materials either on site or off site to produce a 6F capping type material for reuse in the development;
- Undertake UXO mitigation works within the earthworks and geophysical probing in proposed pile locations.
- Divert and install new utilities/drainage;
- General excavation to the level of the bottom of the basements and placement of compacted general granular fill to form the general site platform.
- Surplus and unsuitable material will need to be removed from site unless local areas for deposition can be agreed.

The exact scope and design of the site preparation works will require further consideration subject to client procurement and programme aspirations.

9.3 Building foundations

9.3.1 Support to structural columns and cores

Given the anticipated loading of the proposed seven storey structure and the relatively shallow bedrock, piled foundations are the preferred foundation option to support the main structural loads. These would be installed through the entire thickness of the glacial till and socketed several metres into the underlying Chester Pebble Beds sandstone.

Bored cast-in place piles or continuous flight auger piles (CFA) would be considered the most suitable piled solution with CFA type being the most cost effective solution in these ground conditions.

However, the choice of pile installation and plant selection will need to consider the presence of obstructions within the made ground and glacial till.

Providing the shallow obstructions in the made ground are dealt with before piling, these should not post a constraint. The existing foundations would need to be cleared of potential obstructions at least within the areas of proposed piles.

However, a particularly high SPT reading of 500 was recorded in the glacial till which is likely due to a boulder present in the layer, which are occasionally encountered in the glacial till in Manchester. Boulders such as this could be an obstruction and may be problematic especially for CFA piling. Bored piles are better suited at overcoming localised obstructions but are generally slower and more expensive than CFA.

Due to the limited obstructions encountered in the glacial till and the likelihood that obstructions in the made ground will be removed, CFA piles are currently the favoured option.

The level of the sandstone bedrock to be relatively consistent over the three boreholes drilled, in the range of 26.84 – 28.02m OD. It is recommended that the pile design is based on the shallowest rock level but the lengths of pile for costing purposes are based on the deepest rock level, and some contingency retained for parts of the site where rock level may be deeper than indicated in the investigation.

When choosing parameters for the pile design it is recommended that a characteristic value for undrained shear strength for the glacial till be chosen ignoring the anomalous results found in BH03. This would require the SPT N values above approximately 60 (which are thought to be caused by cobbles in the till), being discounted. Higher credence should be given to shear strength values derived from in-situ tests (SPT and hand shear vane) than the triaxial tests which have been shown to give higher, possibly non-conservative values. A design shear strength profile of $c_u = 40 + 11.6z$ (where z is the depth below top of the glacial till) is proposed.

Characteristic ultimate compressive strength (UCS) values should be derived from the SPT and point load tests with higher credence of given to the SPT results due to the in-situ nature of the test and their more conservative values. A UCS value of 2MPa is recommended for the non-weathered layer. Due to the known weathered nature of the rock and the top 0.5-2m of the rock being not being recovered, it is recommended that a weathered layer of at least 1.5m is assumed in ground models with a UCS less than that of the non-weathered rock.

9.3.2 Support to building floor slabs

Due to the variable nature of the made ground encountered in the boreholes and trial pits and the presence of voids within the fill, it is not recommended that a floor slab is founded directly on the existing made ground.

However if the existing made ground is removed to confirm the top of the underlying natural deposits and the material is replaced with compacted and validated engineered granular fill, the use of a ground bearing slab should be suitable.

9.4 Geoenvironmental issues

The soil assessment has identified that the existing made ground is unlikely to pose a risk to human health if reused within the final development. Exposure of construction workers to potentially contaminated soils should be controlled to be as low as reasonably practicable (ALARP). No soil remediation is likely to be necessary to protect the health of future site users. If soils are to be reused as part of the development, they will need to be subject to validation testing to prove that they are suitable for reuse. If soft landscaping areas are proposed, then a validated clean cover system will be required.

Risks to controlled water are considered to be low and limited perched shallow groundwater was recorded within the made ground beneath the site. Where piled foundations are to extend to bedrock (principal aquifer) a foundation works risk assessment may be required by the environmental regulators.

The ground gas risk assessment suggests that the gassing regime within the site conforms to Characteristic Situation 1 and therefore gas protection measures in new buildings will not be required.

It is considered that all buried concrete at the development site should be designed in accordance with DS-1 and AC-1.

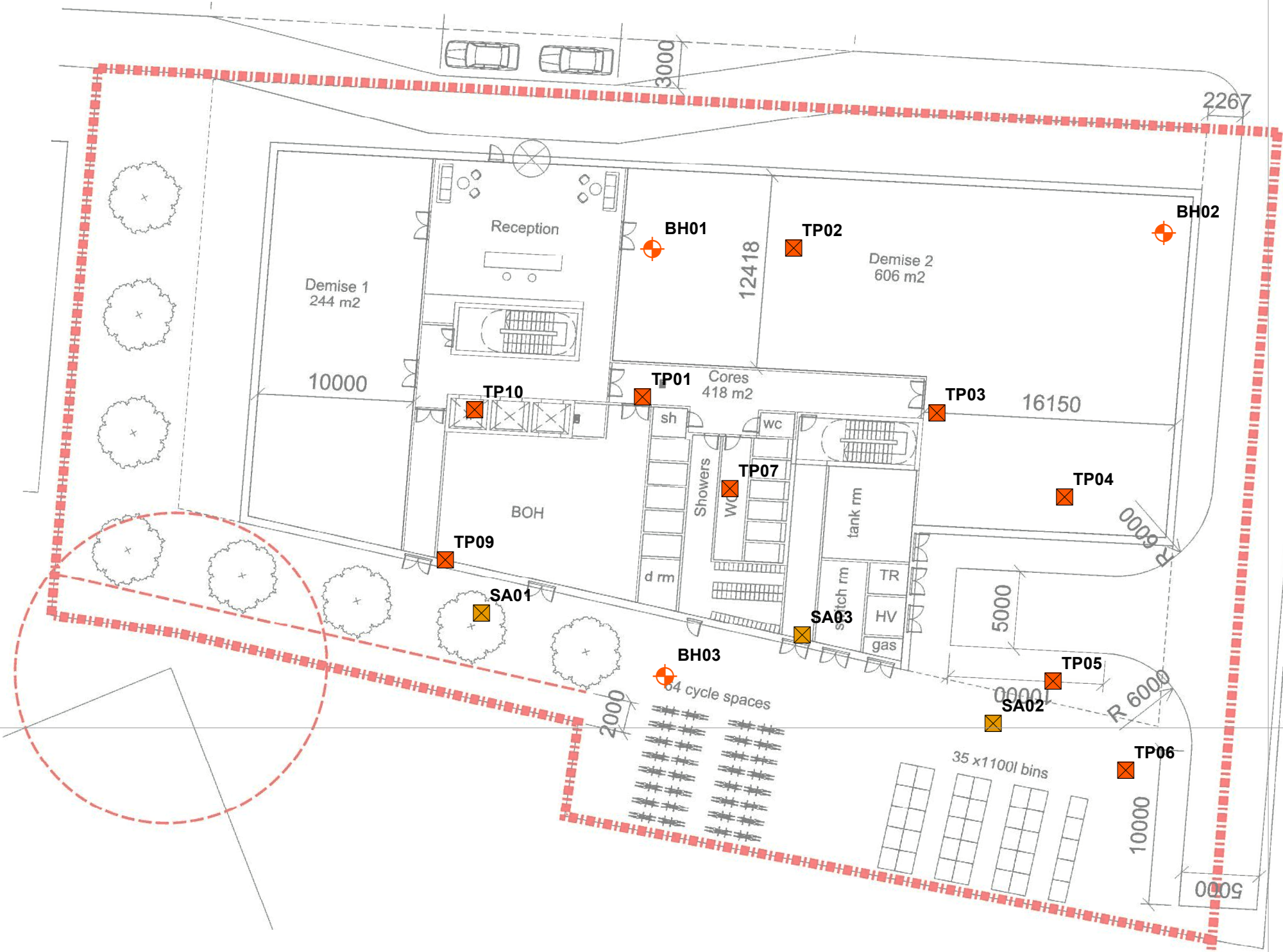
10 References

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- [2] Groundsure, 2019. Enviroinsight report. [Emailed pdf received 24th April 2019]. Reference GS-5962524.
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- [9] Environment Agency (2004) Model Procedures for the Management of Land Contamination. Contaminated Land Report 11
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- [11] British Standards Institute (2013) Guidance on investigations for ground gas – Permanent gases and volatile organic compounds (VOCs).
- [12] BS 5930:2015, Code of practice for ground investigation, dated 2015
- [13] BRE, 2005. Special Digest 1: Concrete in Aggressive Ground. Third Edition. BRE press

Appendix A

GI location plans, geological cross sections and geotechnical figures

A1 Ground investigation locations



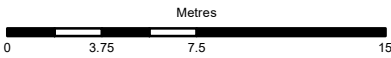
Legend

Type

- SA
- TP
- BH

P0	2019-06-20	TH	TH	TH
Issue	Date	By	Chkd	Appd

ARUP



Client
Bruntwood Science Limited

Job Title
CityLabs 4.0

As-built Exploratory
Hole Location Plan

Scale at A3
1:300

Job No
267661-11

Drawing Status
Preliminary

Drawing No
A1

Issue
P0

A2 Geological cross sections

A2.1 Section 1

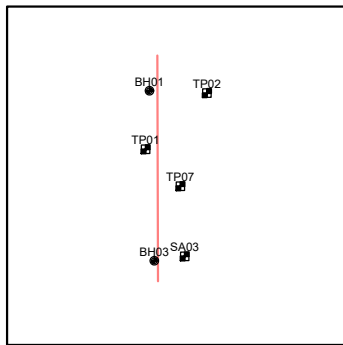
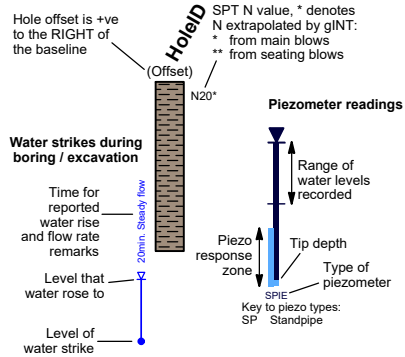


LEGEND

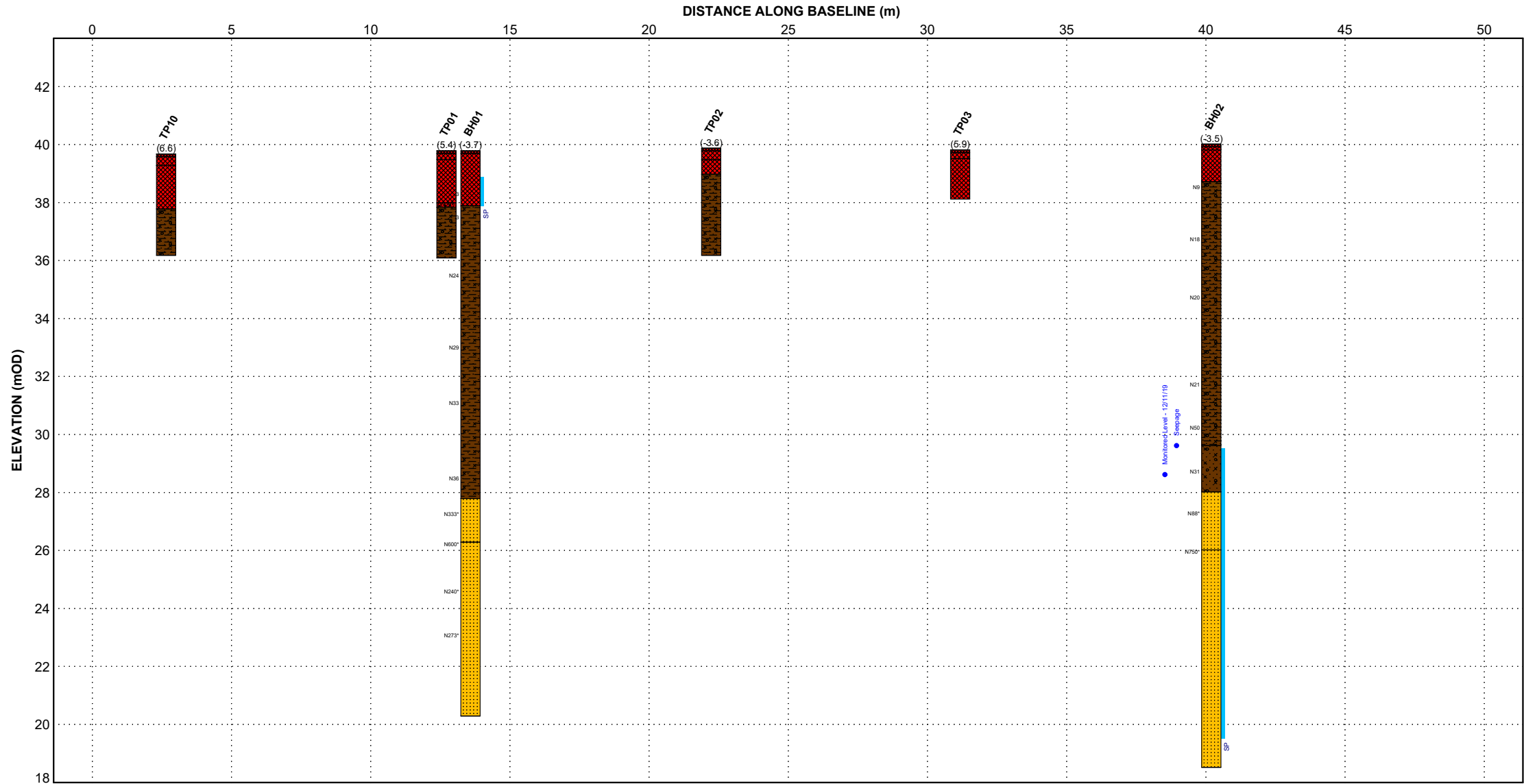
COLOUR LEGEND

MATERIALS

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A2.2 Section 2



LEGEND

Hole offset is +ve to the RIGHT of the baseline

SPT N value, * denotes N extrapolated by gINT:
* from main blows
** from seating blows

Water strikes during boring / excavation

Time for reported water rise and flow rate remarks

Level that water rose to

Level of water strike

20min. Steady flow

Piezometer readings

Range of water levels recorded

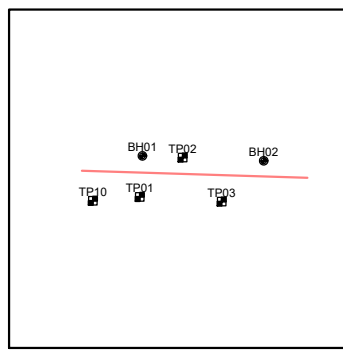
Piezo response zone

Tip depth

Type of piezometer

Key to piezo types:
SP Standpipe

PLAN



COLOUR LEGEND

Sandstone [Sdst]

Glacial Till Deposits [GTD]

Made ground [MG]

MATERIALS

Made Ground - FILL

FILL (MADE GROUND)

Silty sandy CLAY

SANDSTONE

Silty sandy gravelly CLAY

Silty gravelly SAND

CONCRETE

SCALE 1:133V 1:139H @ A3-L

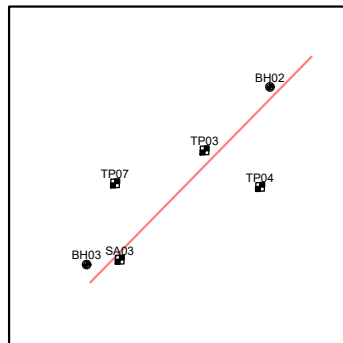
**CITY LABS 4
GEOLOGICAL CROSS SECTION
FIGURE A2.2**

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A2.3 Section 3



LEGEND

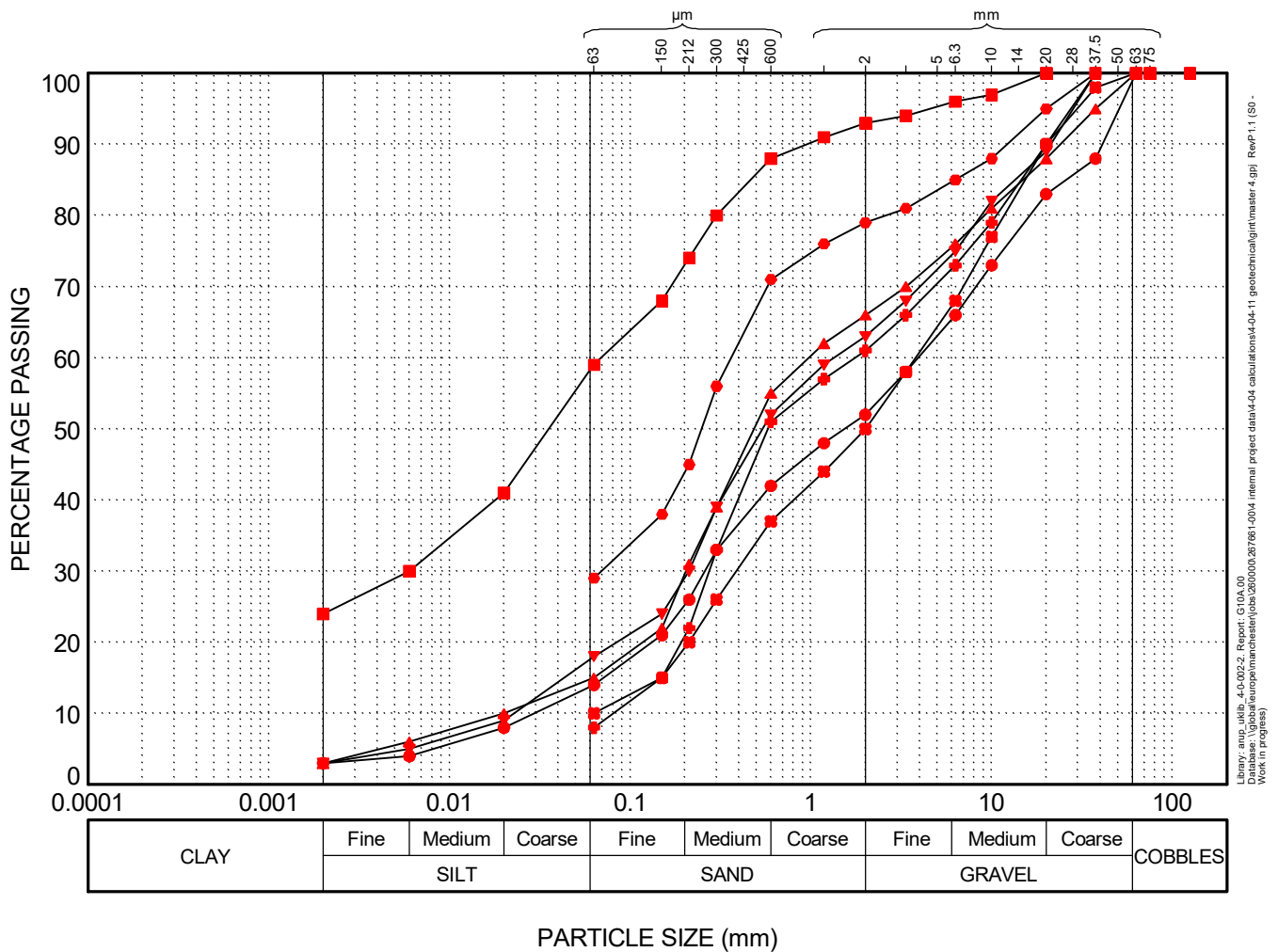


 Sandstone [Sdst]
 Glacial Till Deposits [GTD]
 Made ground [MG]

	Made Ground - FILL
	FILL (MADE GROUND)
	Silty sandy gravelly CLAY
	Silty gravelly SAND
	SANDSTONE
	Silty sandy CLAY
	Silty sandy GRAVEL

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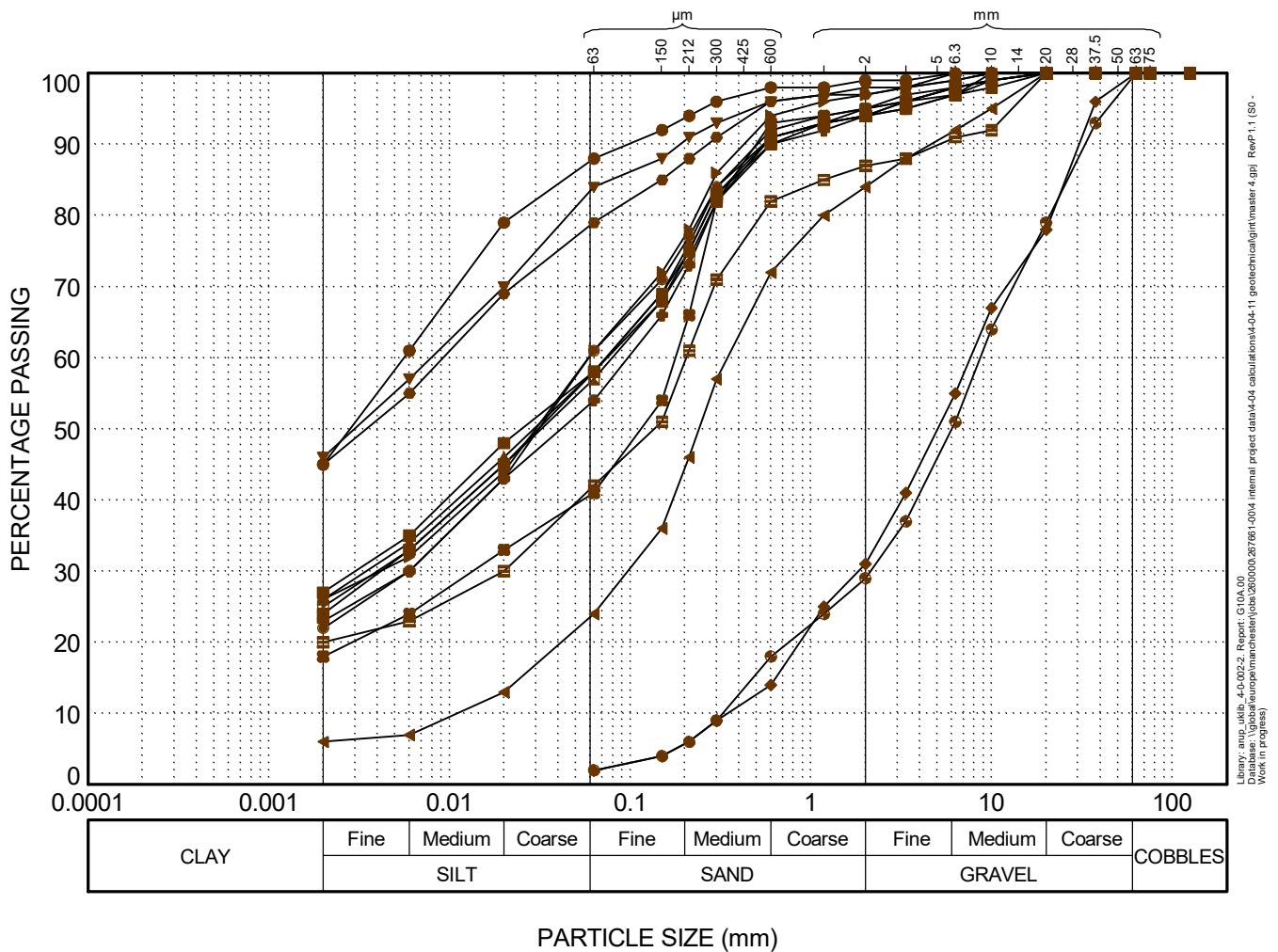
A3a Particle size distribution curve (made ground)



CITY LABS 4
PARTICLE SIZE DISTRIBUTION
MADE GROUND
FIGURE A3a

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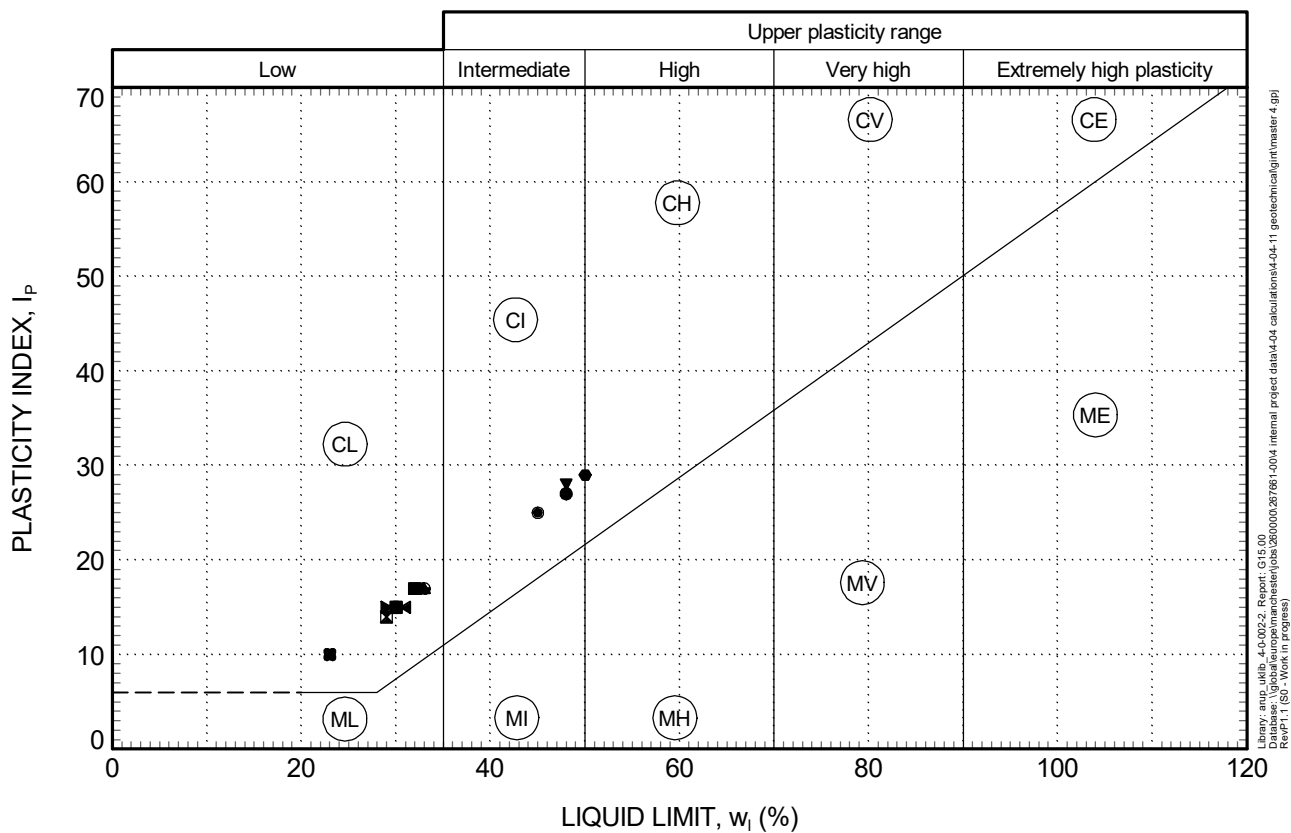
A3b Particle size distribution curve (Glacial Till)



CITY LABS 4
PARTICLE SIZE DISTRIBUTION
GLACIAL TILL DEPOSITS
FIGURE A3b

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A4 Atterberg limit summary

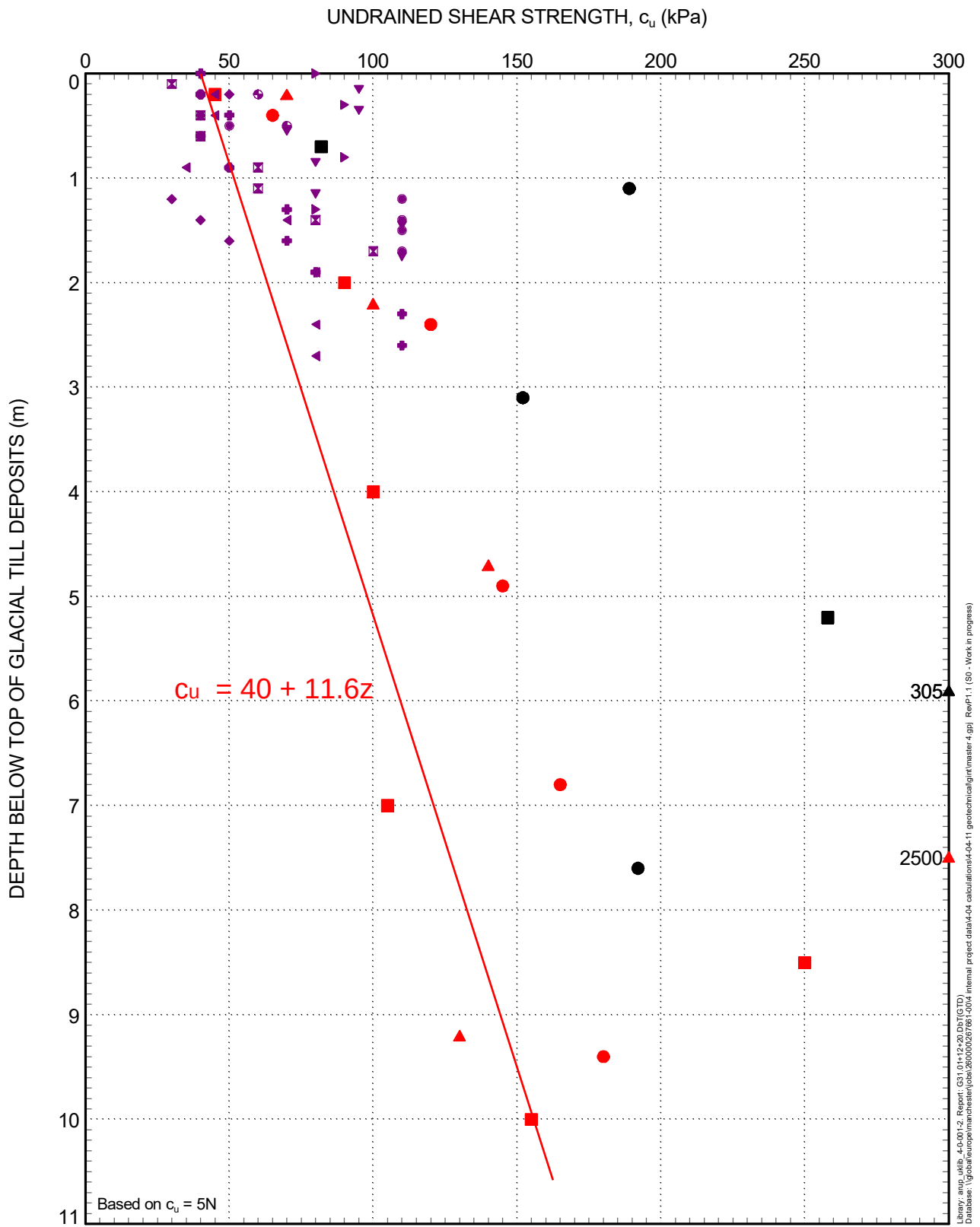


- BH01, 36.8mOD
- BH01, 34.8mOD
- ▲ BH01, 32.3mOD
- ✱ BH01, 30.3mOD
- BH02, 38.0mOD
- ▼ BH02, 36.0mOD
- ✱ BH02, 33.5mOD
- BH03, 36.3mOD
- ▲ BH03, 34.3mOD
- ▼ BH03, 33.3mOD
- ✱ BH03, 31.3mOD
- TP09, 36.6mOD
- TP10, 36.2mOD

CITY LABS 4 **PLASTICITY CHART** **GLACIAL TILL DEPOSITS** **Figure A4**

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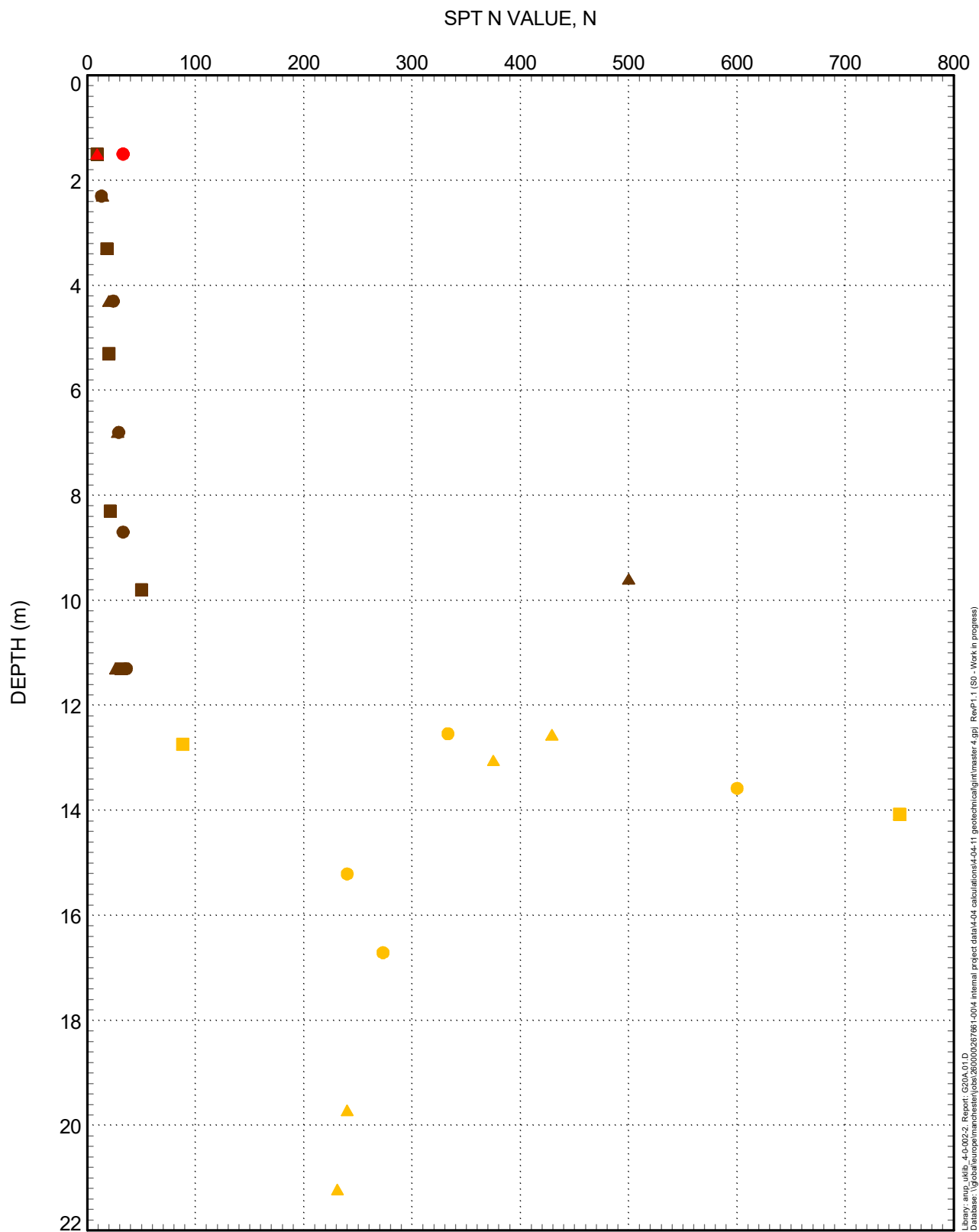
A5 **Glacial Till undrained shear strength**



- From triaxial test
- From hand vane (peak)
- c_u from SPT (x5)
- BH01
- BH02
- ▲ BH03
- ▼ TP01
- ⊕ TP02
- ▲ TP04
- ▼ TP05
- ⊗ TP06
- TP07
- ⊗ TP09
- ◆ TP10

**CITY LABS 4
UNDRAINED SHEAR STRENGTH
GLACIAL TILL DEPOSITS
FIGURE A5**

A6 SPT results



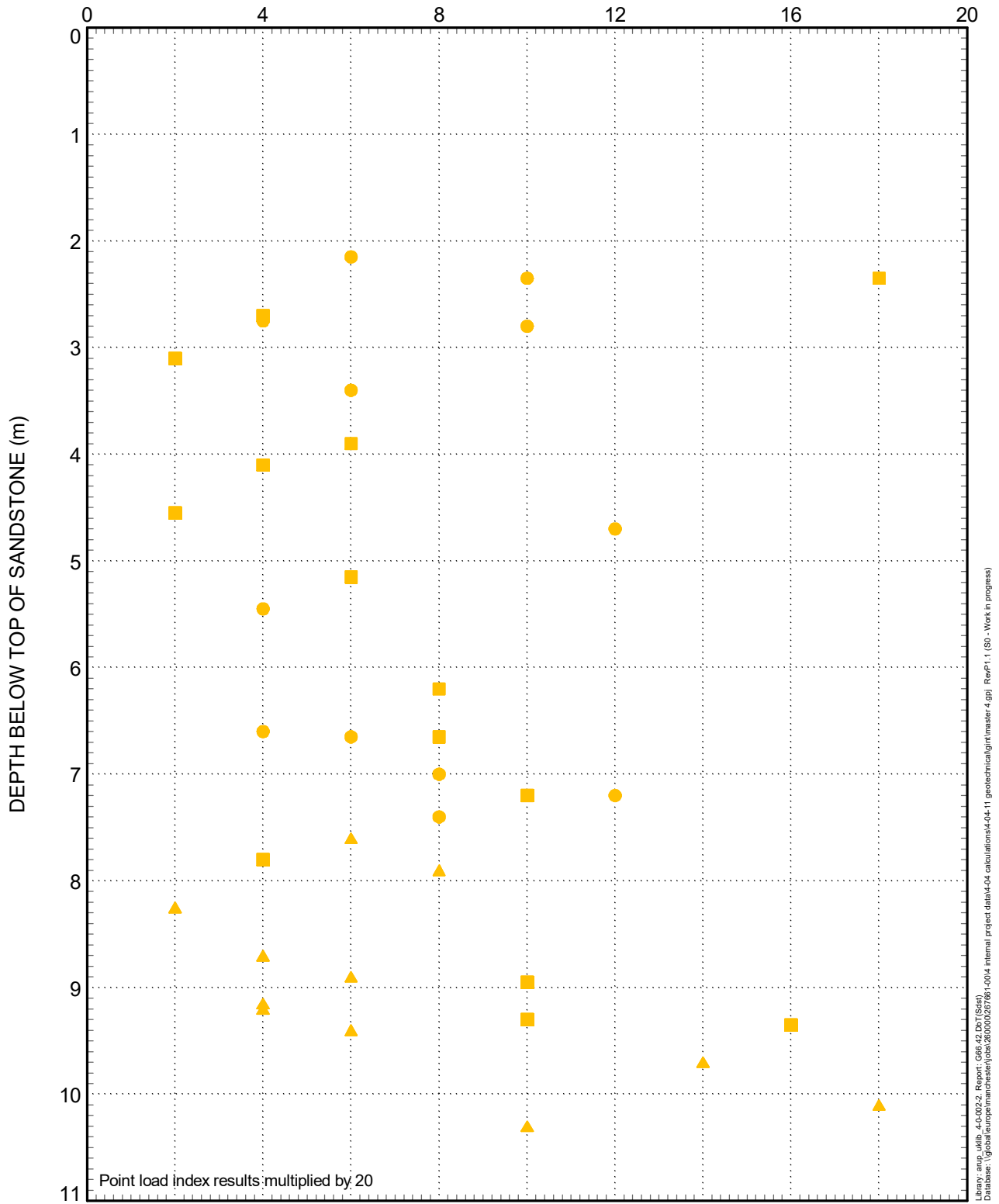
- Sandstone (Sdst)
- Glacial Till Deposits (GTD)
- Made ground (MG)
- BH01
- BH02
- ▲ BH03

CITY LABS 4 STANDARD PENETRATION TESTS Figure A6

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A7 Point load tests

UNIAXIAL (UNCONFINED) COMPRESSIVE STRENGTH, σ_c (MPa)



- Sandstone (Sdst)
- BH01
- BH02
- ▲ BH03

**CITY LABS 4
UCS FROM POINT LOAD TESTS
SANDSTONE
FIGURE A7**

Appendix B

Geoenvironmental Screening Assessment

B1 Human health soil screening assessment

Soil Sample			TP01	TP01	TP02	TP02	TP03	TP03	BH02	BH02	TP04	TP07	TP07	TP10	TP10	TP06	TP06	TP09	TP09	TP05	TP05	BH03	BH03
Depth (m)			0.20	1.00	0.20	0.50	0.20	1.00	0.20	0.50	0.50	0.20	1.00	0.20	1.50	0.20	0.50	0.20	0.50	0.20	1.00	0.30	0.50
Date			15/10/2019	15/10/2019	15/10/2019	15/10/2019	15/10/2019	15/10/2019	15/10/2019	15/10/2019	16/10/2019	16/10/2019	16/10/2019	16/10/2019	16/10/2019	08/10/2019	08/10/2019	08/10/2019	08/10/2019	08/10/2019	07/10/2019	07/10/2019	07/10/2019
Strata			MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG
Determinants	Units	Screening Criteria																					
Asbestos																							
Asbestos Identification		Presence	NAD	NAD	NAD	NAD	NAD	NAD	NAD	NAD	NAD	NAD	NAD	NAD	Chrysotile (weathered damp proof course)	NAD	NAD	NAD	-	NAD	NAD	NAD	NAD
Gravimetric analysis total	%	Presence													0.193								
Gravimetric analysis by ACM type	%	Presence													Weathered DPC (Chrysotile 0.193%)								
Free fibre analysis	%	Presence													<0.001								
Total Asbestos	%	Presence													0.193								
Metals																							
Antimony	mg/kg	7350	4.1	6.7	4.7	7.9	12.8	9.3	5.2	4.8	13	4.9	31.9	4	9.2	24.7	10.6	12.1		4.9	8.5	8.4	13.1
Arsenic	mg/kg	635	25.5	21.4	22.9	36.4	32.3	15.3	37	35.6	33.6	29.5	23.7	26.2	37.9	43.5	42	35.7		38.9	29	41	34.5
Beryllium	mg/kg	12	1.7	1.1	2.6	2.8	2	< 1.0	2	1.7	1.6	1.7	< 1.0	2.3	1.7	2.2	1.7	1.6		1.9	1.4	1.8	1.8
Cadmium	mg/kg	190	0.9	0.6	2	1.6	2.6	< 0.5	8.5	21	1.4	1.5	0.5	0.9	0.7	2.5	1.4	1		0.5	5.3	1.1	1.6
Chromium (III)	mg/kg	8570	27.7	25.7	27.8	37.6	35.8	20.2	37.5	35	37.2	25.7	32.1	24.2	33.8	45.4	37.1	55.4		78.8	28.7	36.4	35.5
Copper	mg/kg	68300	107	70	102	135	200	47.9	127	104	162	137	67.5	110	108	300	207	196		127	200	198	170
Lead C4SL	mg/kg	2300	142	359	508	941	1340	1010	2750	4490	1440	319	11200	413	2930	1240	1770	1470		1800	976	1820	1300
Mercury elemental	mg/kg	58 (25.8)	< 0.5	< 0.5	< 0.5	1.1	1.9	0.6	2.3	1.9	1.5	< 0.5	1.9	< 0.5	1.4	2	4	11.1		1.6	1.3	2	1.1
Nickel	mg/kg	983	74.6	29.2	66.3	60.1	67.1	19.5	44.9	46	43	76.2	22.5	67.9	35.2	88.5	40.3	34.7		36.4	43.5	34.4	64.4
Selenium	mg/kg	12300	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.1	< 1.0		< 1.0	< 1.0	< 1.0	< 1.0
Vanadium (Pentavalent)	mg/kg	6360	64.7	47.7	56.4	61.5	62.2	36.8	58.9	55.3	54.6	61.1	45.6	62.3	77.2	67.2	48.1	43.7		55.7	45.9	52.5	61.5
Zinc	mg/kg	730000	117	211	280	236	468	167	616	1090	414	178	509	138	312	530	620	1290		367	498	568	432
Inorganics																							
Chromium (VI)	mg/kg	33	< 0.8		< 0.8			< 0.8	< 0.8	< 0.8	< 0.8		< 0.8	< 0.8	< 0.8	< 0.8		< 0.8			< 0.8		< 0.8
Inorganic Free Cyanide (chronic)	mg/kg	16200	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.4	< 1.0	1.7	< 1.0	< 1.0	< 1.0		1.3	< 1.0	< 1.0	1.1
Boron	mg/kg	236000	< 0.5	< 0.5	< 0.5	0.7	< 0.5	< 0.5	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	0.9	1.6	0.9		0.9	0.6	0.9	0.7
Miscellaneous																							
pH	pH units	#N/A	8.6	8.9	8.3	7.7	9	8.8	8.2	8.4	8.9	8.7	8.6	8.4	8.1	8.2	8.3	8.8		8.1	8.9	8.3	8.3
Total Organic Carbon	%	#N/A	15	2.7	13	8.4	11	0.84	4.8	4.2	5.3	13	2.1	15	4	19	6.9	4.5	4.6	3.7	9.3	4.4	12
Phenols																							
Phenol (chronic)	mg/kg	34000	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6		< 6	< 6	< 6	< 6
Polyaromatic hydrocarbons																							
Naphthalene	mg/kg	1090 (432)						< 0.1					< 0.1						0.1				0.3
Acenaphthylene	mg/kg	104000						< 0.1					< 0.1						0.3				0.7
Acenaphthene	mg/kg	104000						< 0.1					< 0.1						0.2				2.5
Fluorene	mg/kg	70800						< 0.1					< 0.1						0.2				2
Phenanthrene	mg/kg	22500						0.7					0.3						2.1				19
Anthracene	mg/kg	542000						0.2					< 0.1						0.9				6.3
Fluoranthene	mg/kg	22700						1.3					1.1						6.9				52.4
Pyrene	mg/kg	54500						1.2					1						5.8				42.5
Benzo[a]anthracene	mg/kg	176						0.7					0.6						3.2				23.9
Chrysene	mg/kg	355						0.8					0.8						3.5				25
Benzo[b]fluoranthene	mg/kg	45						0.9					0.8						4				25.4
Benzo[k]fluoranthene	mg/kg	1190						1.1					0.7						3.5				20.1
Benzo[a]pyrene	mg/kg	36						0.9					0.8						3.6				25
Indeno[123-cd]pyrene	mg/kg	509						0.8					0.6						2.8				19.8
Dibenz[ah]anthracene	mg/kg	4						0.1					0.1						0.5				3.1
Benzo[ghi]perylene	mg/kg	3960						0.6					0.6						2.7				17.5
Coronene	mg/kg	#N/A						0.4					0.2						1.2				7.3
Total PAH(16)	mg/kg	#N/A						9.4					7.6						40.3				285
Total PAH (Including Coronene GC-FID)	mg/kg	#N/A						10					8						42				293
BTEX																							
Total BTEX	mg/kg	90						< 0.01					< 0.01						< 0.01				< 0.01
TPH CWG																							
TPH - Aliphatic EC5-EC6	mg/kg	12100 (1150)	< 0.01	< 0.01	< 0.01		< 0.01	< 0.01	< 0.01		< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01			< 0.01		< 0.01	
TPH - Aliphatic >EC6-EC8	mg/kg	39600 (736)	< 0.01	< 0.01	< 0.01		< 0.01	< 0.01	< 0.01		< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01			< 0.01		< 0.01	
TPH - Aliphatic >EC8-EC10	mg/kg	11300 (451)	< 1.0	< 1.0	< 1.0		< 1.0	< 1.0	< 1.0		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0			< 1.0		< 1.0	
TPH - Aliphatic >EC10-EC12	mg/kg	47300 (283)	< 1.0	< 1.0	< 1.0		< 1.0	< 1.0	< 1.0		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0			< 1.0		< 1.0	
TPH - Aliphatic >EC12-EC16	mg/kg	90200 (142)	3.4	< 1.0	< 1.0		< 1.0	< 1.0	< 1.0		< 1.0	3.1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0			< 1.0		< 1.0	
TPH - Aliphatic >EC16-EC21	mg/kg	14300000 (50.9)	9.1	< 1.0	1.2		3.8	< 1.0	< 1.0		2.6	10.8	< 1.0	3.6	< 1.0	< 1.0	2.6			1.8		1.2	
TPH - Aliphatic >EC21-EC35	mg/kg	14300000 (50.9)	11	2.2	9.8		11.5	< 1.0	1.1		28.7	21.4	1.1	7.8	1.7	26.7	49.1			83		37.8	
TPH - Aliphatic >EC35-EC40	mg/kg	#N/A	3.3	< 1.0	2.8		4	< 1.0	< 1.0		8.3	10.8	< 1.0	4	< 1.0	8.5	7.3			29		2.9	
Total aliphatic hydrocarbons (>C5 - C40)	mg/kg	#N/A	27	2.6	13.9		19.9	1	1.8		39.9	46.2	1.5	15.9	2.3	35.7	59.5			114		41.9	
TPH - Aromatic >EC5-EC7 (benzene)	mg/kg	90	< 0.01	< 0.01	< 0.01		< 0.01	< 0.01	< 0.01		< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01			< 0.01		< 0.01	
TPH - Aromatic >EC7-EC8 (toluene)	mg/kg	183681 (4360)	< 0.01	< 0.01	< 0.01		< 0.01	< 0.01	< 0.01		< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01			< 0.01		< 0.01	
TPH - Aromatic >EC8-EC10	mg/kg	17000 (3580)	< 1.0	< 1.0	< 1.0		< 1.0	< 1.0	< 1.0		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0			< 1.0		< 1.0	
TPH - Aromatic >EC10-EC12	mg/kg	34200 (2150)	< 1.0	< 1.0	< 1.0		< 1.0	< 1.0	< 1.0		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0			< 1.0		< 1.0	
TPH - Aromatic >EC12-EC16	mg/kg	37800	16.8	< 1.0	1.6		1.4	< 1.0	< 1.0		3.1	2.5	< 1.0	2.4	< 1.0	< 1.0	3.9			< 1.0		< 1.0	
TPH - Aromatic >EC16-EC21	mg/kg	28100	130	3.4	28.2		17.3	2.2	5.7		44.6	49.1	1.8	32.6	2.8	7.5	33.7			27.3		7.6	
TPH - Aromatic >EC21-EC35	mg/kg	28400	442	18.1	151		206	16	22.6		198	337	14.4	239	16.2	62.6	193			185		188	
TPH - Aromatic >EC35-EC40	mg/kg	#N/A	21.2	1.3</																			

B2 Groundwater screening assessment

Location						BH02	BH03
Date						06/11/2019	06/11/2019
Strata						SST	SST
Area	Units	Screening Criteria	Standard	Number of samples	Number of Exceedences		
Metals							
Arsenic	mg/l	0.01	DWS	2	0	<0.005	<0.005
Beryllium	mg/l	0.004	USEPA	2	0	<0.005	<0.005
Calcium	mg/l	nc	-	2	0	108	100
Cadmium	mg/l	0.0008	EQS	2	0	<0.001	<0.001
Chromium	mg/l	0.0047	EQS	2	0	<0.005	<0.005
Copper	mg/l	0.001	EQS	2	0	<0.005	<0.005
Mercury	mg/l	0.001	DWS	2	0	<0.0001	<0.0001
Magnesium	mg/l	nc	-	2	0	63.7	63.1
Manganese	mg/l	0.05	DWS	2	2	0.887	1.02
Nickel	mg/l	0.004	EQS	2	0	<0.005	<0.005
Lead	mg/l	0.0012	EQS	2	0	<0.001	<0.001
Antimony	mg/l	0.005	DWS	2	0	<0.005	<0.005
Selenium	mg/l	0.01	DWS	2	0	<0.005	<0.005
Vanadium	mg/l	0.02	EQS	2	0	<0.005	<0.005
Zinc	mg/l	0.0123	EQS	2	0	<0.005	<0.005
Inorganics							
Chloride	mg/l	250	DWS	2	0	24.6	33.6
Ammoniacal Nitrogen as N	mg/l	0.39	DWS	2	1	0.6	0.2
Total Cyanide	mg/l	0.001	EQS	2	0	<5	<5
Dissolved Organic Carbon	mg/l	nc	-	2	0	12	11
Hardness (CaCO3)	mg/l	nc	-	2	0	531	510
pH	pH units	nc	nc	2	0	7.4	7.5
Phenols							
Total Phenols	mg/l	0.0077	EQS	2	0	<0.001	<0.001
TPH							
>C5-C6 Aliphatic	mg/l	15	WHO	2	0	<0.001	<0.001
>C6-C8 Aliphatic	mg/l	15	WHO	2	0	<0.001	<0.001
>C8-C10 Aliphatic	mg/l	0.3	WHO	2	0	<0.005	<0.005
>C10-C12 Aliphatic	mg/l	0.3	WHO	2	0	<0.005	<0.005
>C12-C16 Aliphatic	mg/l	0.3	WHO	2	0	0.0079	<0.005
>C16-C21 Aliphatic	mg/l	0.3	WHO	2	0	0.0152	<0.005
>C21-C35 Aliphatic	mg/l	0.3	WHO	2	0	0.0864	0.0547
>C35-C40 Aliphatic	mg/l	0.3	WHO	2	0	<0.005	<0.005
Total (>C5-C40) Aliphatic	mg/l	nc	-	2	0	0.11	0.0547
>C5-C7 Aromatic	mg/l	0.01	WHO	2	0	<0.001	<0.001
>C7-C8 Aromatic	mg/l	0.7	WHO	2	0	<0.001	<0.001
>C8-C10 Aromatic	mg/l	0.3	WHO	2	0	<0.005	<0.005
>C10-C12 Aromatic	mg/l	0.09	WHO	2	0	<0.005	<0.005
>C12-C16 Aromatic	mg/l	0.09	WHO	2	0	<0.005	<0.005
>C16-C21 Aromatic	mg/l	0.09	WHO	2	0	0.0115	<0.005
>C21-C35 Aromatic	mg/l	0.09	WHO	2	0	0.0834	0.05
>C35-C40 Aromatic	mg/l	0.09	WHO	2	0	0.015	<0.005
Total (>C5-C40) Aromatic	mg/l	nc	-	2	0	0.11	0.05
Total (>C5-C40) Ali/Aro	mg/l	nc	-	2	0	0.22	0.105

B3 Gas risk assessment

Location	Strata	Date	Peak CH4	Peak CO2	Min O2	Peak H2S	Peak CO	Peak Flow	Water level	Atmos Pressure	Gas Screening Value (GSV) (l/gas)		Characteristic Situation		Maximum Characteristic Situation
		Units	%	%	%	ppm	ppm	l/h	mbgl	mBar	Methane	Carbon Dioxide	Methane	Carbon Dioxide	Considering CH4 and CO2
BH01	Made Ground	01/11/2019	<0.1	0.7	16.9	0	0	<0.1	Dry	997	0.0001	0.0007	CS1	CS1	CS1
		06/11/2019	<0.1	0.5	18.2	0	0	<0.1	Dry	1001	0.0001	0.0005	CS1	CS1	CS1
		12/11/2019	<0.1	0.4	16.4	0	0	<0.1	Dry	999	0.0001	0.0004	CS1	CS1	CS1
		20/11/2019	<0.1	0.8	16.6	0	0	<0.1	1.86	1006	0.0001	0.0008	CS1	CS1	CS1
		06/12/2019	<0.1	0.6	15.4	0	0	<0.1	1.86	994	0.0001	0.0006	CS1	CS1	CS1
		19/12/2019	<0.1	0.5	15.8	0	0	<0.1	1.84	995	0.0001	0.0005	CS1	CS1	CS1
BH02	Sandstone	01/11/2019	<0.1	5.7	1.2	0	146	<0.1	11.95	997	0.0001	0.0057	CS1	CS1	CS1
		06/11/2019	<0.1	5.5	1	0	154	<0.1	11.88	1001	0.0001	0.0055	CS1	CS1	CS1
		12/11/2019	<0.1	5.3	16.9	0	10	<0.1	11.4	999	0.0001	0.0053	CS1	CS1	CS1
		20/11/2019	<0.1	4.3	3.5	0	0	<0.1	11.85	1006	0.0001	0.0043	CS1	CS1	CS1
		06/12/2019	<0.1	4	3.2	0	0	<0.1	11.79	994	0.0001	0.004	CS1	CS1	CS1
BH03	Sandstone	19/12/2019	<0.1	3.9	3.5	0	0	<0.1	11.74	995	0.0001	0.0039	CS1	CS1	CS1
		01/11/2019	<0.1	0.1	17.8	0	20	<0.1	11.28	997	0.0001	0.0001	Response zone flooded results not used for gas risk assessment		
		06/11/2019	<0.1	0.1	20.2	0	20	<0.1	11.2	1001	0.0001	0.0001			
		12/11/2019	<0.1	0.1	19.1	0	10	<0.1	11	999	0.0001	0.0001			
		20/11/2019	<0.1	0.1	19.2	0	0	<0.1	11.2	1006	0.0001	0.0001			
		06/12/2019	<0.1	0.3	19.4	0	0	<0.1	11.4	994	0.0001	0.0003			
		19/12/2019	<0.1	0.2	19.6	0	0	<0.1	11.36	995	0.0001	0.0002			

Notes:

1) All units are as shown

2) NR = value not reported

Green Characteristic Situation 1

Yellow Characteristic Situation 2 or methane concentration greater than or equal to 1% or carbon dioxide concentration greater than or equal to 5%.

Blue Characteristic Situation 3

Appendix C

CC Geotechnical Ltd Factual Report



CCG-C-19-11195

**GROUND INVESTIGATION
FOR SITE AT**

**CITY LABS 4.0
HEATHERSAGE ROAD, MANCHESTER**

NOVEMBER 2019



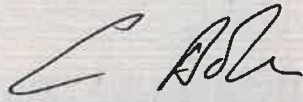
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Reference Number:	CCG-C-19-11195
Main Author:	Daniel O'Regan BSc(Hons) PIEMA
Signature:	
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Approved for Issue by:	Chris Bolan CEng MICE CEnv
Signature:	
For and behalf of CC GEOTECHNICAL LTD	
Date:	November 2019
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Factual data has largely been obtained from enquiries with third parties, the results of which are relied on unless indicated to be inaccurate by contradictory information. Further assessment, investigation, construction activities, could not have been taken into account in the preparation of the report. Where such information might impact upon stated opinions, *CC GEOTECHNICAL LTD* reserves the right to modify such opinions expressed herein.

The findings and opinions conveyed, via this report, are based on information obtained from a variety of sources as detailed in this report, and which *CC GEOTECHNICAL LTD* assumes to be reliable, but has not been independently confirmed. Therefore, *CC GEOTECHNICAL LTD* cannot and does not guarantee the authenticity or reliability of third-party information it has referred to.

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1.0 INTRODUCTION

CC GEOTECHNICAL LTD (CCG) was commissioned by **OVE ARUP & PARTNERS LTD (ARUP)** acting as The Engineer, on behalf of The Client – **BRUNTWOOD SCIENTIFIC LTD (BRUNTWOOD)**, to carry out ground investigation works for City Labs 4.0, Heathersage Road, Manchester, M13 0BH.

The investigative works were carried out in accordance with the Ground Investigation Specification – SPEC/267661/S001 – Issue 1 – June 2019 – issued by **ARUP**.

It must be borne in mind that the data and/or opinions contained in this report should be read in conjunction with the Notes on Limitations, given in Appendix I.

2.0 SITE LOCATION AND DESCRIPTION

This site is situated within the car park of the Diabetes Centre associated with St Marys Hospital and located off Heathersage Road, Manchester, M13 0BH.

The site is approximately centred at Ordnance Survey National Grid Reference 385179E 395819N. A site location plan is presented on **CCG** Drawing 19/11195-1 in Appendix A.

The Diabetes centre and car park were both in active and in use during the investigation.

3.0 DOCUMENTED GEOLOGY

The natural geology prevailing at the site was researched by reference to BGS records. These indicate that the sites are underlain by drift deposits of Glacial Till.

The solid geology comprises Chester Formation - Sandstone. Sedimentary Bedrock formed approximately in the Triassic Period.

Given the history of development of the site it was known that made ground would be present at the surface of the site.

4.0 SCOPE OF INVESTIGATION

The fieldwork was planned in accordance with BS10175: 2013, and carried out in accordance with BS10175: 2013 and BS5930:

2015, insofar as they related to the scope of the investigation as summarised hereunder:

- The sinking of 3nr boreholes (BH01 – BH03) to rock head by cable percussion methods, and further advanced by rotary cored methods to depths of 21mbgl.

The borehole logs annotated with associated SPT “N” values, sampling details, TCR, SCR, RQD, standpipe installation details are given in Appendix B.

- The mechanical excavation of 10nr trial pits (TP01-TP10) to varying depths up to 3.7mbgl.

Logs of the trial pits & photographs are given in Appendix C. NOTE: TP08 was cancelled due to close proximity to an uncharted culvert.

- The mechanical excavation of 3nr trial pits with associated Soakaway tests (SA01 – SA03).

The soakaway test works sheets are presented in Appendix D.

The layout of the investigation is presented on **CCG** Drawing 19/11195-1 in Appendix A.

5.0 LABORATORY TESTING

5.1 Soil & Rock Engineering Testing

The following programme of soil and rock engineering testing was undertaken as instructed by **ARUP**:

- Determination of soil moisture content in accordance with BS 1377: Part 2: 1990
- Determination of Atterberg Limits in accordance with BS 1377: Part 2: 1990
- Determination of particle size distribution by wet sieving in accordance with BS 1377: Part 2: 1990
- Determination of sedimentation distribution by pipette in accordance with BS 1377: Part 2: 1990
- Determination of unconsolidated undrained triaxial compression with measurement of pore pressure in accordance with BS 1377: Part 7: 1990
- Determination of one-dimensional consolidation properties in accordance with BS 1377: Part 5: 1990

- Determination of rock strength by Point Load methods in accordance with ISRM 1985 Suggested Methods

The soil and rock engineering testing were carried out in the UKAS accredited laboratory of **CCG**. The test results are presented in Appendix E.

Photographs of rock cores for BH01 - BH03 are presented in Appendix F.

5.2 Chemical Analyses

The following programme of chemical analyses was undertaken at a UKAS/MCERTS laboratory as instructed by **ARUP**:

5.2.1 Soil Analyses:

Suite E1 (General Suite) – 24nr tests:

- Arsenic
- Cadmium
- Chromium (total)
- Copper
- Lead
- Mercury
- Nickel
- Selenium
- Zinc
- Antimony
- Beryllium
- Vanadium
- Cyanide (total)
- pH
- Boron (water soluble)
- Phenols (total)
- Total Organic Carbon

Suite E2a – 24nr tests:

- Asbestos I.D

Suite E2b – 1nr test:

- Asbestos quantification

Suite E3 – 14nr tests:

- TPHCWG

Suite E9 – 14nr tests:

- Chromium (hexavalent)

5.2.2 Water Analyses:

Suite F1 (General Suite) – 2nr tests:

- Arsenic
- Cadmium
- Chromium (total)
- Copper
- Lead
- Mercury
- Nickel
- Selenium
- Zinc
- Antimony
- Beryllium
- Vanadium
- Cyanide (total)
- pH
- Boron (water soluble)
- Phenols (total)
- Total Organic Carbon

Suite F2 – 2nr tests:

- TPHCWG

In addition to the above scheduled suites, the following tests were also requested:

- BRE SD1 (Suite C) – 12nr tests.
- Full WAC analysis (Suite H & I) – 4nr tests

The chemical test results are presented in Appendix G.

6.0 GAS & GROUNDWATER MONITORING

Monitoring standpipe / piezometers wells were installed in each borehole (BH01, BH02 and BH03).

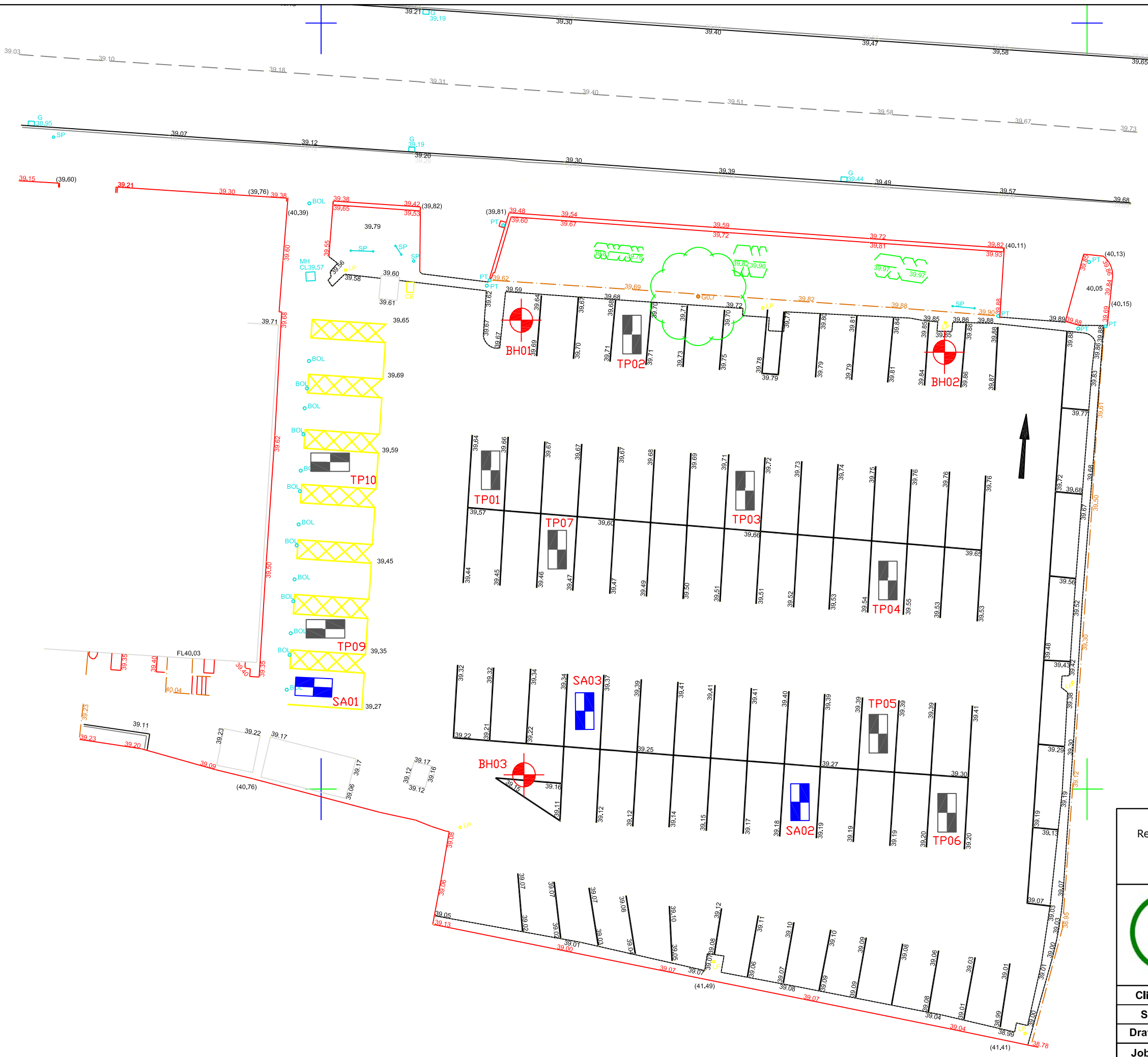
Each installation was periodically monitored for flow rate and composition of ground gas using a LMsXi infra-red analyser. Once the installations were monitored for gases, the standing water levels were recorded by electronic dipmeter. Each well was then purged dry or to 3 x Total Volume per well using an eco-water bailer, prior to groundwater samples being taken.

The results of the gas and groundwater monitoring, together with calibration certificates of the instruments are given in Appendix H.



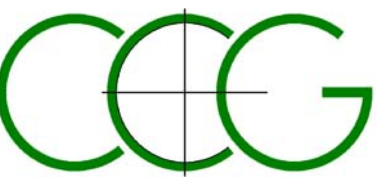
APPENDIX A

DRAWINGS



- Key:
-  Cable Percussion / Rotary Borehole
 -  Trial Pit
 -  Soakaway Test Pit

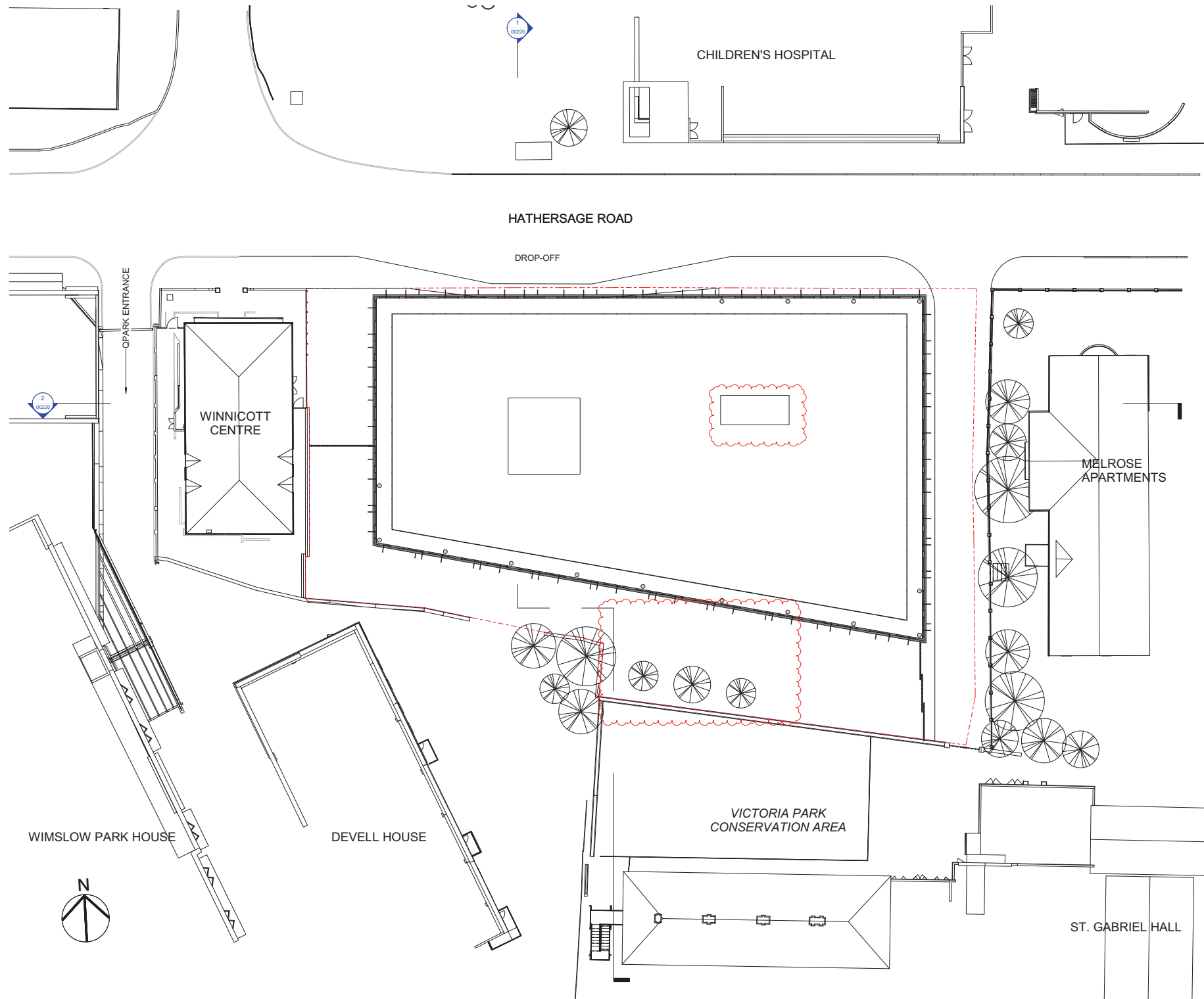
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Client	Bruntwood Science Ltd			
Site	City Labs 4.0, Manchester			
Drawing	Site Investigation Layout			
Job No.	Dwg. No.	Rev. No.	Scale@A3	Date
19/11195	1	0	1:250	Nov 19





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DO NOT SCALE FROM THIS DRAWING
The contractor shall check and verify all dimensions on site and report any discrepancies in writing to Sheppard Robson before proceeding work.

FOR ELECTRONIC DATA ISSUE
Electronic Data drawings are issued as "read only" and should not be interrogated for measurement. All dimensions and levels should read, only from those values stated in text, on the drawing.

REV.	DATE	AMENDMENT
P00	04/06/19	First Issue
P01	09/08/19	Core relocated. Bin & Cycle Store relocated to building internal

KEYPLAN

CLIENT

Bruntwood Science Ltd.

SHEPPARD ROBSON

77 Parkway Camden Town London NW1 7PU
T: +44 (0)20 7504 1700 E: london@sheppardrobson.com

PROJECT
City Labs 4.0

SCALE@A1	DATE	ORIGINATOR	CHECKED	AUTHORISED
1:200	04/06/19	AA	MAC	TO

Proposed Site Plan

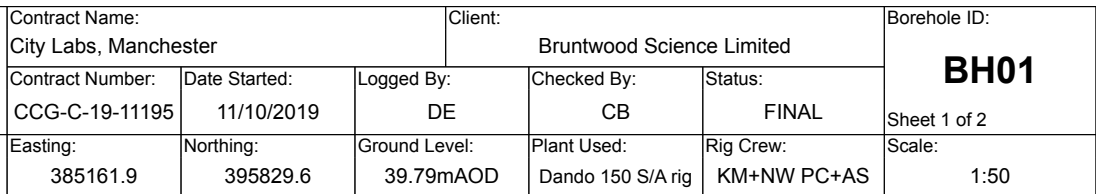
Stage 3

STATUS	PURPOSE FOR ISSUE	SR NO.
S2	For Information	6312
DRAWING NO.	REV.	
6312 - SRA - XX - XX - DR - A - 00110	P01	



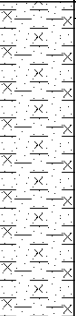
APPENDIX B

CABLE PERCUSSION / ROTARY BOREHOLE LOG SHEETS



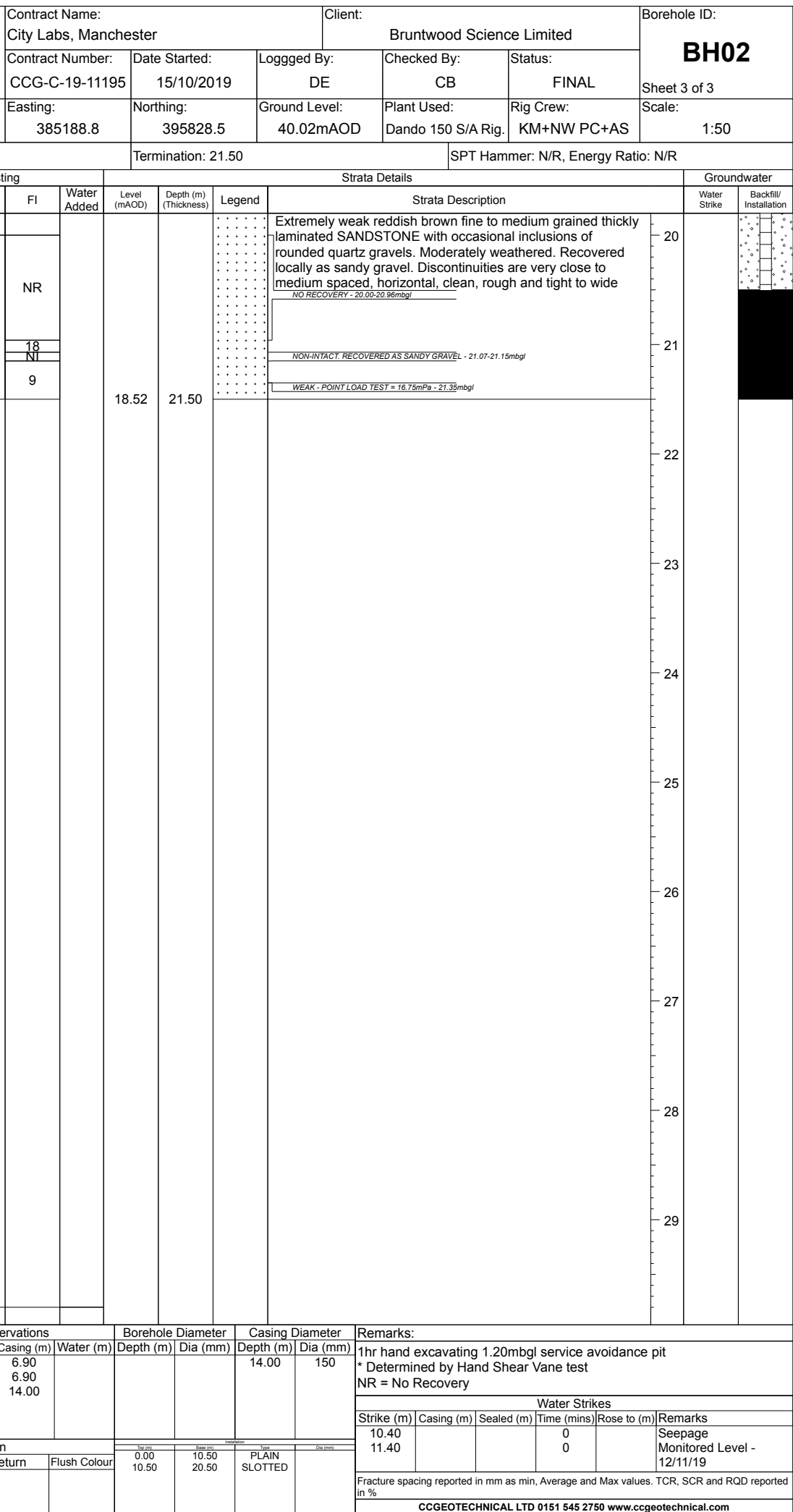
SPT Hammer: N/R, Energy Ratio: N/R

Start & End of Shift Observations					Borehole Diameter		Casing Diameter		Remarks:				
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)	1hr hand excavating 1.20mbgl service avoidance pit NR = No Recovery NI = Non-Intact rock				
11-10-2019	16:30	9.50	9.50				13.50	150					
14-10-2019	08:30	9.50	9.50										
14-10-2019	16:30	13.50	13.50										
Chiselling					Identification				Water Strikes				
From (m)	To (m)	Duration	Remarks	Top (m)	Base (m)	Type	Gap (mm)	Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
12.20	12.80	01:30		0.00	0.90	PLAIN					0		Borehole dry
13.00	13.50	01:00		0.90	1.90	SLOTTED							
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	Contract Name: City Labs, Manchester			Client: Bruntwood Science Limited			Borehole ID: BH01			
	Contract Number: CCG-C-19-11195		Date Started: 11/10/2019		Logged By: DE		Checked By: CB			
	Status: FINAL									
Cable Percussion Borehole Log		Easting: 385161.9		Northing: 395829.6		Ground Level: 39.79mAOD		Plant Used: Dando 150 S/A rig		
						Rig Crew: KM+NW PC+AS		Scale: 1:50		
Weather: Dry				Termination: 19.50				SPT Hammer: N/R, Energy Ratio: N/R		
Samples & In Situ Testing				Strata Details				Groundwater		
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation		
10.50	B		27.79	12.00		Firm becoming stiff brown slightly sandy slightly gravelly silty CLAY of very high undrained shear strength with occasional sand bands. Gravel is fine to medium sub-angular sandstone <i>CONTINUED IN SAME STRATUM</i>	10			
11.00	D	SPT(S)N=36 (3,7/7,9,9,11)								11
12.00	B									12
12.50	D	SPT(S)50 (25 for 20mm/50 for 45mm)	(1.50)		Red weathered SANDSTONE.					
									13	
13.50	B	SPT(S)50 (25 for 70mm/50 for 25mm)	26.29	13.50		Extremely weak to weak reddish brown fine to medium grained thickly laminated SANDSTONE with occasional rounded gravels. Moderately weathered. Recovered locally as sandy gravel. Discontinuities are extremely close to closely spaced, horizontal, clean, rough and tight to wide	14			
13.50	D	NR								
13.50 - 15.00	79	55 0								
						NO RECOVERY - 13.50-13.81mbgl NON-INTACT, RECOVERED AS VERY SANDY GRAVEL - 13.81-14.14mbgl NON-INTACT, RECOVERED AS GRAVELLY SAND - 14.19-14.23mbgl				
						NON-INTACT, RECOVERED AS SANDY GRAVEL - 14.57-14.60mbgl				
						WEAK - POINT LOAD TEST = 9.06mPa - 14.80mbgl				
						SPT at 15.00mbgl - 100(6, 18/38, 62/50mm) NO RECOVERY - 15.00-15.32mbgl	15			
						NON-INTACT, RECOVERED AS GRAVEL - 15.32-15.36mbgl WEAK - POINT LOAD TEST = 5.39mPa - 15.40mbgl NON-INTACT, RECOVERED AS VERY SANDY GRAVEL - 15.48-15.89mbgl				
15.00 - 16.50	79	15 0	(6.00)		NON-INTACT, RECOVERED AS SANDY GRAVEL - 15.92-16.00mbgl SPT at 16mbgl - 100(10, 15/100 for 110mbgl) NON-INTACT, RECOVERED AS VERY SANDY GRAVEL - 16.08-16.50mbgl	16				
						VERY WEAK - POINT LOAD TEST = 3.63mPa - 17.45mbgl NON-INTACT, RECOVERED AS SANDY GRAVEL - 17.46-17.53mbgl				
16.50 - 18.00	94	63 15				NO RECOVERY - 18.00-18.12mbgl NON-INTACT, RECOVERED AS VERY GRAVELLY SAND - 18.16-18.50mbgl	18			
						WEAK - POINT LOAD TEST = 5.45mPa - 18.65mbgl NON-INTACT, RECOVERED AS GRAVELLY SAND - 18.83-18.90mbgl	19			
18.00 - 19.50	92	59 39				WEAK - POINT LOAD TEST = 7.84mPa - 19.40mbgl				
			20.29	19.50						
	TCR	SCR	RQD	FI	Water					
Start & End of Shift Observations				Borehole Diameter		Casing Diameter		Remarks:		
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)		
11-10-2019	16:30	9.50	9.50				13.50	150		
14-10-2019	08:30	9.50	9.50							
14-10-2019	16:30	13.50	13.50							
								1hr hand excavating 1.20mbgl service avoidance pit NR = No Recovery NI = Non-Intact rock		
								Water Strikes		
								Strike (m) Casing (m) Sealed (m) Time (mins) Rose to (m) Remarks		
								0 Borehole dry		
Chiselling				Top (m)		Base (m)		Type		
From (m)	To (m)	Duration	Remarks	0.00	0.90	PLAIN SLOTTED				
12.20	12.80	01:30								
13.00	13.50	01:00								
CC GEOTECHNICAL LTD 0151 545 2750 www.ccgeotechnical.com										

	Contract Name: City Labs, Manchester			Client: Bruntwood Science Limited			Borehole ID: BH02		
	Contract Number: CCG-C-19-11195	Date Started: 15/10/2019	Logged By: DE	Checked By: CB	Status: FINAL	Sheet 1 of 3			
	Cable Percussion Borehole Log	Easting: 385188.8	Northing: 395828.5	Ground Level: 40.02mAOD	Plant Used: Dando 150 S/A Rig.	Rig Crew: KM+NW PC+AS	Scale: 1:50		
Weather: Dry		Termination: 21.50			SPT Hammer: N/R, Energy Ratio: N/R				
Samples & In Situ Testing				Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation	
0.50	B		39.92 39.82	0.10 0.20		TARMAC.			
1.00	B			(1.10)		Black sandy slightly silty GRAVEL. Gravel is fine to coarse sub-angular ash and brick (MADE GROUND).	1		
1.20	D	SPT(S)N=9 (1,1/2,2,2,3)				Dark brown slightly sandy slightly gravelly silty CLAY. Gravel is fine to medium sub-angular to sub-rounded sandstone, brick and cinders (MADE GROUND)			
1.50	B		38.72	1.30		Stiff brown slightly sandy slightly gravelly silty CLAY of high to very high undrained shear strength. Gravel is fine to medium sub-angular sandstone.			
2.00	U	Cu = 82kPa					2		
2.50	B								
3.00	D	SPT(S)N=18 (1,2/4,4,5,5)					3		
3.50	B								
4.00	U	Cu = > 110kPa*					4		
4.50	B								
5.00	D	SPT(S)N=20 (2,3/4,5,5,6)					5		
6.00	B			(9.10)			6		
6.50	U	Cu = 258kPa					7		
7.50	B								
8.00	D	SPT(S)N=21 (2,4/4,5,6,6)					8		
9.00	B						9		
9.50	D	SPT(S)N=50 (5,8/8,12,15,15)							
Continued next sheet									
Start & End of Shift Observations					Borehole Diameter		Casing Diameter		Remarks:
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)	
15-10-2019	16:30	6.90	6.90				14.00	150	1hr hand excavating 1.20mbgl service avoidance pit
16-10-2019	08:30	6.90	6.90						* Determined by Hand Shear Vane test
16-10-2019	16:30	14.00	14.00						NR = No Recovery
					Water Strikes				
					Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)
					10.40			0	
					11.40			0	
Chiselling					Remarks				
From (m)	To (m)	Duration			Top (m)	Bottom (m)	Notes		
12.50	14.00	01:30			0.00	10.50	PLAIN SLOTTED		
					Seepage Monitored Level - 12/11/19				
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	Contract Name: City Labs, Manchester			Client: Bruntwood Science Limited			Borehole ID: BH02	
	Contract Number: CCG-C-19-11195		Date Started: 15/10/2019		Logged By: DE		Checked By: CB	
	Status: FINAL							
Cable Percussion Borehole Log		Easting: 385188.8		Northing: 395828.5		Ground Level: 40.02mAOD		Plant Used: Dando 150 S/A Rig.
						Rig Crew: KM+NW PC+AS		Scale: 1:50
Weather: Dry				Termination: 21.50				SPT Hammer: N/R, Energy Ratio: N/R
Samples & In Situ Testing				Strata Details				Groundwater
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
10.50	B		29.62	10.40		Stiff brown slightly sandy slightly gravelly silty CLAY of high to very high undrained shear strength. Gravel is fine to medium sub-angular sandstone.	10	
11.00	D	SPT(S)N=31 (3,6/7,6,8,10)		(1.60)		CONTINUED BORING IN SAME STRATUM	11	
12.00	B		28.02	12.00		Dense brown silty clayey gravelly fine to coarse grained SAND. Gravel is fine to medium sub-angular to sub-rounded sandstone.	12	
12.50	D	SPT(S)50 (8,13/50 for 170mm)		(2.00)		Red weathered SANDSTONE.	13	
13.50	B							
14.00	D	SPT(S)50 (25 for 20mm/50 for 20mm)	26.02	14.00		Extremely weak reddish brown fine to medium grained thickly laminated SANDSTONE with occasional inclusions of rounded quartz gravels. Moderately weathered. Recovered locally as sandy gravel. Discontinuities are very close to medium spaced, horizontal, clean, rough and tight to wide	14	
14.00 - 15.50	98	67 0				NO RECOVERY - 14.00-14.03mbgl NON-INTACT, RECOVERED AS SANDY GRAVEL - 14.03-14.34mbgl NON-INTACT, RECOVERED AS GRAVEL - 14.43-14.48mbgl NON-INTACT, RECOVERED AS GRAVEL - 14.80-14.84mbgl VERY WEAK - POINT LOAD TEST = 2.26mPa - 15.10mbgl	15	
15.50 - 17.00	100	79 7				NON-INTACT, RECOVERED AS SANDY GRAVEL - 15.79-15.87mbgl VERY WEAK - POINT LOAD TEST = 4.54mPa - 16.10mbgl NON-INTACT, RECOVERED AS GRAVELLY SAND - 16.33-16.52mbgl NON-INTACT, RECOVERED AS SANDY GRAVEL - 16.59-16.81mbgl	16	
17.00 - 18.50	100	37 0				WEAK - POINT LOAD TEST = 5.46mPa - 17.15mbgl NON-INTACT, RECOVERED AS VERY SANDY GRAVEL - 17.19-18.11mbgl	17	
18.50 - 20.00	100	66 30				WEAK - POINT LOAD TEST = 8.09mPa - 18.20mbgl NON-INTACT, RECOVERED AS SLIGHTLY GRAVELLY SAND - 18.33-18.43mbgl	18	
						NON-INTACT, RECOVERED AS SANDY GRAVEL - 18.87-19.04mbgl WEAK - POINT LOAD TEST = 9.94mPa - 19.20mbgl NON-INTACT, RECOVERED AS VERY SANDY GRAVEL - 19.37-19.59mbgl	19	
	TCR	SCR	RQD	FI	Water			
Start & End of Shift Observations				Borehole Diameter		Casing Diameter		Remarks:
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)
15-10-2019	16:30	6.90	6.90				14.00	150
16-10-2019	08:30	6.90	6.90					
16-10-2019	16:30	14.00	14.00					
								1hr hand excavating 1.20mbgl service avoidance pit * Determined by Hand Shear Vane test NR = No Recovery
								Water Strikes
								Strike (m) Casing (m) Sealed (m) Time (mins) Rose to (m) Remarks
								10.40 0 Seepage Monitored Level - 12/11/19
								11.40 0
								CC GEOTECHNICAL LTD 0151 545 2750 www.ccgeotechnical.com
Chiselling				Top (m)		Bottom (m)		Remarks
From (m)	To (m)	Duration	Remarks	0.00	10.50	20.50	PLAIN SLOTTED	
12.50	14.00	01:30						



	Contract Name: City Labs, Manchester				Client: Bruntwood Science Limited			Borehole ID: BH03		
	Contract Number: CCG-C-19-11195		Date Started: 07/10/2019		Logged By: DE		Checked By: CB		Status: FINAL	
	Easting: 385162.7		Northing: 395803.2		Ground Level: 39.34mAOD		Plant Used: Dando 150 S/A Rig		Rig Crew: KM+CC PC+AS	
Cable Percussion Borehole Log								Scale: 1:50		
Weather: Wet				Termination: 23.00				SPT Hammer: N/R, Energy Ratio: N/R		
Samples & In Situ Testing				Strata Details					Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description			Water Strike	Backfill/ Installation
0.30	ES		39.24	0.10 (0.30)		TARMAC.			1	
0.50	B		38.94	0.40 (0.40)		Black very gravelly fine to coarse grained SAND of medium cobble content. Gravel is fine to coarse sub-angular to angular ash and brick (MADE GROUND).				
0.50	ES		38.54	0.80 (1.30)		Brown very sandy GRAVEL of medium cobble content. Gravel is fine to coarse sub-angular brick (MADE GROUND).				
1.00	B					Soft to firm grey/brown slightly sandy slightly gravelly silty CLAY with organic inclusions. Gravel is fine to coarse angular to sub-angular brick and sandstone (MADE GROUND)			2	
1.20	D	SPT(S)N=9 (1,0/2,2,2,3)								
1.50	B									
2.00	D	SPT(S)N=14 (2,3/3,3,4,4)	37.24	2.10		Stiff becoming hard brown sandy slightly gravelly silty CLAY with occasional sand lenses. Gravel is fine to medium sub-angular sandstone			3	
2.50	B									
3.00	U	Cu = > 110kPa*								
3.50	B								4	
4.00	D	SPT(S)N=20 (3,5/4,5,5,6)								
4.50	B									
5.00	U	Cu = > 110kPa*							5	
6.00	B									
6.50	D	SPT(S)N=28 (3,4/6,7,7,8)								
7.50	B								6	
8.00	U	Cu = 305kPa								
9.00	B									
9.50	D	SPT(S)50 (25 for 70mm/50 for 30mm)	29.54	9.80					7	
						Continued next sheet				
Start & End of Shift Observations					Borehole Diameter		Casing Diameter		Remarks:	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)	1hr hand excavating 1.20mbgl service avoidance pit * Determined by Hand Shear Vane test NR = No Recovery	
07-10-2019	16:30	3.50					12.00	150		
08-10-2019	08:30	3.50								
08-10-2019	16:30	12.50								
09-10-2019	08:30	12.50		10.50						
Chiselling					Top (m)		Bottom (m)		Remarks	
From (m)	To (m)	Duration	Remarks		0.00	15.00	15.00	22.00	PLAIN SLOTTED	
12.50	13.00	01:00								
					Strike (m)		Casing (m)	Sealed (m)	Time (mins)	Rose to (m)
					10.50				0	
					11.00				0	
					Seepage Monitored Level - 12/11/2019					
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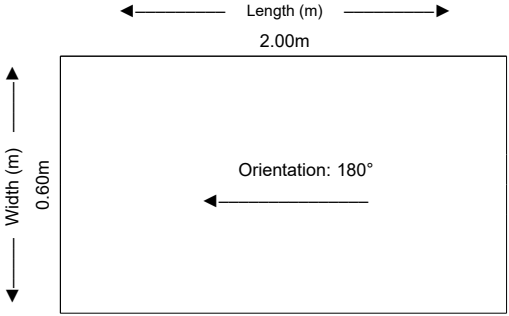
Weather: Wet			Termination: 23.00			SPT Hammer: N/R, Energy Ratio: N/R								
Samples & In Situ Testing						Strata Details					Groundwater			
Depth	Sample ID	Test Result		Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description			Water Strike	Backfill/ Installation			
10.50	B	SPT(S)N=26 (2,5/8,8,6,4)		26.84	(2.70)		Medium dense becoming dense brown very sandy slightly silty GRAVEL. Gravel is fine to coarse sub-rounded sandstone and quartz			10				
11.00	D									11				
12.00	B									12				
12.50	D	SPT(S)50 (25 for 45mm/50 for 35mm)		26.34	12.50 (0.50)		Red weathered SANDSTONE.							
13.00	D	SPT(S)50 (25 for 30mm/50 for 40mm)								13				
13.00 - 14.50	0	0	0							14				
14.50 - 16.00	0	0	0	NR	(6.00)		Extremely weak brown SANDSTONE recovered as brown fine to medium grained SAND. <i>NO RECOVERY - 13.00-19.13mbgl</i>			15				
16.00 - 17.00	0	0	0							16				
17.00 - 17.50	0	0	0							17				
17.50 - 18.50	0	0	0							18				
18.50 - 19.00	0	0	0							19				
19.00 - 19.50	74	48	0	20.34	19.00		Very weak to weak reddish brown fine to medium grained thickly laminated SANDSTONE. Moderately weathered. Recovered locally as gravelly sand. Discontinuities are very close to medium spaced, horizontal, clean, rough and tight to wide <i>NON-INTACT, RECOVERED AS GRAVEL - 19.13-19.20mbgl</i>			19				
19.50 - 20.00	100	0	0											
TCR	SCR	RQD	FI							Water				
Start & End of Shift Observations					Borehole Diameter		Casing Diameter		Remarks:					
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)						
07-10-2019	16:30	3.50					12.00	150	1hr hand excavating 1.20mbgl service avoidance pit					
08-10-2019	08:30	3.50							* Determined by Hand Shear Vane test					
08-10-2019	16:30	12.50							NR = No Recovery					
09-10-2019	08:30	12.50		10.50										
Chiselling					10.00		15.00		Water Strikes					
From (m)	To (m)	Duration	Remarks	0.00	15.00	PLAIN	15.00		Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
12.50	13.00	01:00							10.50			0		Seepage
									11.00			0		Monitored Level - 12/11/2019
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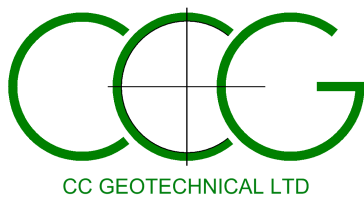
	Contract Name: City Labs, Manchester				Client: Bruntwood Science Limited				Borehole ID: BH03				
	Contract Number: CCG-C-19-11195		Date Started: 07/10/2019		Logged By: DE		Checked By: CB		Status: FINAL				
	Easting: 385162.7		Northing: 395803.2		Ground Level: 39.34mAOD		Plant Used: Dando 150 S/A Rig		Rig Crew: KM+CC PC+AS				
Rotary Core Drilling Log										Sheet 3 of 3			
										Scale: 1:50			
Weather: Wet				Termination: 23.00				SPT Hammer: N/R, Energy Ratio: N/R					
Samples & In Situ Testing						Strata Details						Groundwater	
Depth	TCR	SCR	RQD	FI	Water Added	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description			Water Strike	Backfill/Installation
				NI					Very weak to weak reddish brown fine to medium grained thickly laminated SANDSTONE. Moderately weathered. Recovered locally as gravelly sand. Discontinuities are very close to medium spaced, horizontal, clean, rough and tight to wide			20	
20.00 - 20.50	100	68	0	14					NON-INTACT, RECOVERED AS GRAVEL - 19.26-19.31mbgl SPT at 19.50mbgl - 100(8.12/27, 73/50mm) NON-INTACT, RECOVERED AS GRAVELLY SAND - 19.50-20.11mbgl WEAK - POINT LOAD TEST = 8.95mPa - 20.40mbgl NON-INTACT, RECOVERED AS GRAVELLY SAND - 20.45-20.50mbgl NON-INTACT, RECOVERED AS GRAVELLY SAND - 20.54-20.75mbgl NON-INTACT, RECOVERED AS SAND - 20.80-20.85mbgl SPT at 21.00mbgl - 100(6.20/46, 60/55mm)			21	
20.50 - 21.00	92	46	0	NI					NON-INTACT, RECOVERED AS SLIGHTLY GRAVELLY SAND - 21.23-21.28mbgl WEAK - POINT LOAD TEST = 6.74mPa - 21.40mbgl			22	
21.00 - 21.50	100	90	50	13			(4.00)					23	
21.50 - 22.00	100	90	90	NI								24	
22.00 - 23.00	97	97	70	8					WEAK - POINT LOAD TEST = 14.89mPa - 22.20mbgl WEAK - POINT LOAD TEST = 10.87mPa - 22.80mbgl			25	
						16.34	23.00					26	
												27	
												28	
												29	
Start & End of Shift Observations						Borehole Diameter		Casing Diameter		Remarks:			
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)	1hr hand excavating 1.20mbgl service avoidance pit				
07-10-2019	16:30	3.50						12.00	150	* Determined by Hand Shear Vane test			
08-10-2019	08:30	3.50								NR = No Recovery			
08-10-2019	16:30	12.50											
09-10-2019	08:30	12.50		10.50									
Flush Information						Top (m)		Base (m)		Remarks			
Top (m)	Base (m)	Flush Type	Return	Flush Colour	Top (m)	Base (m)	Top (m)	Base (m)	Top (m)	Base (m)	Remarks		
					0.00	15.00	15.00	22.00	PLAIN				
					15.00	22.00			SLOTTED				
Fracture spacing reported in mm as min, Average and Max values. TCR, SCR and RQD reported in %													
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APPENDIX C

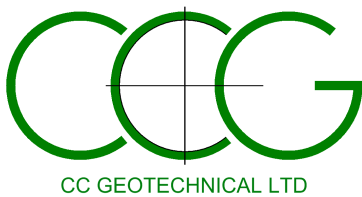
TRIAL PIT LOG SHEETS & PHOTOGRAPHS

	Contract Name: City Labs, Manchester		Client: Bruntwood Science Limited			Trial Pit ID: TP01														
	Contract Number: CCG-C-19-11195	Date Started: 15-10-2019	Logged By: DE	Checked By: CB	Status: FINAL	Sheet 1 of 1														
Trial Pit Log		Easting: 385161.3	Northing: 395820.5	Ground Level: 39.79mAOD	Plant Used: JCB 3CX	Date Printed: 19-11-2019	Scale: 1:25													
Weather: Dry			Hole Termination: 3.70			Stability:														
Samples & In Situ Testing				Strata Details			Water	Backfill												
Depths	Sample ID	Test Result	Reduced Level	Depth (m) (Thickness)	Legend	Strata Description														
0.10 0.20 0.20	D B ES		39.69 39.49	0.10 0.30		TARMAC.	1													
0.50 0.50	B ES					Black slightly silty very gravelly SAND. Gravel is fine to coarse sub-angular ash and brick (MADE GROUND).														
						Brown gravelly slightly silty SAND. Gravel is fine to coarse angular to sub-angular brick and sandstone (MADE GROUND)														
1.00 1.00	B ES			(1.50)																
1.50 1.50	B ES																			
			37.99	1.80		Concrete slab.														
2.00	B	HVP=95kPa HVP=95kPa HVP=70kPa HVP=80kPa	37.84	1.95		Stiff brown becoming grey slightly sandy slightly gravelly silty CLAY. Gravel is fine to coarse sub-rounded to rounded sandstone.			2											
3.00	B	HVP=80kPa HVP=110kPa		(1.75)					3											
3.70	B	HVP=110kPa	36.09	3.70		End of Trial Pit at 3.70m														
Dimensions:				General Remarks:																
Final Depth: 3.70m				HVP value average (set of 3) Mex Cone Test at 0.20mbgl = CBR 7-10% Intact Wall on western elevation of pit																
																				
Inclination: 90°																				
				Water Strikes																
				<table><tr><td>Strike (m)</td><td>Casing (m)</td><td>Sealed (m)</td><td>Time (mins)</td><td>Rose to (m)</td><td>Remarks</td></tr><tr><td></td><td></td><td></td><td>0</td><td></td><td>Dry</td></tr></table>					Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks				0		Dry
Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks															
			0		Dry															
				CC GEOTECHNICAL LTD 0151 545 2750 www.ccgeotechnical.com																



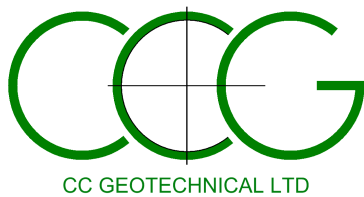
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Site	City Labs, Manchester
Job Number:	CCG-C-19-11195
Trial Pit Number:	TP01



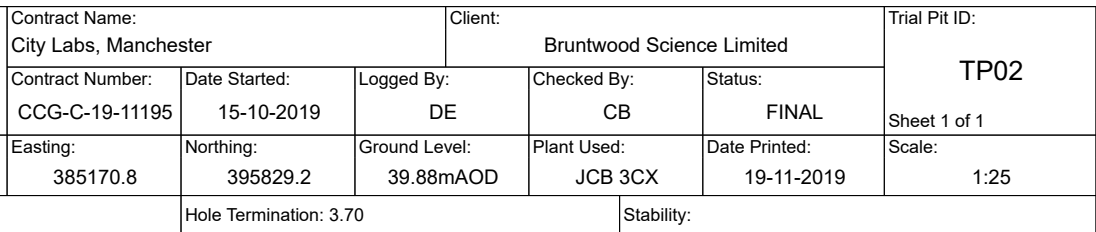
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Site	City Labs, Manchester
Job Number:	CCG-C-19-11195
Trial Pit Number:	TP01



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Site	City Labs, Manchester
Job Number:	CCG-C-19-11195
Trial Pit Number:	TP01



Dimensions:

Final Depth: 3.70m

Length (m)

2.40m

Width (m)

0.60m

Orientation: 180°

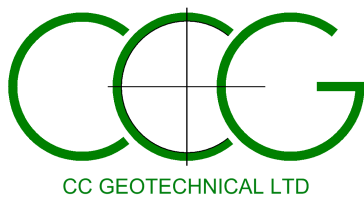
Inclination: 90°

General Remarks:

HVP value average (set of 3)
Mexe Cone Test at 0.20mbgl = CBR 4-6%

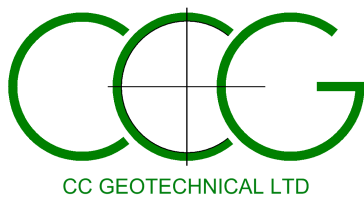
Water Strikes					
Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
			0		Dry

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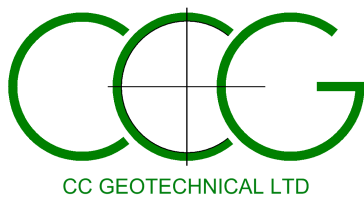
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Site	City Labs, Manchester
Job Number:	CCG-C-19-11195
Trial Pit Number:	TP02



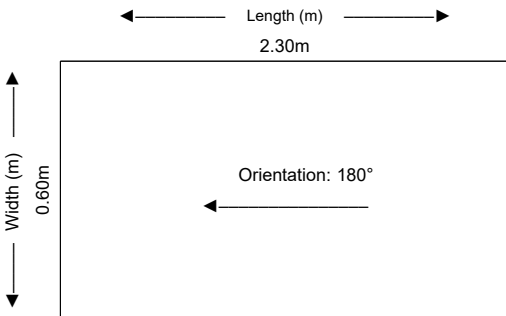
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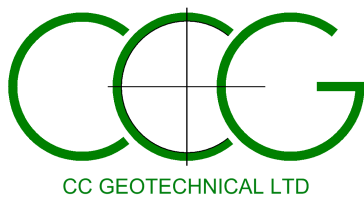
Site	City Labs, Manchester
Job Number:	CCG-C-19-11195
Trial Pit Number:	TP02



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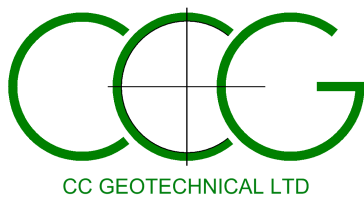
Site	City Labs, Manchester
Job Number:	CCG-C-19-11195
Trial Pit Number:	TP02

	Contract Name: City Labs, Manchester			Client: Bruntwood Science Limited			Trial Pit ID: TP03		
	Contract Number: CCG-C-19-11195	Date Started: 15-10-2019	Logged By: DE	Checked By: CB	Status: FINAL	Sheet 1 of 1			
Trial Pit Log		Easting: 385179.5	Northing: 395819.5	Ground Level: 39.82mAOD	Plant Used: JCB 3CX	Date Printed: 19-11-2019	Scale: 1:25		
Weather: Dry			Hole Termination: 1.70			Stability:			
Samples & In Situ Testing				Strata Details				Water	Backfill
Depths	Sample ID	Test Result	Reduced Level	Depth (m) (Thickness)	Legend	Strata Description			
0.10	D		39.72	0.10		TARMAC.			
0.20	B					Black slightly silty very gravelly fine to medium grained SAND. Gravel is fine to coarse sub-angular ash and brick (MADE GROUND).			
0.20	ES		39.52	0.30		Brown gravelly slightly silty SAND with medium cobble content. Gravel is fine to coarse angular to sub-angular brick, coal and cinders with inclusions of glass (MADE GROUND)			
0.50	B								
0.50	ES								
1.00	B			(1.40)			1		
1.00	ES								
1.50	B								
1.50	ES		38.12	1.70		End of Trial Pit at 1.70m	2		
							3		
Dimensions:				General Remarks:					
Final Depth: 1.70m				Mexe Cone Test at 0.50mbgl = CBR 4-6%					
				Terminated due to instability of all elevations (As agreed with the Engineer)					
				Water Strikes					
				Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
Inclination: 90°									
				0					Dry
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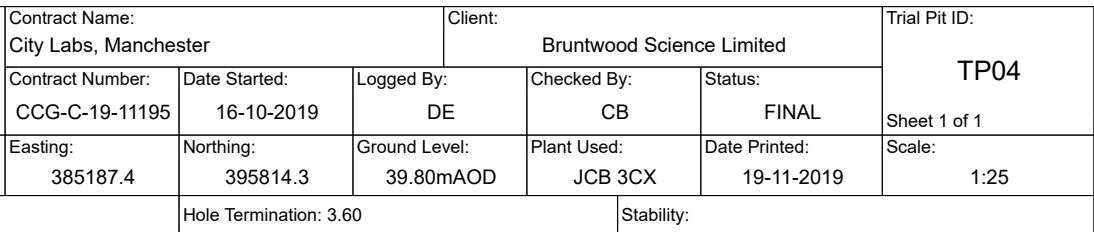
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Site	City Labs, Manchester
Job Number:	CCG-C-19-11195
Trial Pit Number:	TP03



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Site	City Labs, Manchester
Job Number:	CCG-C-19-11195
Trial Pit Number:	TP03



Dimensions:

Final Depth: 3.60m

Length (m)

2.60m

Width (m)

0.60m

Orientation: 180°

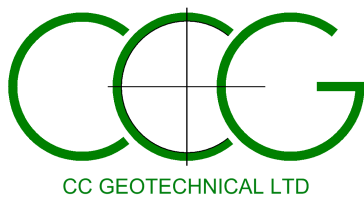
Inclination: 90°

General Remarks:

HVP value average (set of 3)
Mexe Cone Test at 0.20mbgl = CBR 2-5%

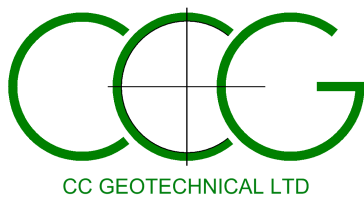
Water Strikes					
Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
			0		Dry

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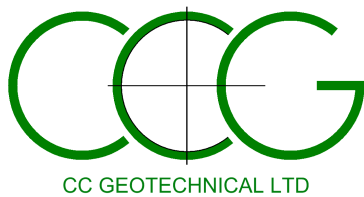
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Site	City Labs, Manchester
Job Number:	CCG-C-19-11195
Trial Pit Number:	TP04



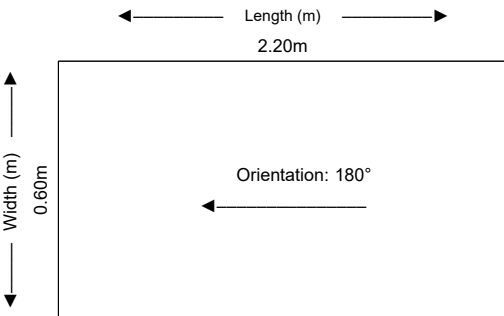
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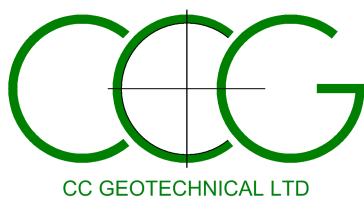
Site	City Labs, Manchester
Job Number:	CCG-C-19-11195
Trial Pit Number:	TP04



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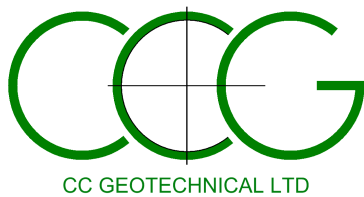
Site	City Labs, Manchester
Job Number:	CCG-C-19-11195
Trial Pit Number:	TP04

	Contract Name: City Labs, Manchester			Client: Bruntwood Science Limited			Trial Pit ID: TP05			
	Contract Number: CCG-C-19-11195	Date Started: 07-10-2019	Logged By: DE	Checked By: CB	Status: FINAL	Sheet 1 of 1				
Trial Pit Log		Easting: 385186.7	Northing: 395802.9	Ground Level: 39.50mAOD	Plant Used: JCB 3CX	Date Printed: 19-11-2019	Scale: 1:25			
Weather: Dry			Hole Termination: 2.70			Stability:				
Samples & In Situ Testing				Strata Details				Water	Backfill	
Depths	Sample ID	Test Result	Reduced Level	Depth (m) (Thickness)	Legend	Strata Description				
0.10 0.20 0.20	D B ES	HVP=70kPa HVP=80kPa	39.40	0.10 (0.30)		TARMAC	1			
0.50 0.50	B ES		39.10	0.40 (0.30)		Brown slightly silty gravelly SAND with medium cobble content. Gravel is fine to coarse angular brick (MADE GROUND).				
1.00 1.00	B ES		38.80	0.70 (0.50)		Firm to stiff black very silty very gravelly fine to coarse grained SAND. Gravel is fine to coarse sub-angular coal, cinders, concrete and brick MADE GROUND).				
1.50	B	HVP=90kPa	38.30	1.20 (1.50)		Stiff brown becoming grey slightly sandy slightly gravelly silty CLAY. Gravel is fine to coarse sub-rounded sandstone.	2			
2.00	B	HVP=90kPa								
2.70	B	HVP=80kPa	36.80	2.70	----- End of Trial Pit at 2.70m -----		3			
Dimensions:										
Final Depth: 2.70m					General Remarks:					
					HVP value average (set of 3) Mexe Cone Test at 0.20mbgl = CBR 2-5%					
					Water Strikes					
					Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
					1.20			0		Seepage
Inclination: 90°										
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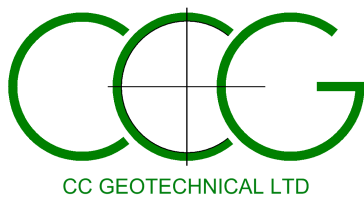
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Site	City Labs, Manchester
Job Number:	CCG-C-19-11195
Trial Pit Number:	TP05



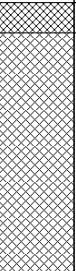
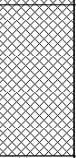
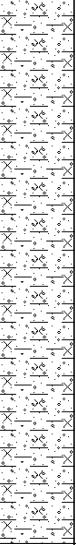
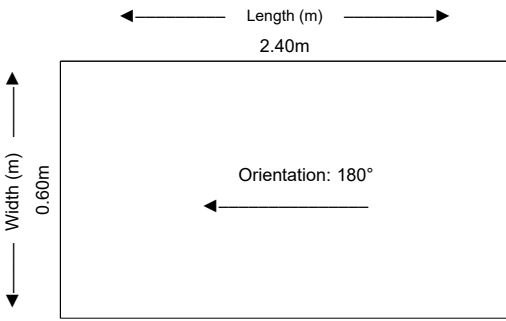
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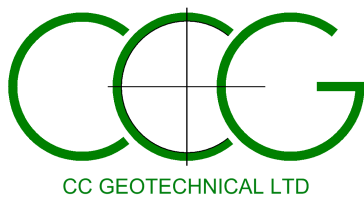
Site	City Labs, Manchester
Job Number:	CCG-C-19-11195
Trial Pit Number:	TP05



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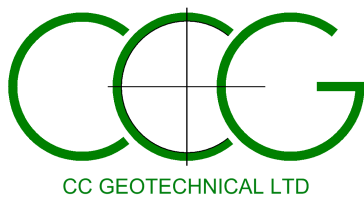
Site	City Labs, Manchester
Job Number:	CCG-C-19-11195
Trial Pit Number:	TP05

	Contract Name: City Labs, Manchester			Client: Bruntwood Science Limited			Trial Pit ID: TP06																			
	Contract Number: CCG-C-19-11195	Date Started: 08-10-2019	Logged By: DE	Checked By: CB	Status: FINAL	Sheet 1 of 1																				
Trial Pit Log	Easting: 385191.2	Northing: 395797.4	Ground Level: 39.39mAOD	Plant Used: JCB 3CX	Date Printed: 19-11-2019	Scale: 1:25																				
	Weather: Dry		Hole Termination: 3.20		Stability:																					
Samples & In Situ Testing			Strata Details				Water	Backfill																		
Depths	Sample ID	Test Result	Reduced Level	Depth (m) (Thickness)	Legend	Strata Description																				
0.10 0.20 0.20	D B ES		39.29	0.10		TARMAC	1																			
0.50 0.50	B ES			(0.80)		Black/dark brown very gravelly silty slightly clayey fine to coarse grained SAND with medium cobble content. Gravel is fine to coarse sub-angular coal, concrete, ceramic and brick with inclusions of glass (MADE GROUND)																				
1.00 1.00	B ES		38.49	0.90		Black slightly silty clayey sandy GRAVEL with medium cobble content. Gravel is fine to coarse sub-angular ash, and brick (MADE GROUND)																				
1.50	B	HVP=30kPa		1.40		Soft to firm becoming firm then stiff brown becoming grey slightly sandy slightly gravelly silty CLAY. Gravel is fine to coarse sub-rounded to rounded sandstone.	2																			
		HVP=40kPa																								
2.00	B	HVP=40kPa																								
		HVP=60kPa		(1.80)																						
		HVP=60kPa					3																			
		HVP=80kPa																								
3.00	B	HVP=100kPa																								
			36.19	3.20		End of Trial Pit at 3.20m																				
Dimensions:			General Remarks:																							
Final Depth: 3.20m			HVP value average (set of 3) Mexce Cone Test at 0.50mbgl = CBR 2-6%																							
																										
Inclination: 90°																										
			<table><tr><th colspan="6">Water Strikes</th></tr><tr><th>Strike (m)</th><th>Casing (m)</th><th>Sealed (m)</th><th>Time (mins)</th><th>Rose to (m)</th><th>Remarks</th></tr><tr><td>2.80</td><td></td><td></td><td>0</td><td></td><td>Seepage</td></tr></table>						Water Strikes						Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	2.80			0		Seepage
Water Strikes																										
Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks																					
2.80			0		Seepage																					
			CC GEOTECHNICAL LTD 0151 545 2750 www.ccgteotechnical.com																							



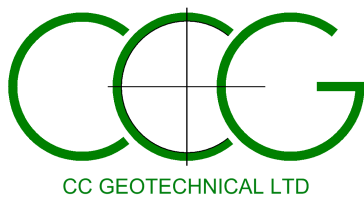
Unit 1
 Deltic Way
 Knowsley Industrial Estate
 Merseyside
 L33 7BA
 e: enquiries@ccgeotechnical.co.uk
 w: www.ccgeotechnical.co.uk

Site	City Labs, Manchester
Job Number:	CCG-C-19-11195
Trial Pit Number:	TP06



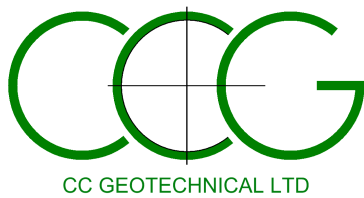
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Site	City Labs, Manchester
Job Number:	CCG-C-19-11195
Trial Pit Number:	TP06



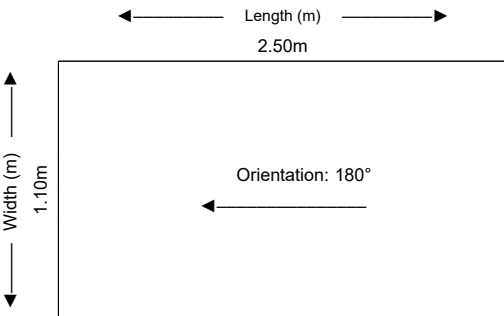
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Knowsley Industrial Estate
Merseyside
L33 7BA
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w: www.ccgeotechnical.co.uk

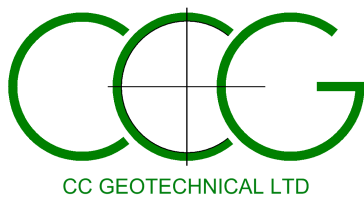
Site	City Labs, Manchester
Job Number:	CCG-C-19-11195
Trial Pit Number:	TP06



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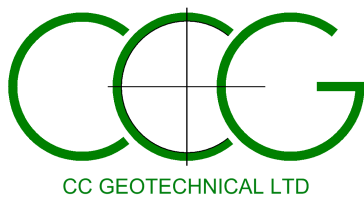
Site	City Labs, Manchester
Job Number:	CCG-C-19-11195
Trial Pit Number:	TP06

	Contract Name: City Labs, Manchester		Client: Bruntwood Science Limited			Trial Pit ID: TP07													
	Contract Number: CCG-C-19-11195	Date Started: 16-10-2019	Logged By: DE	Checked By: CB	Status: FINAL	Sheet 1 of 1													
Trial Pit Log	Easting: 385166.7	Northing: 395814.8	Ground Level: 39.67mAOD	Plant Used: JCB 3CX	Date Printed: 19-11-2019	Scale: 1:25													
	Weather: Dry		Hole Termination: 3.60		Stability:														
Samples & In Situ Testing				Strata Details			Water	Backfill											
Depths	Sample ID	Test Result	Reduced Level	Depth (m) (Thickness)	Legend	Strata Description													
0.10 0.20 0.20	D B ES		39.57	0.10 (0.30)		TARMAC. Black slightly silty very gravelly fine to medium grained SAND. Gravel is fine to coarse sub-angular ash and brick (MADE GROUND).	1												
0.50 0.50	B ES		39.27	0.40		Brown very gravelly silty fine to coarse grained SAND. Gravel is fine to coarse sub-angular brick, concrete and cinders with inclusions of glass and metal (MADE GROUND)													
1.00 1.00	B ES			(1.50)															
1.50 1.50	B ES						2												
2.00	B	HVP=40kPa	37.77	1.90		Firm becoming stiff brown becoming grey slightly sandy slightly gravelly silty CLAY. Gravel is fine to coarse sub-rounded sandstone.													
		HVP=50kPa																	
3.00	B	HVP=50kPa HVP=110kPa HVP=110kPa		(1.70)			3												
3.60	B	HVP=110kPa	36.07	3.60		End of Trial Pit at 3.60m													
Dimensions:				General Remarks:															
Final Depth: 3.60m				HVP value average (set of 3) Mexe Cone Test at 0.50mbgl = CBR 5-7% Intact Wall on western elevation of pit. Unstable at eastern elevation.															
																			
Inclination: 90°																			
				Water Strikes															
				<table><tr><td>Strike (m)</td><td>Casing (m)</td><td>Sealed (m)</td><td>Time (mins)</td><td>Rose to (m)</td><td>Remarks</td></tr><tr><td></td><td></td><td></td><td>0</td><td></td><td>Dry</td></tr></table>				Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks				0		Dry
Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks														
			0		Dry														
				CC GEOTECHNICAL LTD 0151 545 2750 www.ccgeotechnical.com															



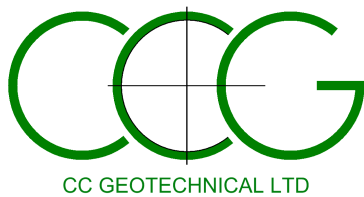
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L33 7BA
e: enquiries@ccgeotechnical.co.uk
w: www.ccgeotechnical.co.uk

Site	City Labs, Manchester
Job Number:	CCG-C-19-11195
Trial Pit Number:	TP07



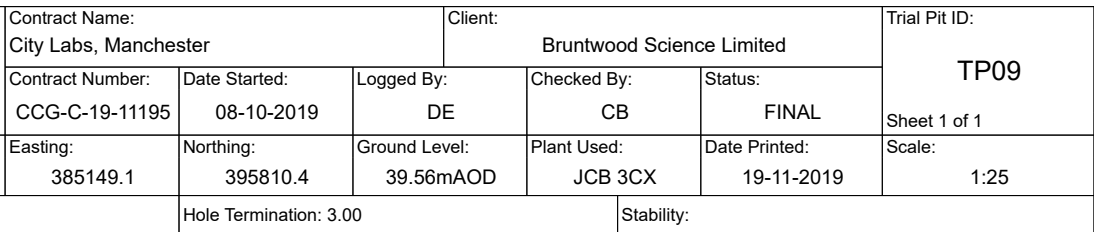
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Merseyside
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e: enquiries@ccgeotechnical.co.uk
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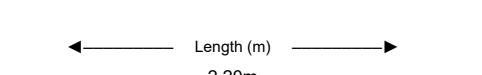
Site	City Labs, Manchester
Job Number:	CCG-C-19-11195
Trial Pit Number:	TP07

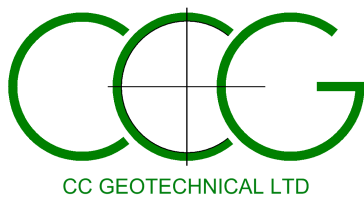


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Site	City Labs, Manchester
Job Number:	CCG-C-19-11195
Trial Pit Number:	TP07

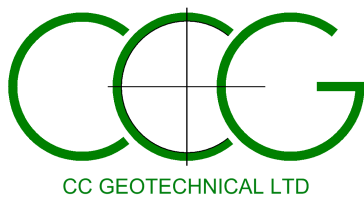


Dimensions: Final Depth: 3.00m  Length (m) 2.20m Width (m) 0.80m Orientation: 90°	General Remarks: HVP value average (set of 3) Mexe Cone Test at 0.20mbgl = CBR 2-5% Intact Wall and buttress on western elevation of pit. Unstable at northern elevation.
--	---



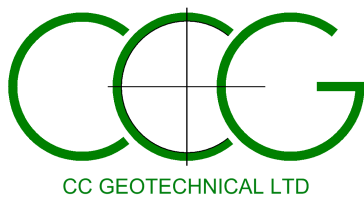
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Site	City Labs, Manchester
Job Number:	CCG-C-19-11195
Trial Pit Number:	TP09



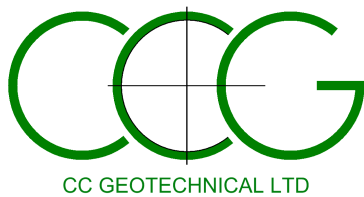
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Site	City Labs, Manchester
Job Number:	CCG-C-19-11195
Trial Pit Number:	TP09



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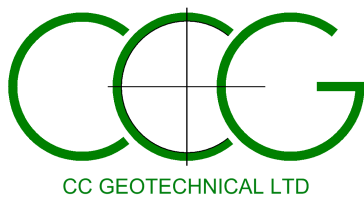
Site	City Labs, Manchester
Job Number:	CCG-C-19-11195
Trial Pit Number:	TP09



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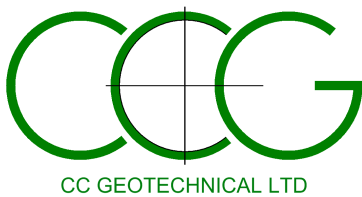
Site	City Labs, Manchester
Job Number:	CCG-C-19-11195
Trial Pit Number:	TP09

	Contract Name: City Labs, Manchester			Client: Bruntwood Science Limited			Trial Pit ID: TP10		
	Contract Number: CCG-C-19-11195	Date Started: 16-10-2019	Logged By: DE	Checked By: CB	Status: FINAL	Sheet 1 of 1			
Trial Pit Log	Easting: 385150.9	Northing: 395819.7	Ground Level: 39.67mAOD	Plant Used: JCB 3CX	Date Printed: 19-11-2019	Scale: 1:25			
	Weather: Dry		Hole Termination: 3.50		Stability:				
Samples & In Situ Testing				Strata Details				Water	Backfill
Depths	Sample ID	Test Result	Reduced Level	Depth (m) (Thickness)	Legend	Strata Description			
0.10 0.20 0.20	D B ES		39.58	0.10 (0.30)		TARMAC. Black slightly silty very gravelly fine to medium grained SAND. Gravel is fine to coarse sub-angular ash and brick (MADE GROUND).	1		
0.50 0.50	B ES		39.28	0.40		Brown very gravelly silty fine to coarse grained SAND. Gravel is fine to coarse sub-angular brick, concrete, ceramic and cinders with inclusions of glass and metal (MADE GROUND)			
1.00 1.00	B ES			(1.50)					
1.50 1.50	B ES						2		
2.00	B	HVP=50kPa HVP=40kPa HVP=40kPa	37.78	1.90		Soft to firm brown becoming grey slightly sandy slightly gravelly silty CLAY. Gravel is fine to coarse sub-rounded sandstone.			
				(1.60)					
3.00	B	HVP=50kPa HVP=30kPa HVP=40kPa					3		
3.50	B	HVP=50kPa	36.17	3.50		End of Trial Pit at 3.50m			
Dimensions:				General Remarks:					
Final Depth: 3.50m				HVP value average (set of 3) Mexe Cone Test at 0.50mbgl = CBR 4-7% Intact Wall on eastern elevation of pit. Unstable on north, south and west elevations.					
← Length (m) → 2.60m ↑ Width (m) ↓ 1.30m Orientation: 90° ←									
Inclination: 90°				Water Strikes					
				Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
							0		Dry
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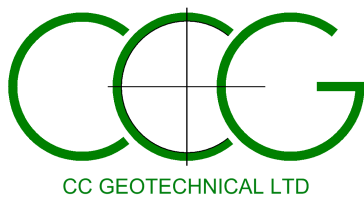
Unit 1
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L33 7BA
e: enquiries@ccgeotechnical.co.uk
w: www.ccgeotechnical.co.uk

Site	City Labs, Manchester
Job Number:	CCG-C-19-11195
Trial Pit Number:	TP10



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w: www.ccgeotechnical.co.uk

Site	City Labs, Manchester
Job Number:	CCG-C-19-11195
Trial Pit Number:	TP10



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Site	City Labs, Manchester
Job Number:	CCG-C-19-11195
Trial Pit Number:	TP10



APPENDIX D

SOAKAWAY TEST WORKSHEETS



SOIL INFILTRATION DATA

allowance for infiltration through soakaway base: 100%

available on-site infiltration test results: ☒ Yes ☐ No

use soakage trial pit table below

internal surface area of trial pit ' a_{p50} ' [m^2] = 7.00storage volume between 75-25% ' V_p ' [m^3] = 1.65time for water to fall from 75-25% ' t_p ' [min] = 1440.00soil infiltration rate ' f ' [m/s] =

SOAKAGE TRIAL PIT DATA

soakage trial pit width ' W_t ' [m] = 1.00soakage trial pit length ' L_t ' [m] = 2.20total depth from ground level ' D_{tb} ' [m] = 2.00depth to pipe invert level ' D_{tp} ' [m] = 0.50soakage trial pit effective depth ' D_{teff} ' [m] = 1.50

free volume in infill aggregate [%] = 100

NOTE: faces of excavation assumed to be vertical

Soil Description

0.00 - 0.10mbgl - TARMAC

0.10 - 0.7mbgl - Black very gravelly SAND of medium cobble content. Gravel is fine to coarse sub-angular to angular ash and brick (MADE GROUND).

0.7 - 1.70mbgl - Brown slightly sandy slightly gravelly silty CLAY. Gravel is fine to coarse sub-angular brick (MADE GROUND).

1.40 - 2.00mbgl - Brown slightly sandy silty CLAY.

SA1 TEST ABORTED

SOAKAGE TRIAL PIT INFILTRATION TEST RESULTS

water level measurement N ^o :		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18*	19*
Soakage Trial 1	time [min] =																			
	depth to water [m] =																			
Soakage Trial 2	time [min] =																			
	depth to water [m] =																			
Soakage Trial 3	time [min] =																			
	depth to water [m] =																			



SOIL INFILTRATION DATA

allowance for infiltration through soakaway base: 100%

available on-site infiltration test results: ☒ Yes ☐ No

use soakage trial pit table below

internal surface area of trial pit ' a_{p50} ' [m^2] = 6.82storage volume between 75-25% ' V_p ' [m^3] = 1.57time for water to fall from 75-25% ' t_p ' [min] = #DIV/0!soil infiltration rate ' f ' [m/s] = #DIV/0!

SOAKAGE TRIAL PIT DATA

soakage trial pit width ' W_t ' [m] = 0.95soakage trial pit length ' L_t ' [m] = 2.20total depth from ground level ' D_{tb} ' [m] = 2.00depth to pipe invert level ' D_{tp} ' [m] = 0.50soakage trial pit effective depth ' D_{teff} ' [m] = 1.50

free volume in infill aggregate [%] = 100

NOTE: faces of excavation assumed to be vertical

Soil Description

0.00 - 0.10mbgl - TARMAC

0.10 - 1.00mbgl - Black very gravelly SAND of medium cobble content. Gravel is fine to coarse sub-angular to angular ash and brick (MADE GROUND).

1.00 - 1.40mbgl - Brown slightly sandy slightly gravelly silty CLAY. Gravel is fine to coarse sub-angular brick (MADE GROUND).

1.40 - 2.00mbgl - Brown slightly sandy silty CLAY.

SOAKAGE TRIAL PIT INFILTRATION TEST RESULTS

water level measurement N ^o :		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17		
Soakage Trial 1	time [min] =	0	1	2	3	4	5	10	20	30	40	50	60	90	120	150	180	210		
	depth to water [m] =	0.52	0.53	0.54	0.55	0.56	0.57	0.61	0.68	0.69	0.72	0.74	0.75	0.77	0.79	0.81	0.82	0.83		
Soakage Trial 2	time [min] =																			
	depth to water [m] =																			
Soakage Trial 3	time [min] =																			
	depth to water [m] =																			



SOIL INFILTRATION DATA

allowance for infiltration through soakaway base: **100%**
 available on-site infiltration test results: ☒ Yes ☐ No
 use soakage trial pit table below
 internal surface area of trial pit ' a_{p50} ' [m^2] = 7.19
 storage volume between 75-25% ' V_p ' [m^3] = 1.73
 time for water to fall from 75-25% ' t_p ' [min] = 65.00
 soil infiltration rate ' f ' [m/s] = 6.18E-05

SOAKAGE TRIAL PIT DATA

soakage trial pit width ' W_t ' [m] = **1.05**
 soakage trial pit length ' L_t ' [m] = **2.20**
 total depth from ground level ' D_{tb} ' [m] = **2.00**
 depth to pipe invert level ' D_{tp} ' [m] = **0.50**
 soakage trial pit effective depth ' D_{teff} ' [m] = 1.50
 free volume in infill aggregate [%] = **100**

NOTE: faces of excavation assumed to be vertical

Soil Description

0.00 - 0.10mbgl - TARMAC

0.10 - 1.10mbgl - Black very gravelly SAND of medium cobble content. Gravel is fine to coarse sub-angular to angular ash and brick (MADE GROUND).

1.10 - 1.60mbgl - Brown slightly sandy slightly gravelly silty CLAY. Gravel is fine to coarse sub-angular brick (MADE GROUND).

1.60 - 2.00mbgl - Brown slightly sandy silty CLAY.

SOAKAGE TRIAL PIT INFILTRATION TEST RESULTS

water level measurement N ^o :		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17		
Soakage Trial 1	time [min] =	0	1	2	3	4	5	10	20	30	40	50	60	90	120	150	180	210		
	depth to water [m] =	0.51	0.53	0.54	0.55	0.56	0.57	0.61	0.66	0.69	0.73	0.75	0.77	0.81	0.85	0.88	0.89	0.91		
Soakage Trial 2	time [min] =																			
	depth to water [m] =																			
Soakage Trial 3	time [min] =																			
	depth to water [m] =																			



APPENDIX E

SOIL & ROCK ENGINEERING TEST RESULTS

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Deltic Place
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Liverpool
L33 7BU

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Fax: (0151) 548 7892
Email: enquiries@ccgeotechnical.com
www.ccgeotechnical.com



LABORATORY REPORT

CONTRACT NUMBER: CCG-C-19-11195

CONTRACT TITLE: CITY LABS, MANCHESTER

CLIENT: BRUNTWOOD SCIENCE LIMITED
Union, 2-10 Albert Square, Manchester, M2 6LW

DATE RECEIVED: 24/10/19
DATE COMMENCED: 29/10/19
DATE COMPLETED: 13/11/19
REPORT DATE: 13/11/19

Test Description	Qty
Determination of Moisture Content BS 1377-2:1990 (a)	22
Particle Size Distribution BS 1377-2:1990 (a)	22
Determination of Liquid & Plastic Limits BS1377-2:1990 (a)	14
Sedimentation by Pipette BS 1377-2:1990 (#)	17
One Dimensional Consolidation Properties BS 1377-5:1990 (a)	9
Unconsolidated Undrained Triaxial Compression Test BS 1377-7:1990 (a)	6
Laboratory Determination of California Bearing Ratio BS 1377-4:1990 (#)	2
Point Load test ISRM 1985: Suggested Method (a)	37

Notes: Observations and interpretations are not accredited by UKAS
denotes non-accredited test
a denotes UKAS accredited test
s denotes test undertaken by approved subcontractor

This report is issued in accordance with the requirements of the United Kingdom Accreditation Services and EN ISO/IEC 17025:2005. The results reported herein relate only to the material supplied to the laboratory. This report shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved Signatories: Chris Bolan (Managing Director) – Daniel Kerfoot (Laboratory Manager)

SUMMARY OF LABORATORY SOIL TEST RESULTS

BH / TP / WS Number	Sample Type	Depth From (m)	Depth To (m)	Moisture Content (%)	Bulk Density (Mg/m ³)	Dry Density (Mg/m ³)	Shear Strength (kN/m ²)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 0.425mm (%)	Soil Classification	UKAS accredited test (Y/N)	Description / Test Method Samples described in accordance with BS EN ISO 14688-2 2004
BH01	B	1.50	1.50	22	-	-	-	-	-	-	-	-	Y	Reddish brown very sandy silty slightly clayey GRAVEL. Gravel is fine to coarse angular to subangular brick, concrete, sandstone, glass. (MADE GROUND) (BS1377Pt2:3.2,9.2,9.4)
BH01	U	3.00	3.45	20	2.15	1.80	189	48	21	27	97	CI	Y	Brown slightly sandy slightly gravelly silty CLAY of very high undrained shear strength. Gravel is fine to medium subangular to subrounded sandstone. (BS1377Pt2:3.2,4.4,5,9.2,9.4,Pt7:8)
BH01	U	5.00	5.45	20	2.16	1.80	152	32	15	17	89	CL	Y	Brown sandy slightly gravelly silty CLAY of very high undrained shear strength. Gravel is fine to medium subangular sandstone. (BS1377Pt2:3.2,4.4,5,9.2,9.4,Pt7:8)
BH01	B	7.50	7.50	19	-	-	-	33	16	17	89	CL	Y	Brown sandy slightly gravelly silty CLAY. Gravel is fine to medium subangular sandstone. (BS1377Pt2:3.2,4.4,5,9.2,9.4)
BH01	U	9.50	9.95	10	2.23	2.09	192	23	13	10	91	CL	Y	Brown sandy slightly gravelly silty CLAY of very high undrained shear strength. Gravel is fine to medium subangular sandstone. (BS1377Pt2:3.2,4.4,5,9.2,9.4,Pt7:8)
BH01	B	10.50	10.50	18	-	-	-	-	-	-	-	-	Y	Brown sandy slightly gravelly silty CLAY. Gravel is fine to medium subangular sandstone. (BS1377Pt2:3.2)

SITE: CITY LABS, MANCHESTER (CCG-C-19-11195)
 CLIENT: BRUNTWOOD SCIENCE LTD

DATE: 08.11.19

Key:- BD = Bulk Disturbed; SD = Small Disturbed; U100 = Undisturbed 100mm; WS = Window Sample

CL = Low Plasticity; CI = Intermediate; CH = High; CV = Very high; CE = Extremely high; NP = Non-plastic

(* Denotes Hand Shear Vane test result)

Sample description not accredited by UKAS



11195 BH01 RES.xls



CC Geotechnical Ltd
Tel: 0151 545 2750
e: lab@ccgeotechnical.com

PARTICLE SIZE DISTRIBUTION

Job Ref

CCG-C-19-11195

Borehole/Pit No.

BH01

Site Name

CITY LABS, MANCHESTER

Sample No.

1

Specimen Description

Reddish brown very sandy silty slightly clayey GRAVEL

Depth, m

1.50

Specimen Reference

Specimen Depth

m

Sample Type

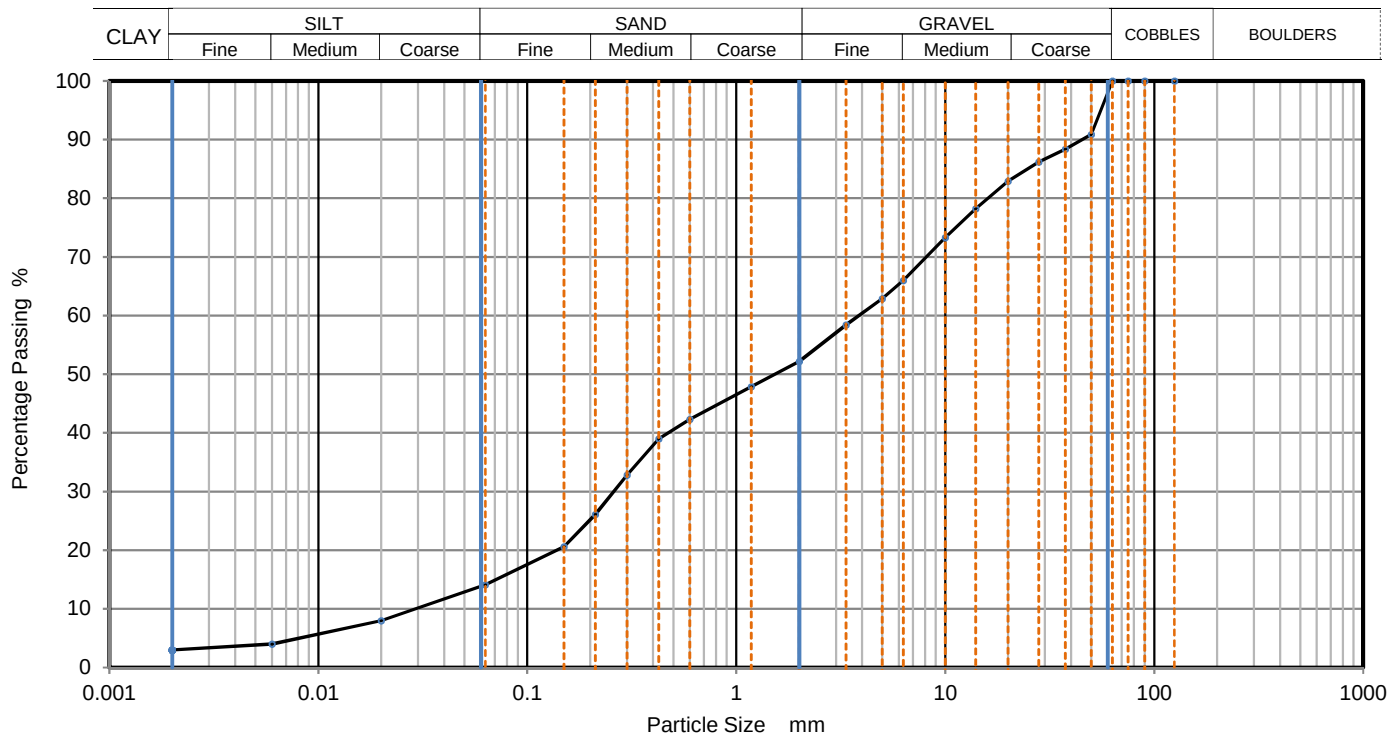
B

Test Method

BS1377:Part 2:1990 Clause 9.2 & 9.4

KeyLAB ID

CCGL201911070



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	8
90	100	0.0060	4
75	100	0.0020	3
63	100		
50	91		
37.5	88		
28	86		
20	83		
14	78		
10	73		
6.3	66		
5	63		
3.35	58		
2	52		
1.18	48		
0.6	42		
0.425	39		
0.3	33		
0.212	26		
0.15	21		
0.063	14		

Dry Mass of sample, g

Sample Proportions	% dry mass
Very coarse	0
Gravel	48
Sand	38
Silt	11
Clay	3

Grading Analysis	
D ₁₀₀	mm
D ₆₀	mm
D ₃₀	mm
D ₁₀	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	Fig
JE	DK	DK	07/11/2019 16:25	Sheet



CC Geotechnical Ltd
Tel: 0151 545 2750
e: lab@ccgeotechnical.com

PARTICLE SIZE DISTRIBUTION

Job Ref

CCG-C-19-11195

Borehole/Pit No.

BH01

Site Name

CITY LABS, MANCHESTER

Sample No.

1

Specimen Description

Brown slightly sandy slightly gravelly silty CLAY

Depth, m

3.00

Specimen Reference

Specimen Depth

m

Sample Type

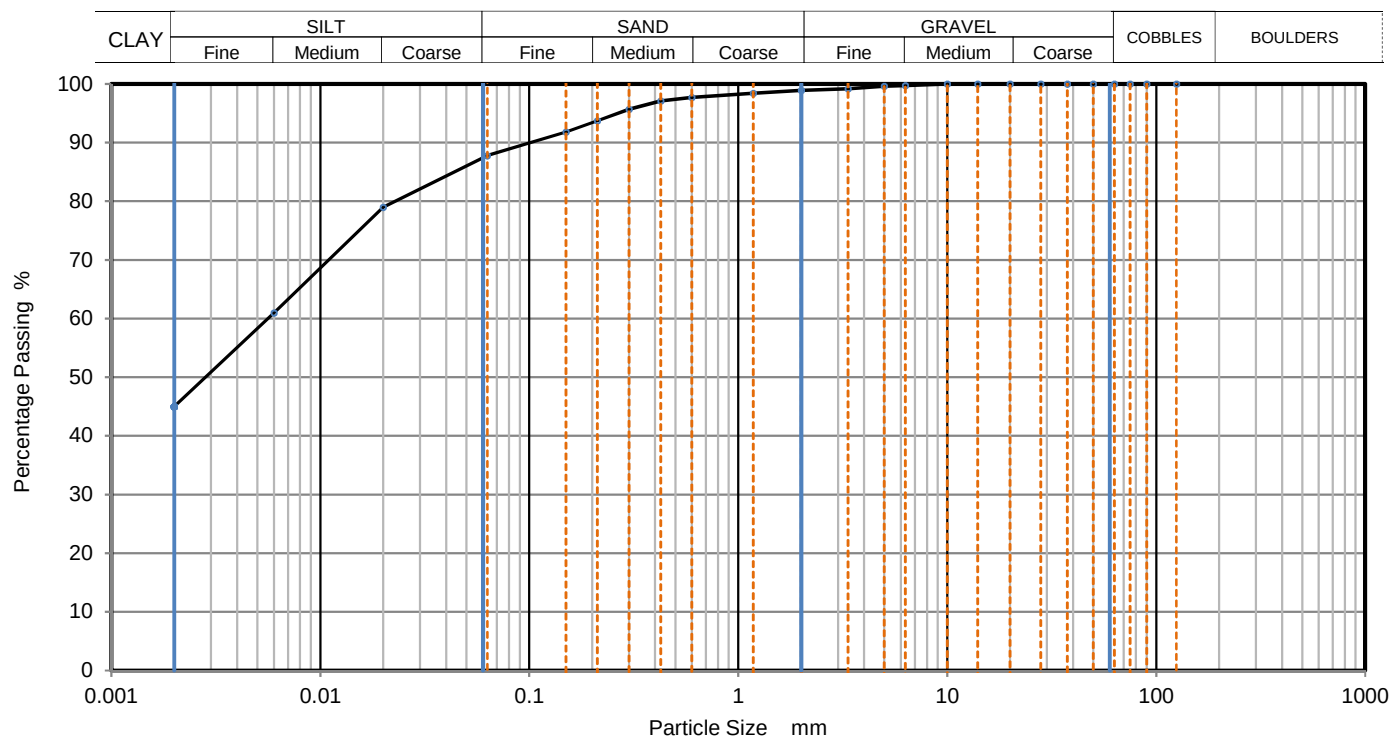
U

Test Method

BS1377:Part 2:1990 Clause 9.2 & 9.4

KeyLAB ID

CCGL201911060



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	79
90	100	0.0060	61
75	100	0.0020	45
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	99		
2	99		
1.18	98		
0.6	98		
0.425	97		
0.3	96		
0.212	94		
0.15	92		
0.063	88		

Dry Mass of sample, g

Sample Proportions	% dry mass
Very coarse	0
Gravel	1
Sand	11
Silt	43
Clay	45

Grading Analysis	
D ₁₀₀	mm
D ₆₀	mm
D ₃₀	mm
D ₁₀	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	Fig
JE	DK	DK	08/11/2019 16:21	Sheet



CC Geotechnical Ltd
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PARTICLE SIZE DISTRIBUTION

Job Ref

CCG-C-19-11195

Borehole/Pit No.

BH01

Site Name

CITY LABS, MANCHESTER

Sample No.

1

Specimen Description

Brown sandy slightly gravelly silty CLAY

Depth, m

5.00

Specimen Reference

Specimen Depth

m

Sample Type

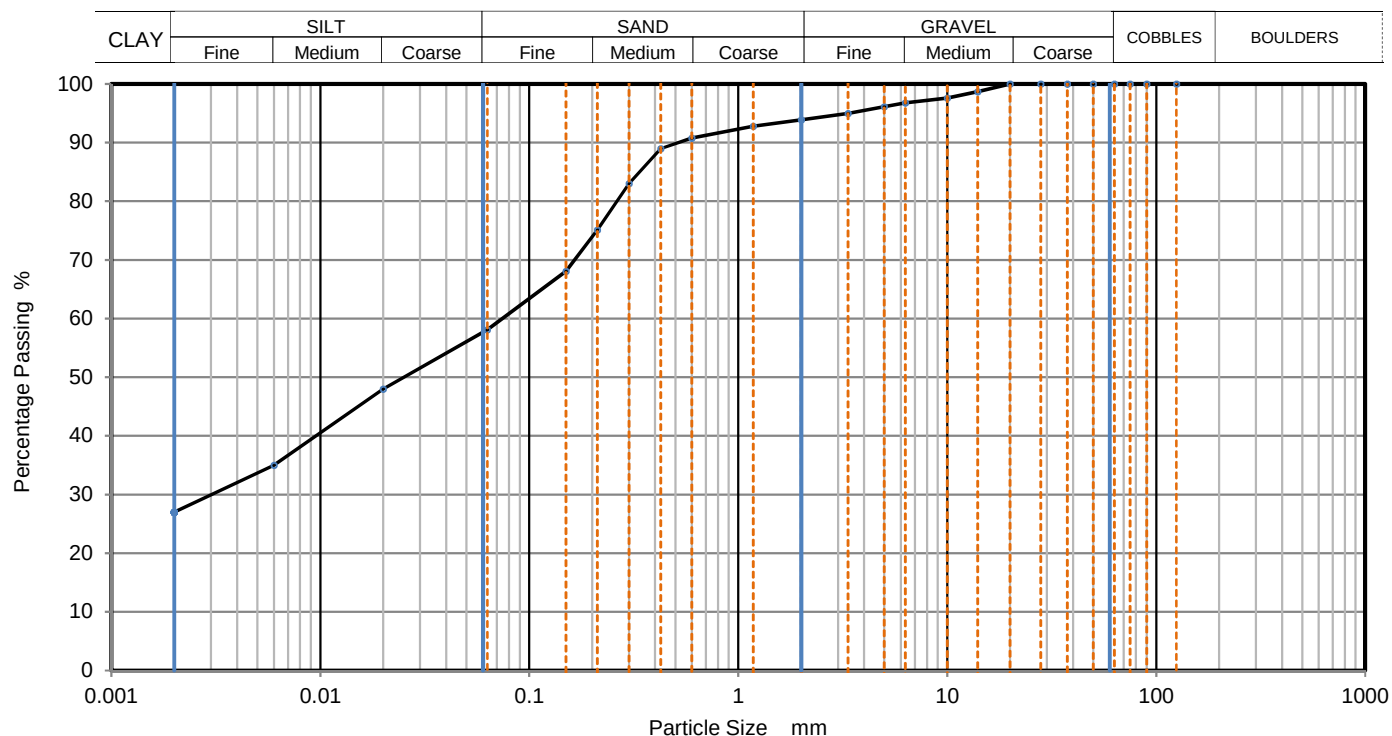
U

Test Method

BS1377:Part 2:1990 Clause 9.2 & 9.4

KeyLAB ID

CCGL201911071



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	48
90	100	0.0060	35
75	100	0.0020	27
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	99		
10	98		
6.3	97		
5	96		
3.35	95		
2	94		
1.18	93		
0.6	91		
0.425	89		
0.3	83		
0.212	75		
0.15	68		
0.063	58		

Dry Mass of sample, g

Sample Proportions	% dry mass
Very coarse	0
Gravel	6
Sand	36
Silt	31
Clay	27

Grading Analysis	
D ₁₀₀	mm
D ₆₀	mm
D ₃₀	mm
D ₁₀	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	Fig
JE	DK	DK	08/11/2019 14:50	Sheet



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PARTICLE SIZE DISTRIBUTION

Job Ref

CCG-C-19-11195

Borehole/Pit No.

BH01

Site Name

CITY LABS, MANCHESTER

Sample No.

1

Specimen
Description

Brown sandy slightly gravelly silty CLAY

Depth, m

7.50

Specimen
Reference

Specimen
Depth

m

Sample Type

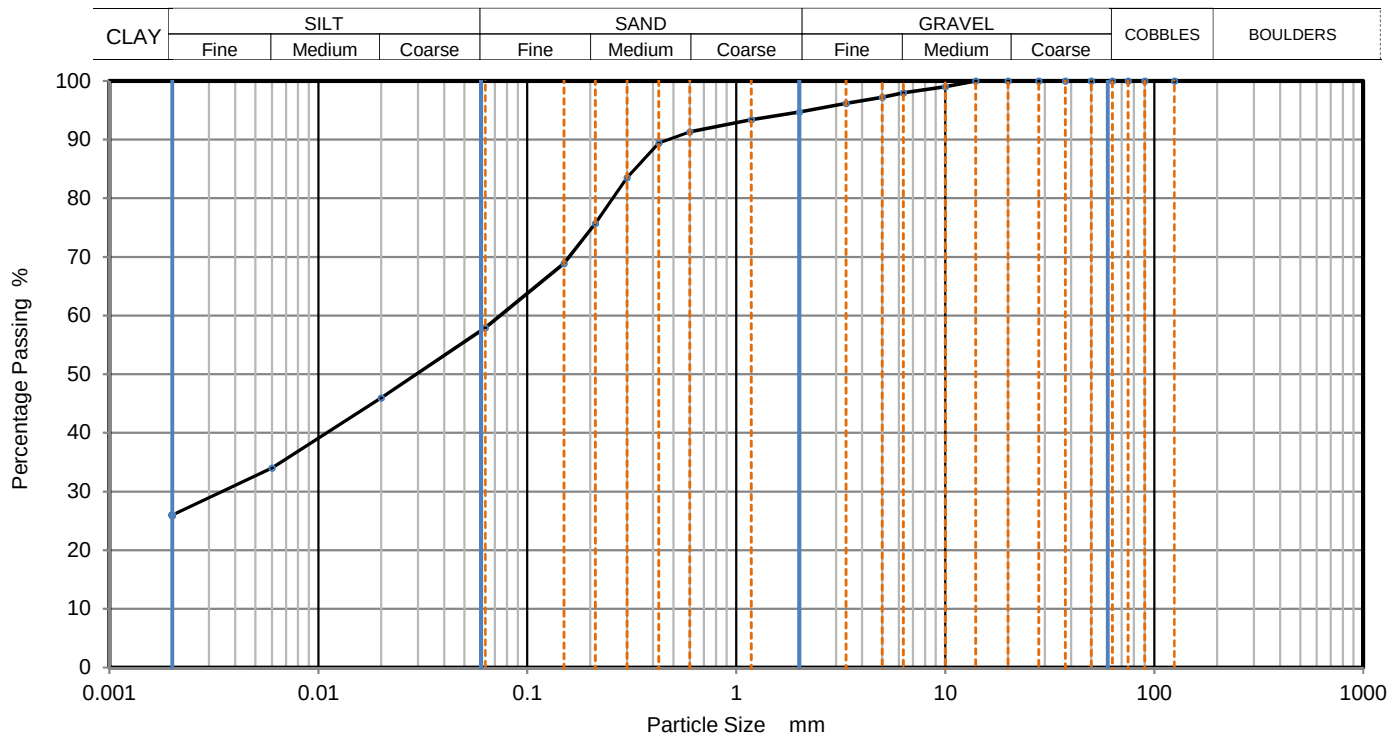
B

Test Method

BS1377:Part 2:1990 Clause 9.2 & 9.4

KeyLAB ID

CCGL201911072



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	46
90	100	0.0060	34
75	100	0.0020	26
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	99		
6.3	98		
5	97		
3.35	96		
2	95		
1.18	93		
0.6	91		
0.425	89		
0.3	84		
0.212	76		
0.15	69		
0.063	58		

Dry Mass of sample, g

Sample Proportions	% dry mass
Very coarse	0
Gravel	5
Sand	37
Silt	32
Clay	26

Grading Analysis	
D ₁₀₀	mm
D ₆₀	mm
D ₃₀	mm
D ₁₀	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	Fig
JE	DK	DK	08/11/2019 14:56	Sheet



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PARTICLE SIZE DISTRIBUTION

Job Ref

CCG-C-19-11195

Borehole/Pit No.

BH01

Site Name

CITY LABS, MANCHESTER

Sample No.

1

Specimen Description

Brown sandy slightly gravelly silty CLAY

Depth, m

9.50

Specimen Reference

Specimen Depth

m

Sample Type

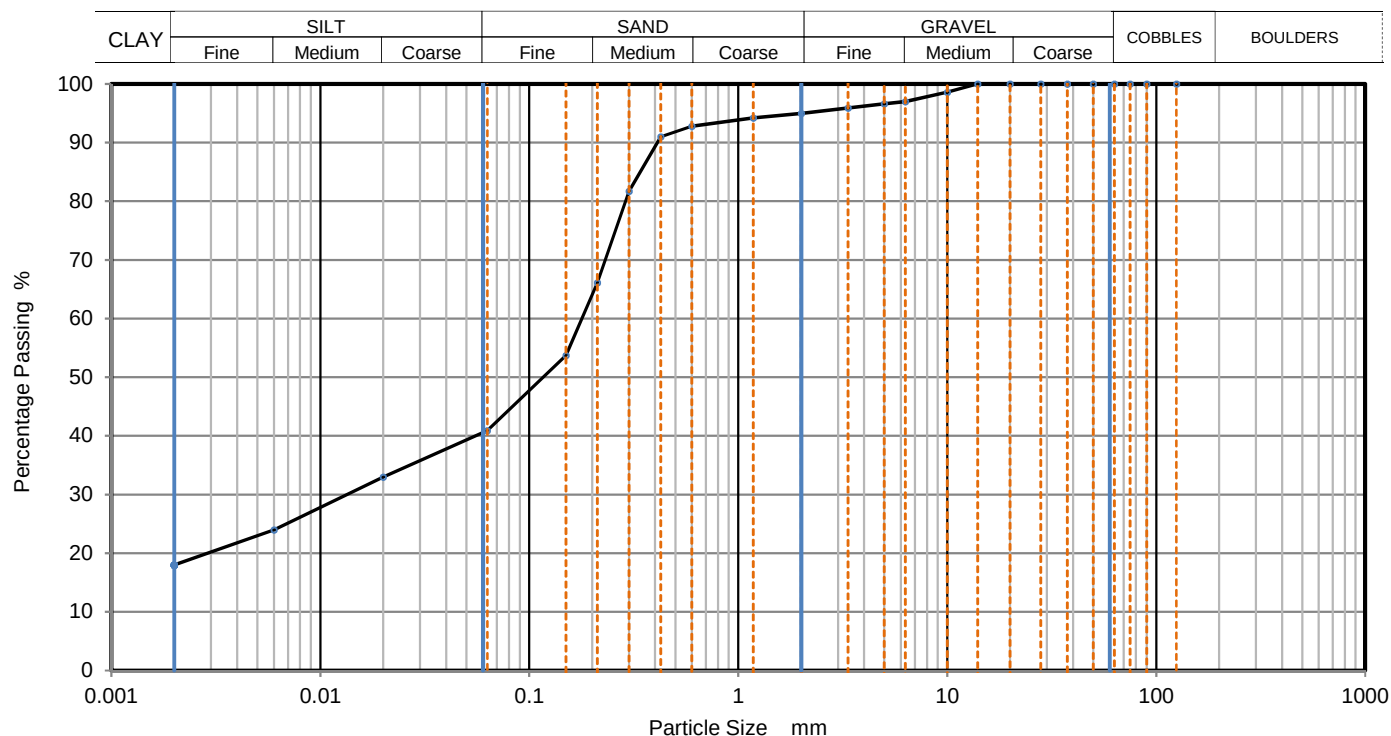
U

Test Method

BS1377:Part 2:1990 Clause 9.2 & 9.4

KeyLAB ID

CCGL201911073



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	33
90	100	0.0060	24
75	100	0.0020	18
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	99		
6.3	97		
5	97		
3.35	96		
2	95		
1.18	94		
0.6	93		
0.425	91		
0.3	82		
0.212	66		
0.15	54		
0.063	41		

Dry Mass of sample, g

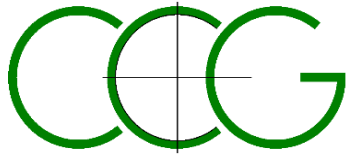
Sample Proportions	% dry mass
Very coarse	0
Gravel	5
Sand	54
Silt	23
Clay	18

Grading Analysis	
D ₁₀₀	mm
D ₆₀	mm
D ₃₀	mm
D ₁₀	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

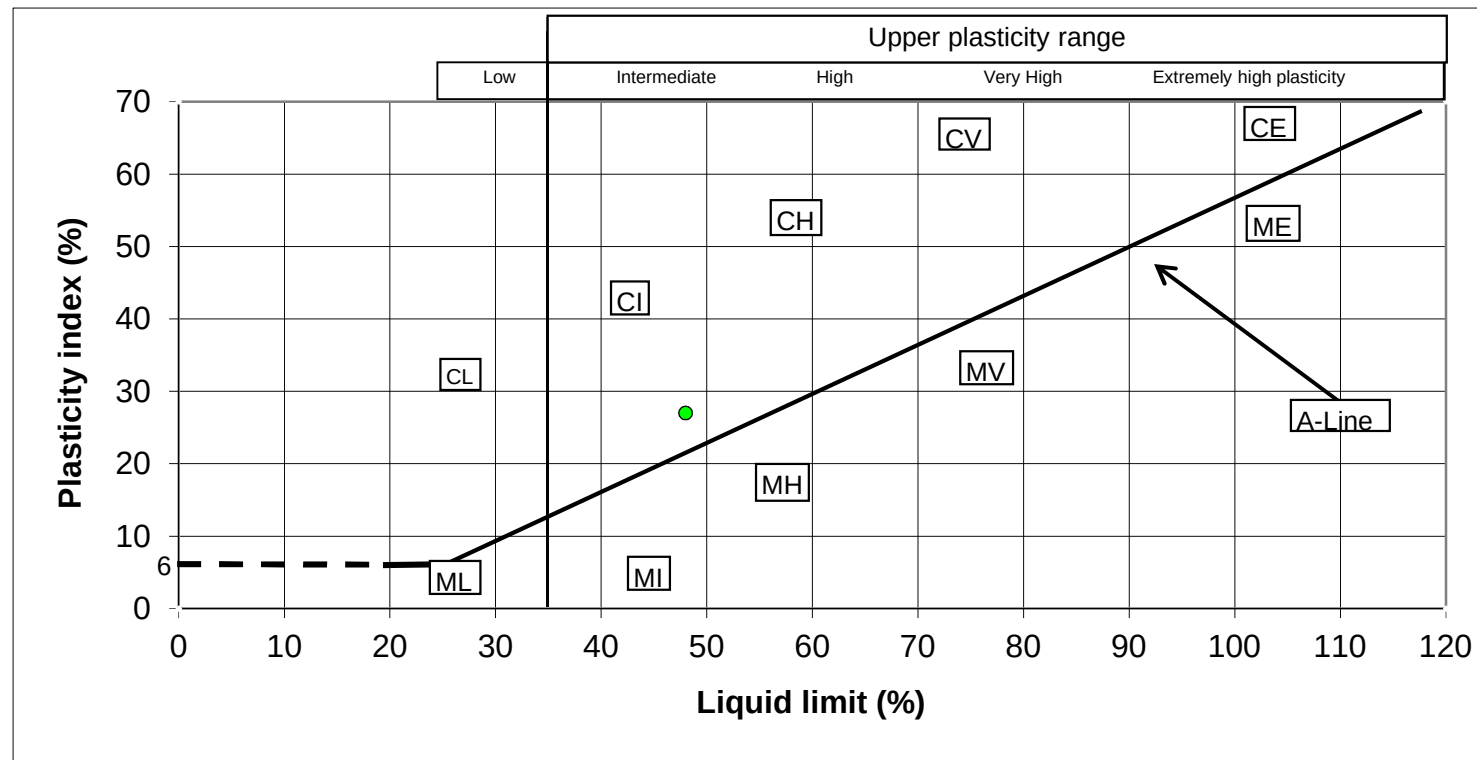
Operator	Checked	Approved	Sheet printed	Fig
JE	DK	DK	08/11/2019 14:59	Sheet



ATTERBERG TEST RESULT SHEET

BS 1377:Part 2:1990:cl 4.4,5

SILT (M-SOIL), M plots below A-Line , CLAY,C, plots above A-Line, M and C may be combined as FINE SOIL, F.



BH	Sample Depth	Liquid limit	Plasticity index
BH01	3.00	48.0	27.0

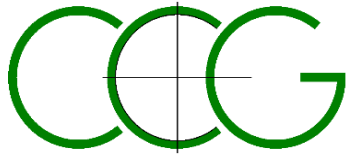


4514

APPROVED BY	DK
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CLIENT: BRUNTWOOD SCIENCE LTD

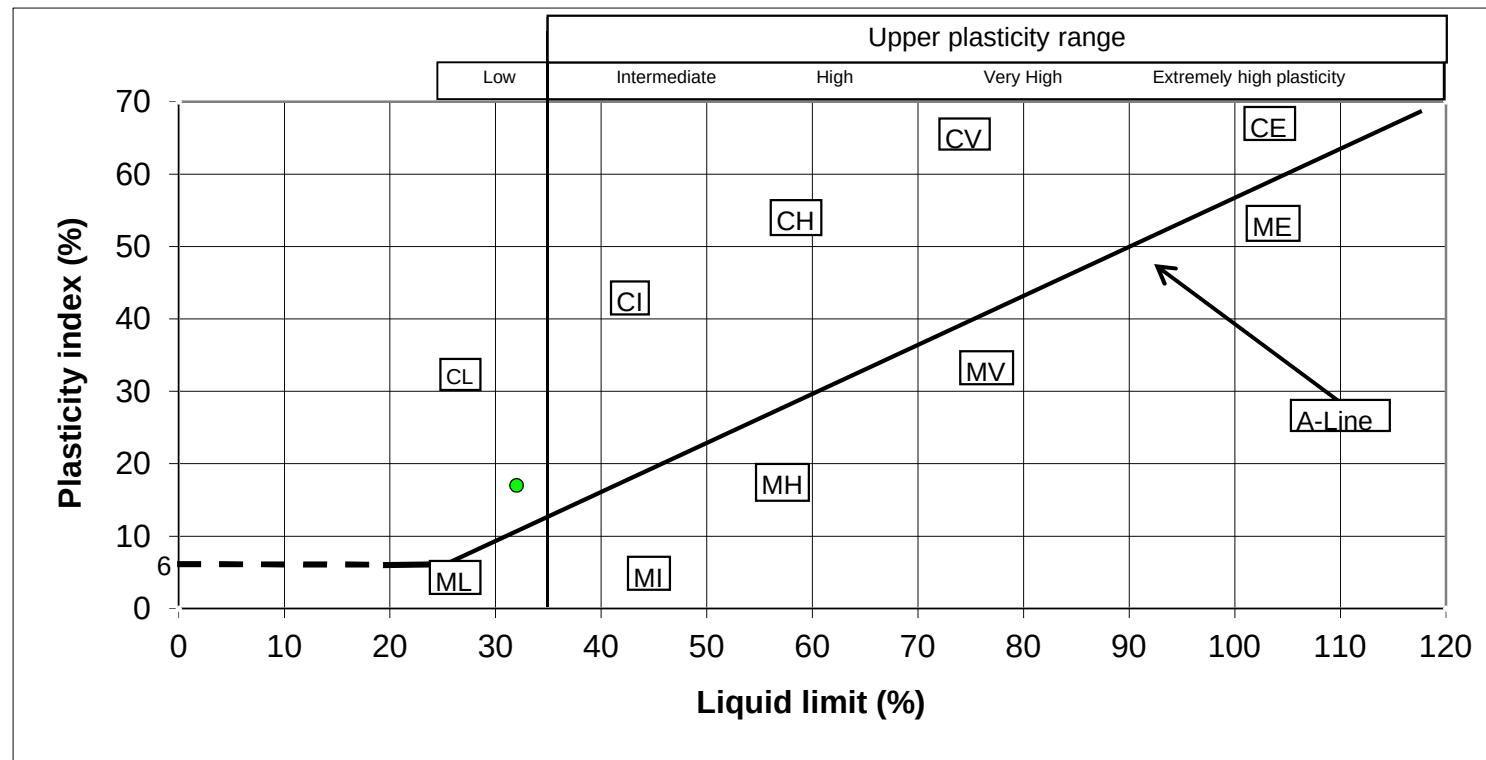
SITE: CITY LABS, MANCHESTER (CCG-C-19-11195)



ATTERBERG TEST RESULT SHEET

BS 1377:Part 2:1990:cl 4.4,5

SILT (M-SOIL), M plots below A-Line, CLAY, C, plots above A-Line, M and C may be combined as FINE SOIL, F.



BH	Sample Depth	Liquid limit	Plasticity index
BH01	5.00	32.0	17.0



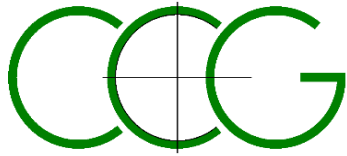
4514

APPROVED BY	DK
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CLIENT: BRUNTWOOD SCIENCE LTD

SITE: CITY LABS, MANCHESTER (CCG-C-19-11195)

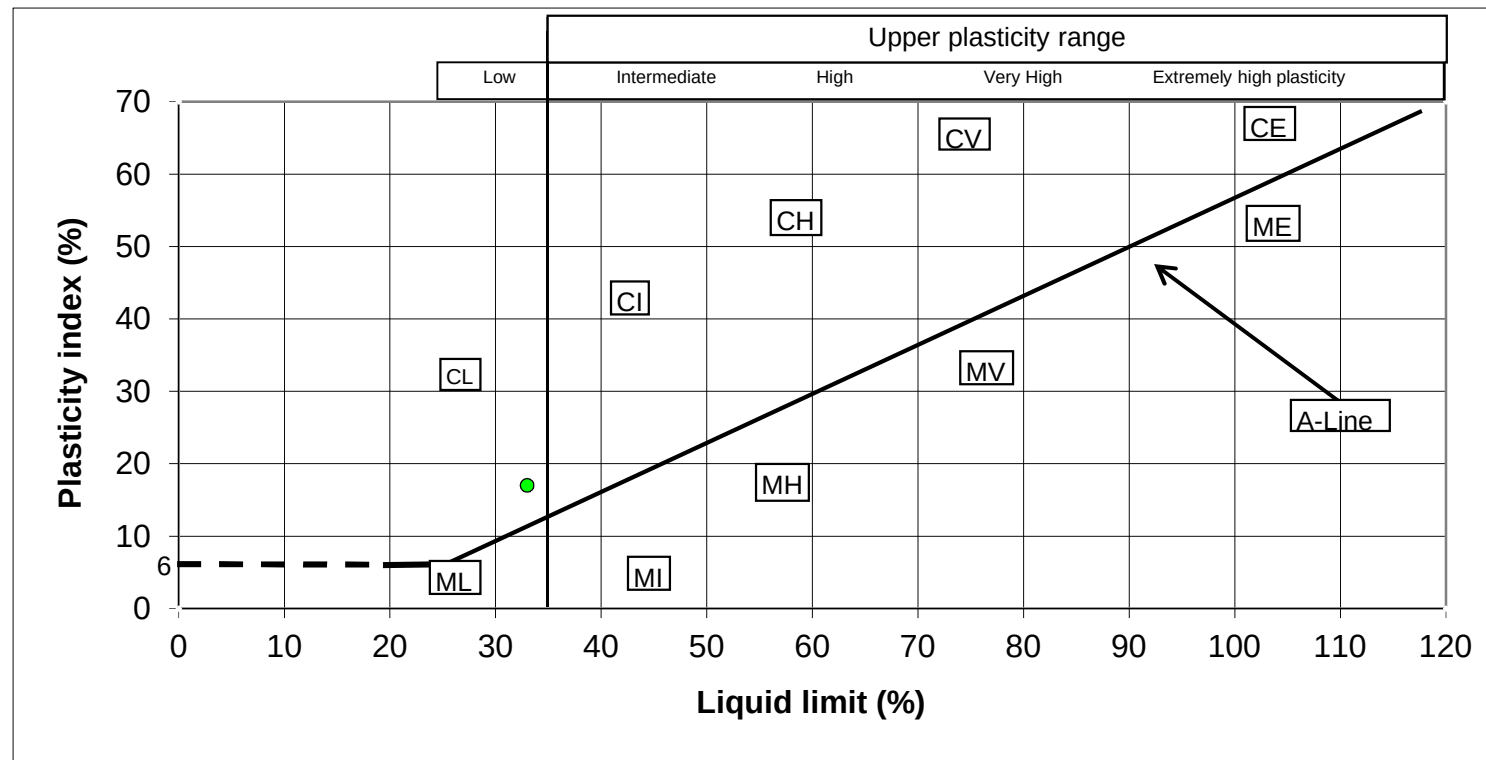
CCG-CMS-FO-204 Issue 2



ATTERBERG TEST RESULT SHEET

BS 1377:Part 2:1990:cl 4.4,5

SILT (M-SOIL), M plots below A-Line , CLAY,C, plots above A-Line, M and C may be combined as FINE SOIL, F.



BH	Sample Depth	Liquid limit	Plasticity index
BH01	7.50	33.0	17.0



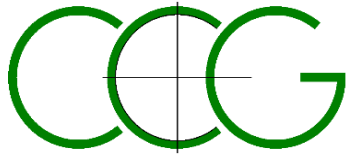
4514

APPROVED BY	DK
-------------	----

CLIENT: BRUNTWOOD SCIENCE LTD

SITE: CITY LABS, MANCHESTER (CCG-C-19-11195)

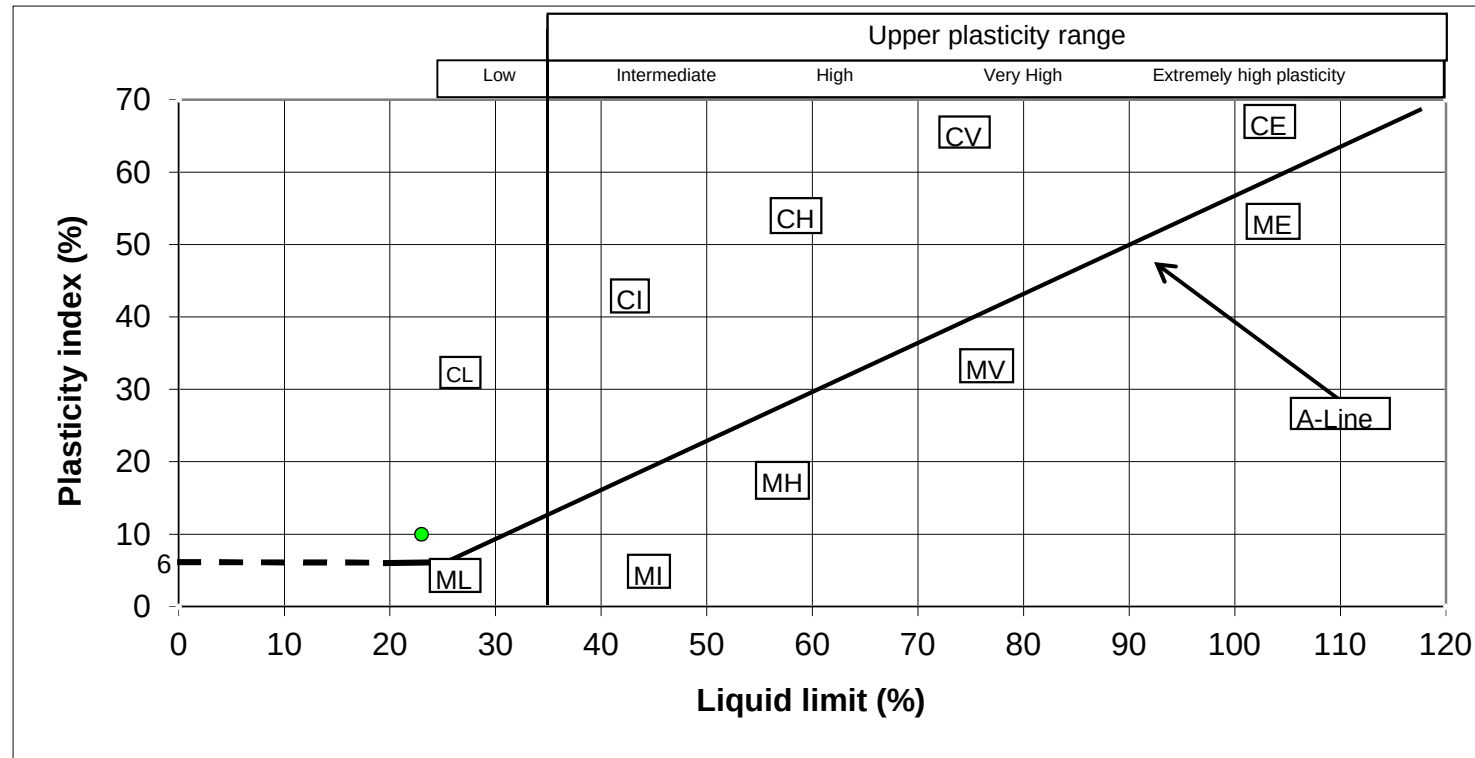
CCG-CMS-FO-204 Issue 2



ATTERBERG TEST RESULT SHEET

BS 1377:Part 2:1990:cl 4.4,5

SILT (M-SOIL), M plots below A-Line , CLAY,C, plots above A-Line, M and C may be combined as FINE SOIL, F.



BH	Sample Depth	Liquid limit	Plasticity index
BH01	9.50	23.0	10.0



4514

APPROVED BY	DK
-------------	----

CLIENT: BRUNTWOOD SCIENCE LTD	SITE: CITY LABS, MANCHESTER (CCG-C-19-11195)
-------------------------------	--



CC Geotechnical Ltd
Tel: 0151 545 2750
e: lab@ccgeotechnical.com

Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen

Job Ref CCG-C-19-11195

Borehole/Pit No. BH01

Site Name CITY LABS, MANCHESTER

Sample No. 1

Soil Description Brown slightly sandy slightly gravelly silty CLAY

Depth 3.00

Specimen Reference Specimen Depth 3.00 m

Sample Type U

Specimen Description

Date of test

Test Method BS 1377:1990:Part 7

31.10.19



Test Number

1

Length

203.4 mm

Diameter

104.0 mm

Bulk Density

2.15 Mg/m³

Moisture Content

19.6 %

Dry Density

1.80 Mg/m³

Rate of Strain

2.0 %/min

Cell Pressure

60 kPa

At failure

Axial Strain

11.8 %

Deviator Stress, $(\sigma_1 - \sigma_3)_f$

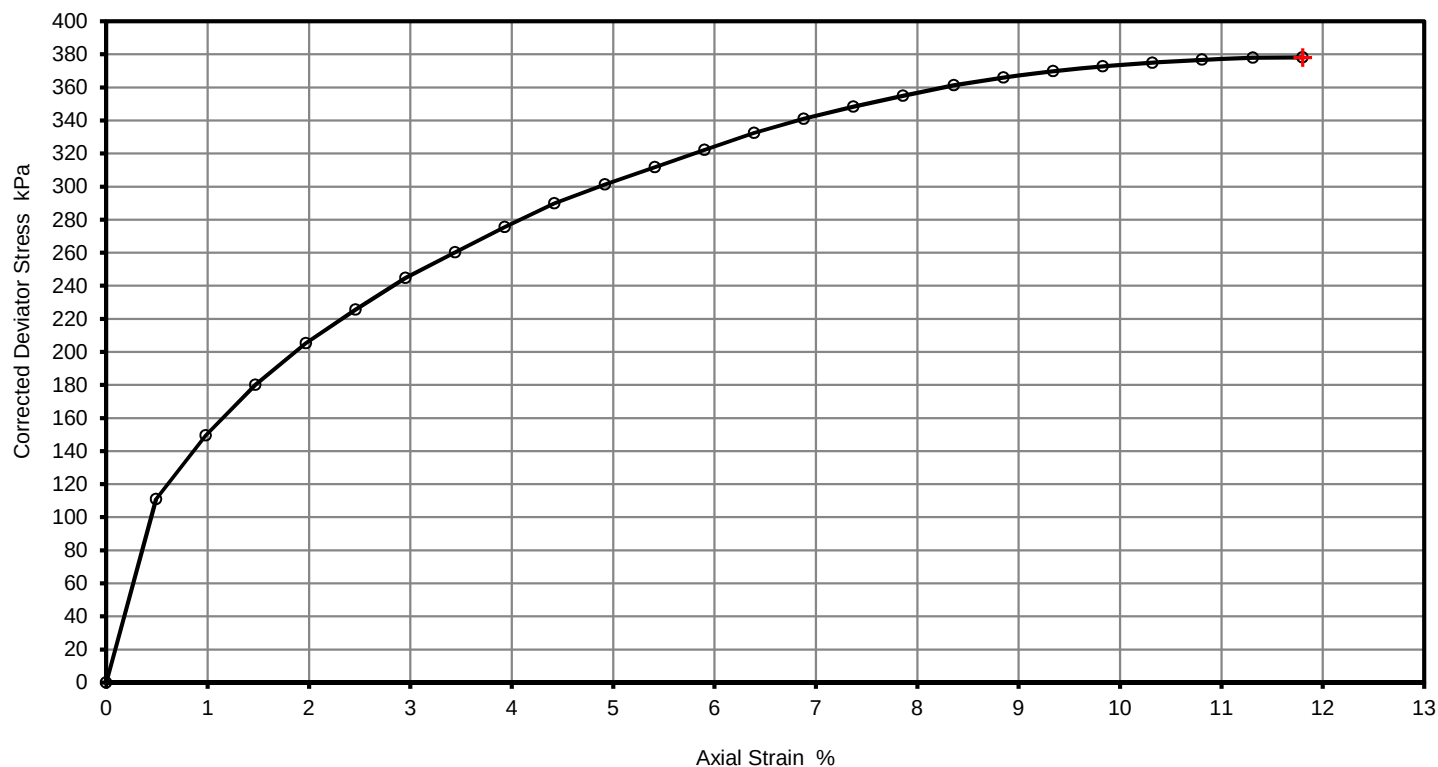
378 kPa

Undrained Shear Strength, c_u

189 kPa $\frac{1}{2}(\sigma_1 - \sigma_3)_f$

Mode of Failure

Deviator Stress v Axial Strain



Remarks

Approved

Printed

DK

08/11/2019 15:29

Fig. No.

1

Sheet

1



CC Geotechnical Ltd
Tel: 0151 545 2750
e: lab@ccgeotechnical.com

Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen

Job Ref CCG-C-19-11195

Borehole/Pit No. BH01

Site Name CITY LABS, MANCHESTER

Sample No. 1

Soil Description Brown sandy slightly gravelly silty CLAY

Depth 5.00

Specimen Reference Specimen Depth 5.00 m

Sample Type U

Specimen Description

Date of test

Test Method BS 1377:1990:Part 7

01.11.19



Test Number

1

Length

204.0 mm

Diameter

102.4 mm

Bulk Density

2.16 Mg/m³

Moisture Content

20.3 %

Dry Density

1.80 Mg/m³

Rate of Strain

2.0 %/min

Cell Pressure

100 kPa

At failure

Axial Strain

19.6 %

Deviator Stress, $(\sigma_1 - \sigma_3)_f$

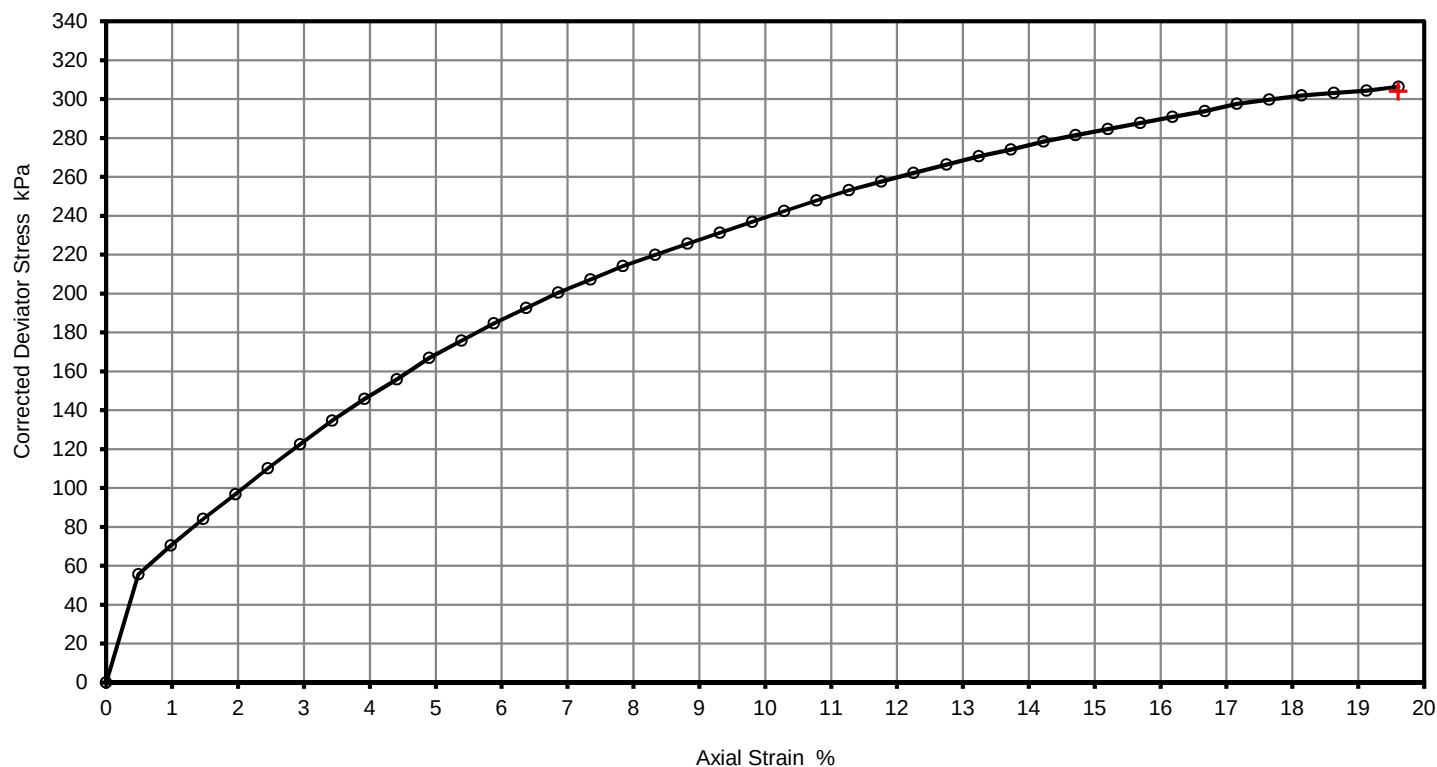
304 kPa

Undrained Shear Strength, c_u

152 kPa $\frac{1}{2}(\sigma_1 - \sigma_3)_f$

Mode of Failure

Deviator Stress v Axial Strain



Remarks

Approved

Printed

DK

08/11/2019 16:02

Fig. No.

1

Sheet

1



CC Geotechnical Ltd
Tel: 0151 545 2750
e: lab@ccgeotechnical.com

Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen

Job Ref

CCG-C-19-11195

Borehole/Pit No.

BH01

Site Name

CITY LABS, MANCHESTER

Sample No.

1

Soil Description

Brown sandy slightly gravelly silty CLAY

Depth

9.50

Specimen Reference

Specimen
Depth

9.50

m

Sample Type

U

Specimen Description

Date of test

01.11.19

Test Method

BS 1377:1990:Part 7



Test Number

1

Length

202.9

mm

Diameter

103.5

mm

Bulk Density

2.23

Mg/m³

Moisture Content

10.1

%

Dry Density

2.09

Mg/m³

Rate of Strain

2.0

%/min

Cell Pressure

190

kPa

At failure

Axial Strain

18.2

%

Deviator Stress, $(\sigma_1 - \sigma_3)_f$

383

kPa

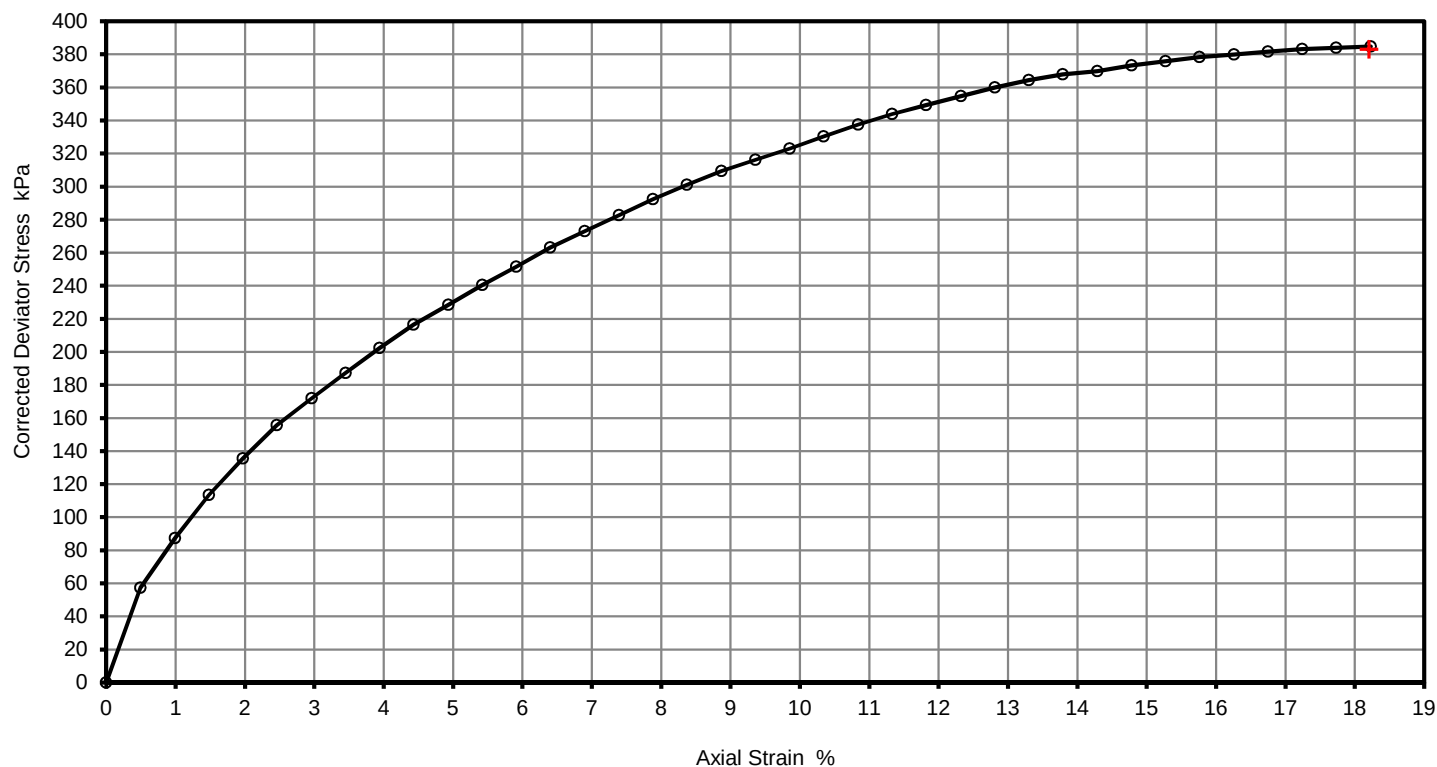
Undrained Shear Strength, c_u

192

kPa $\frac{1}{2}(\sigma_1 - \sigma_3)_f$

Mode of Failure

Deviator Stress v Axial Strain



Remarks

Approved

Printed

DK

08/11/2019 16:15

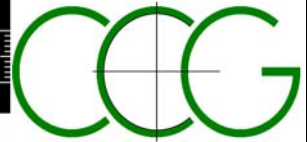
Fig. No.

1

Sheet

1

One Dimensional Consolidation Properties (Oedometer)

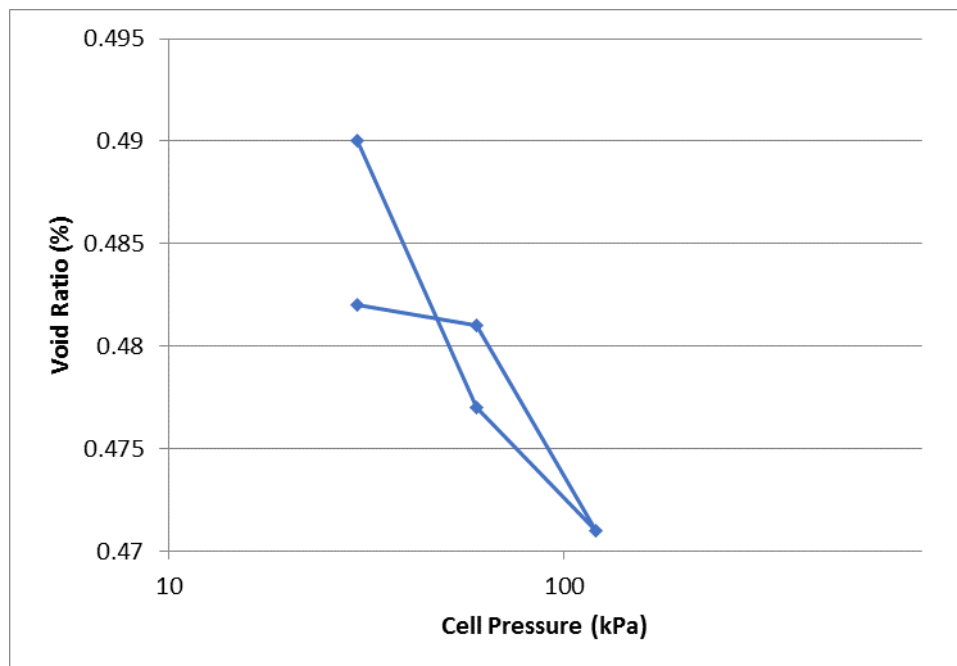


Client	BRUNTWOOD SCIENCE LTD	Lab Ref	
Project	CITY LABS, MANCHESTER	Job	CCG C 19 11195
Borehole	BH01	Sample	1

Test Details			
Standard	BS 1377: Part 5: 1990: Clause 3	Particle Density	2.65 Mg/m ³
Sample Type	Undisturbed sample - open drive	Lab Temperature	20.0 deg.C
Sample Depth	3.00 m		
Sample Description	Brown slightly sandy slightly gravelly silty CLAY		
Variations from Procedure	None		

Specimen Details			
Specimen Reference	A	Description	
Depth within Sample	0.00 mm	Orientation within Sample	
Specimen Mass	188.69 g	Condition	Natural Moisture
Specimen Height	20.01 mm	Preparation	
Comments			

Test Apparatus			
Ring Number	1	Ring Diameter	74.95 mm
Ring Height	20.01 mm	Ring Weight	129.34 g
Lever Ratio	9.00: 1		



Height of Solid Particles	13.46 mm	Swelling Pressure	
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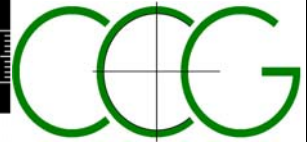
Initial Moisture Content*	19.9 %	Final Moisture Content	21.7 %
Initial Bulk Density	2.14 Mg/m ³	Final Bulk Density	2.17 Mg/m ³
Initial Dry Density	1.78 Mg/m ³	Final Dry Density	1.78 Mg/m ³
Initial Void Ratio	0.4870	Final Void Ratio	0.4897
Initial Degree of Saturation	108.46 %	Final Degree of Saturation	117.63 %

[illegible]

Method of Time Fitting Used	Log time
------------------------------------	----------

Tested by and Date:	DK 11.11.19
Checked by and Date:	DK 11.11.19
Approved by and Date:	CB 11.11.19

One Dimensional Consolidation Properties (Oedometer)

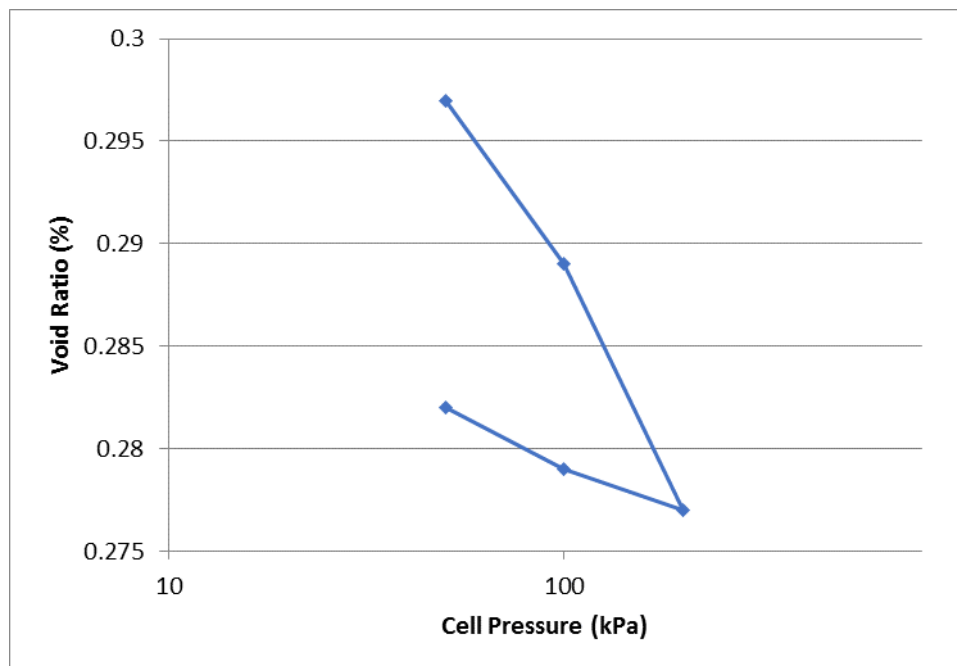


Client	BRUNTWOOD SCIENCE LTD	Lab Ref	
Project	CITY LABS, MANCHESTER	Job	CCG C 19 11195
Borehole	BH01	Sample	1

Test Details			
Standard	BS 1377: Part 5: 1990: Clause 3	Particle Density	2.65 Mg/m ³
Sample Type	Undisturbed sample - open drive	Lab Temperature	20.0 deg.C
Sample Depth	5.00 m		
Sample Description	Brown sandy slightly gravelly silty CLAY		
Variations from Procedure	None		

Specimen Details			
Specimen Reference	A	Description	
Depth within Sample	0.00 mm	Orientation within Sample	
Specimen Mass	189.54 g	Condition	Natural Moisture
Specimen Height	19.08 mm	Preparation	
Comments			

Test Apparatus			
Ring Number	8	Ring Diameter	74.92 mm
Ring Height	19.08 mm	Ring Weight	117.39 g
Lever Ratio	9.00: 1		



Height of Solid Particles	14.59 mm	Swelling Pressure	
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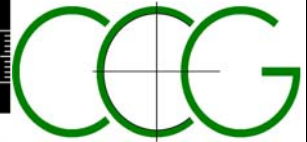
Initial Moisture Content*	11.2 %	Final Moisture Content	12.7 %
Initial Bulk Density	2.25 Mg/m ³	Final Bulk Density	2.33 Mg/m ³
Initial Dry Density	2.03 Mg/m ³	Final Dry Density	2.07 Mg/m ³
Initial Void Ratio	0.3080	Final Void Ratio	0.2822
Initial Degree of Saturation	96.58 %	Final Degree of Saturation	119.21 %

[illegible]

Method of Time Fitting Used	Log time
------------------------------------	----------

Tested by and Date:	DK 13.11.19
Checked by and Date:	DK 13.11.19
Approved by and Date:	CB 13.11.19

One Dimensional Consolidation Properties (Oedometer)

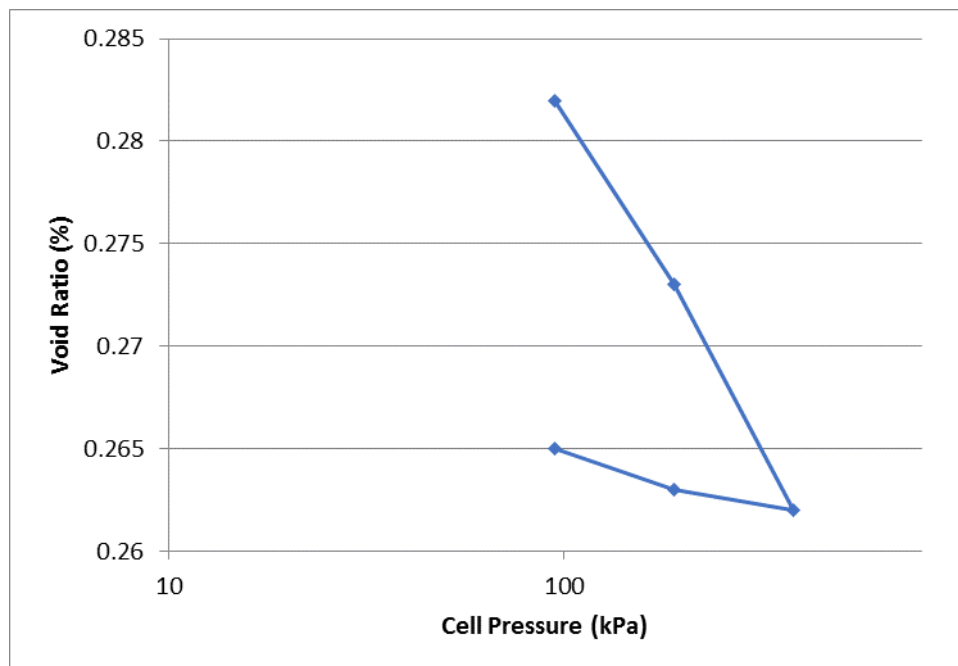


Client	BRUNTWOOD SCIENCE LTD	Lab Ref	
Project	CITY LABS, MANCHESTER	Job	CCG C 19 11195
Borehole	BH01	Sample	1

Test Details			
Standard	BS 1377: Part 5: 1990: Clause 3	Particle Density	2.65 Mg/m ³
Sample Type	Undisturbed sample - open drive	Lab Temperature	20.0 deg.C
Sample Depth	9.50 m		
Sample Description	Brown slightly sandy slightly gravelly silty CLAY		
Variations from Procedure	None		

Specimen Details			
Specimen Reference	A	Description	
Depth within Sample	0.00 mm	Orientation within Sample	
Specimen Mass	199.45 g	Condition	Natural Moisture
Specimen Height	20.35 mm	Preparation	
Comments			

Test Apparatus			
Ring Number	5	Ring Diameter	74.96 mm
Ring Height	19.08 mm	Ring Weight	128.83 g
Lever Ratio	9.00: 1		



Height of Solid Particles	15.64 mm	Swelling Pressure	
----------------------------------	----------	--------------------------	--



Initial Moisture Content*	9.0 %	Final Moisture Content	10.5 %
Initial Bulk Density	2.22 Mg/m ³	Final Bulk Density	2.31 Mg/m ³
Initial Dry Density	2.04 Mg/m ³	Final Dry Density	2.09 Mg/m ³
Initial Void Ratio	0.3012	Final Void Ratio	0.2652
Initial Degree of Saturation	97.67 %	Final Degree of Saturation	104.88 %

[illegible]

Method of Time Fitting Used	Log time
------------------------------------	----------

Tested by and Date:	DK 08.11.19
Checked by and Date:	DK 08.11.19
Approved by and Date:	CB 08.11.19

POINT LOAD TEST RESULTS

ISRM 1985: Suggested Method

PROJECT No.:- CCG-C-19-11195 SITE:- CITYLABS, MANCHESTER

DATE: 07.11.19

[illegible]

*NOTE- a = axial ; d = diametral ; i = irregular lump or block (see diagrams, right, for details)

p = perpendicular; l = parallel, u = unknown

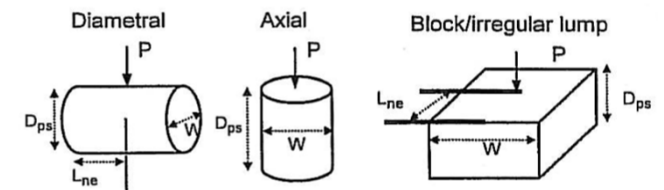
DIA. KEY- P = load ; Dps = platen separation ;

W = width of shortest dimension perpendicular to load ;

L_{ne} = length from platens to nearest free end

TESTED BY: JE

APPROVED BY: DK



SUMMARY OF LABORATORY SOIL TEST RESULTS

BH / TP / WS Number	Sample Type	Depth From (m)	Depth To (m)	Moisture Content (%)	Bulk Density (Mg/m ³)	Dry Density (Mg/m ³)	Shear Strength (kN/m ²)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 0.425mm (%)	Soil Classification	UKAS accredited test (Y/N)	Description / Test Method Samples described in accordance with BS EN ISO 14688-2 2004
BH02	B	1.00	1.00	27	-	-	-	-	-	-	-	-	Y	Dark brown slightly sandy slightly gravelly silty CLAY. Gravel is fine to medium subangular to subrounded sandstone, brick, cinders. (MADE GROUND) (BS1377Pt2:3.2,9.2,9.4)
BH02	U	2.00	2.45	25	2.02	1.62	82	50	21	29	89	CI /CH	Y	Brown slightly sandy slightly gravelly silty CLAY of high undrained shear strength. Gravel is fine to medium subangular sandstone. (BS1377Pt2:3.2,4.4,5,9.2,9.4,Pt7:8)
BH02	U	4.00	4.45	23	-	-	>110*	48	20	28	95	CI	Y	Brown slightly sandy slightly gravelly silty CLAY. Gravel is fine to medium subangular sandstone. (BS1377Pt2:3.2,4.4,5,9.2,9.4)
BH02	U	6.50	6.95	11	2.28	2.05	258	30	15	15	84	CL	Y	Brown sandy slightly gravelly silty CLAY of very high undrained shear strength. Gravel is fine to medium subrounded to subangular sandstone. (BS1377Pt2:3.2,4.4,5,Pt7:8)
BH02	B	9.00	9.00	15	-	-	-	-	-	-	-	-	Y	Brown sandy slightly gravelly silty CLAY. Gravel is fine to medium subrounded sandstone. (BS1377Pt2:3.2,9.2,9.4)
BH02	B	10.50	10.50	13	-	-	-	-	-	-	67	NP	Y	Brown silty clayey gravelly fine to coarse grained SAND. Gravel is fine to medium subrounded to subangular sandstone. (BS1377Pt2:3.2,4.4,5,9.2,9.4)

SITE: CITY LABS, MANCHESTER (CCG-C-19-11195)
 CLIENT: BRUNTWOOD SCIENCE LTD

DATE: 12.11.19

Key:- BD = Bulk Disturbed; SD = Small Disturbed; U100 = Undisturbed 100mm; WS = Window Sample

CL = Low Plasticity; CI = Intermediate; CH = High; CV = Very high; CE = Extremely high; NP = Non-plastic

(* Denotes Hand Shear Vane test result)

Sample description not accredited by UKAS



11195 BH02 RES.xls



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e: lab@ccgeotechnical.com

PARTICLE SIZE DISTRIBUTION

Job Ref

CCG-C-19-11195

Borehole/Pit No.

BH02

Site Name

CITY LABS, MANCHESTER

Sample No.

1

Specimen Description

Dark brown slightly sandy slightly gravelly silty CLAY

Depth, m

1.00

Specimen Reference

Specimen Depth

m

Sample Type

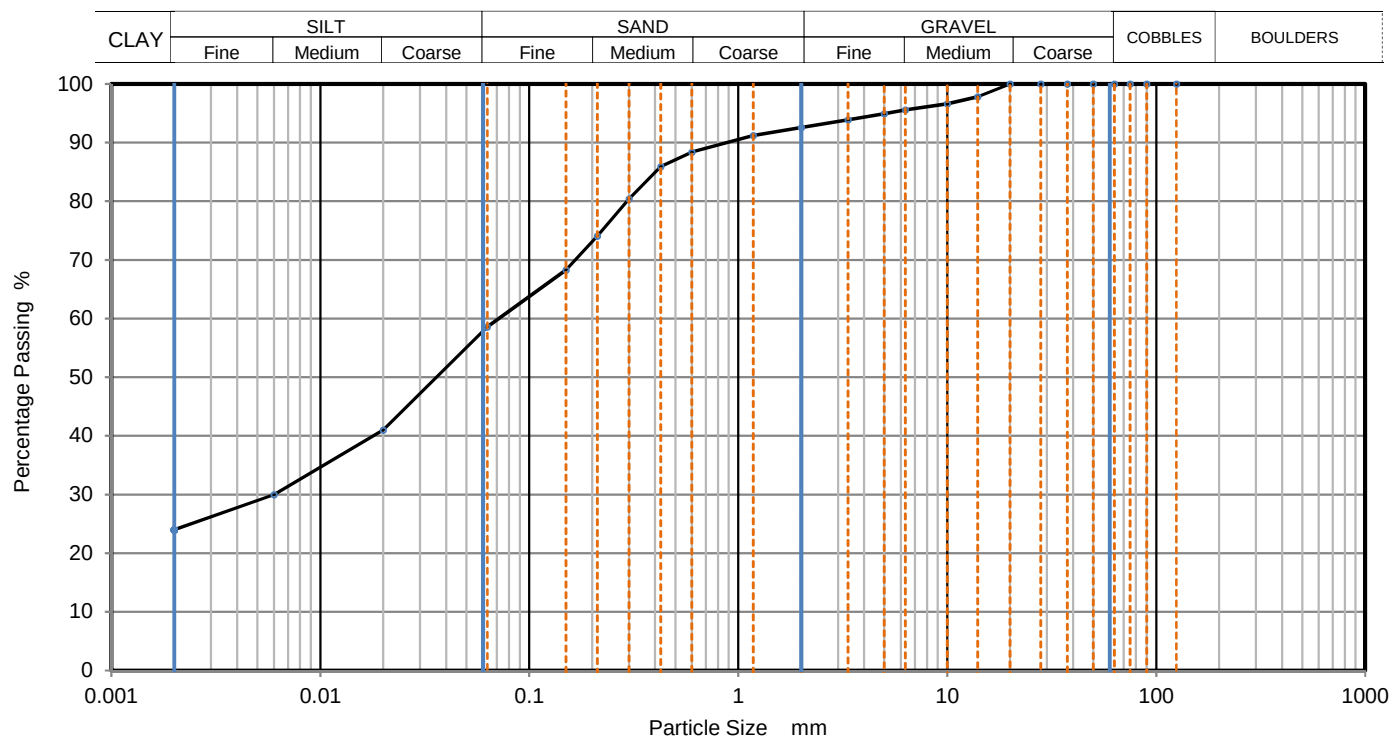
B

Test Method

BS1377:Part 2:1990 Clause 9.2 & 9.4

KeyLAB ID

CCGL201911090



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	41
90	100	0.0060	30
75	100	0.0020	24
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	98		
10	97		
6.3	96		
5	95		
3.35	94		
2	93		
1.18	91		
0.6	88		
0.425	86		
0.3	80		
0.212	74		
0.15	68		
0.063	59		

Dry Mass of sample, g

Sample Proportions	% dry mass
Very coarse	0
Gravel	7
Sand	34
Silt	35
Clay	24

Grading Analysis	
D ₁₀₀	mm
D ₆₀	mm
D ₃₀	mm
D ₁₀	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	Fig
JE	DK	DK	09/11/2019 11:08	Sheet



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PARTICLE SIZE DISTRIBUTION

Job Ref

CCG-C-19-11195

Borehole/Pit No.

BH02

Site Name

CITY LABS, MANCHESTER

Sample No.

1

Specimen
Description

Brown slightly sandy slightly gravelly silty CLAY

Depth, m

2.00

Specimen
Reference

Specimen
Depth

m

Sample Type

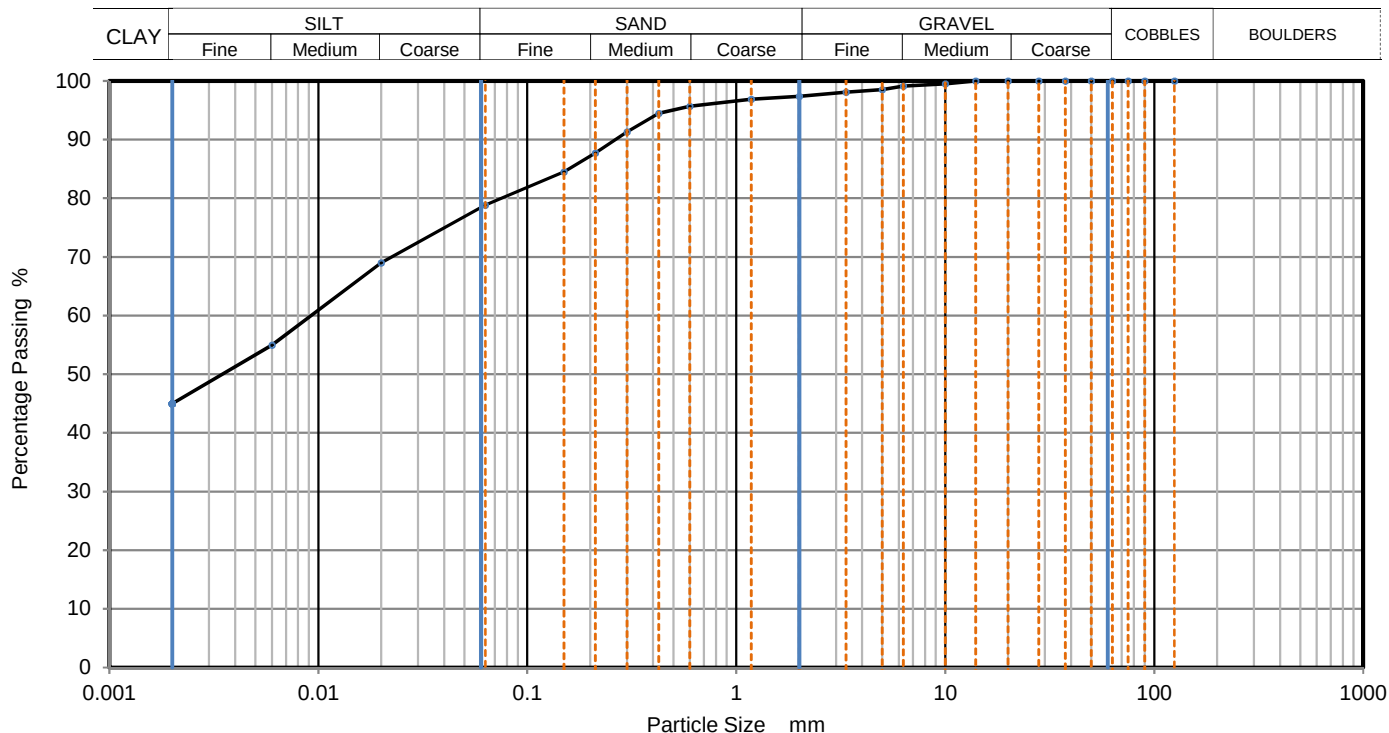
U

Test Method

BS1377:Part 2:1990 Clause 9.2 & 9.4

KeyLAB ID

CCGL201911074



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	69
90	100	0.0060	55
75	100	0.0020	45
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	99		
5	99		
3.35	98		
2	97		
1.18	97		
0.6	96		
0.425	95		
0.3	91		
0.212	88		
0.15	85		
0.063	79		

Dry Mass of sample, g

Sample Proportions	% dry mass
Very coarse	0
Gravel	3
Sand	18
Silt	34
Clay	45

Grading Analysis	
D ₁₀₀	mm
D ₆₀	mm
D ₃₀	mm
D ₁₀	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	Fig
JE	DK	DK	08/11/2019 16:23	Sheet



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PARTICLE SIZE DISTRIBUTION

Job Ref

CCG-C-19-11195

Borehole/Pit No.

BH02

Site Name

CITY LABS, MANCHESTER

Sample No.

1

Specimen Description

Brown slightly sandy slightly gravelly silty CLAY

Depth, m

4.00

Specimen Reference

Specimen Depth

m

Sample Type

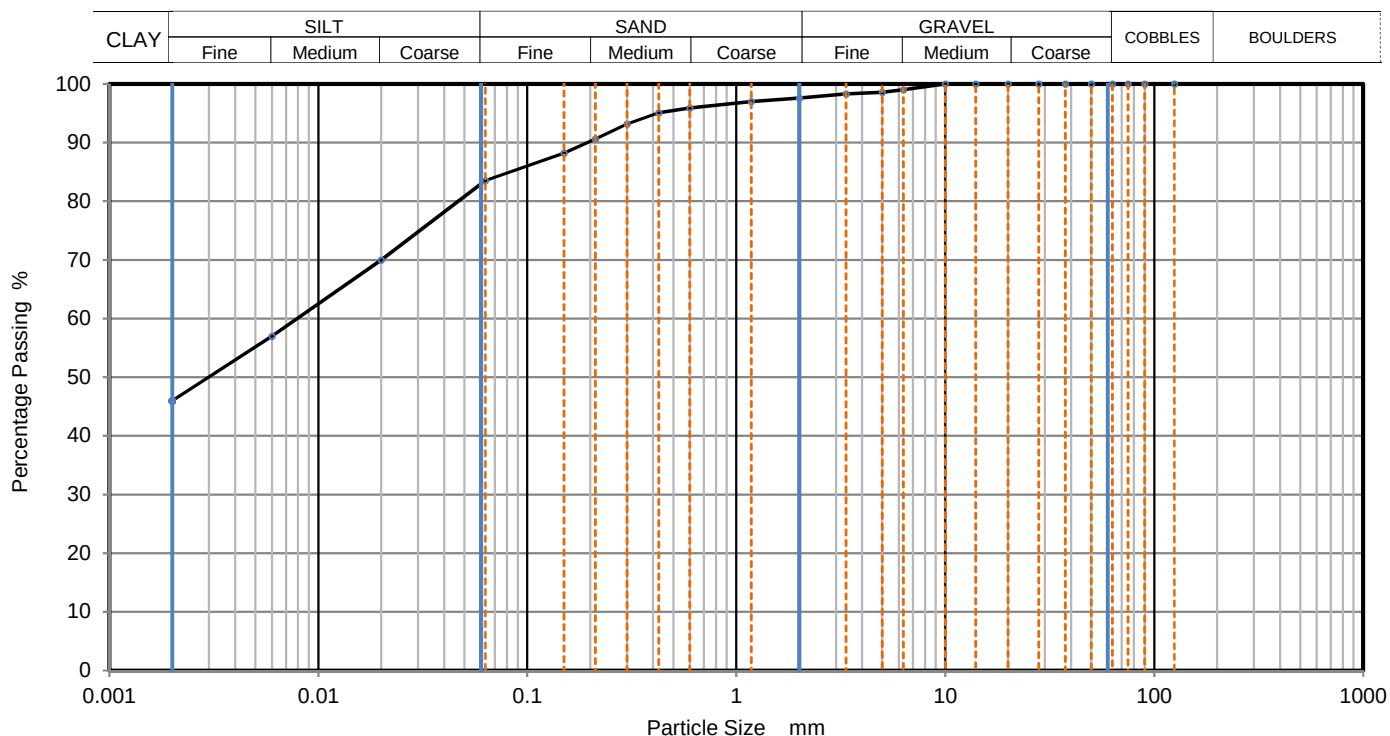
U

Test Method

BS1377:Part 2:1990 Clause 9.2 & 9.4

KeyLAB ID

CCGL201911075



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	70
90	100	0.0060	57
75	100	0.0020	46
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	99		
5	99		
3.35	98		
2	98		
1.18	97		
0.6	96		
0.425	95		
0.3	93		
0.212	91		
0.15	88		
0.063	84		

Dry Mass of sample, g

Sample Proportions	% dry mass
Very coarse	0
Gravel	2
Sand	14
Silt	38
Clay	46

Grading Analysis	
D ₁₀₀	mm
D ₆₀	mm
D ₃₀	mm
D ₁₀	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	Fig
JE	DK	DK	08/11/2019 16:28	Sheet



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PARTICLE SIZE DISTRIBUTION

Job Ref

CCG-C-19-11195

Borehole/Pit No.

BH02

Site Name

CITY LABS, MANCHESTER

Sample No.

1

Specimen Description

Brown sandy slightly gravelly silty CLAY

Depth, m

6.50

Specimen Reference

Specimen Depth

m

Sample Type

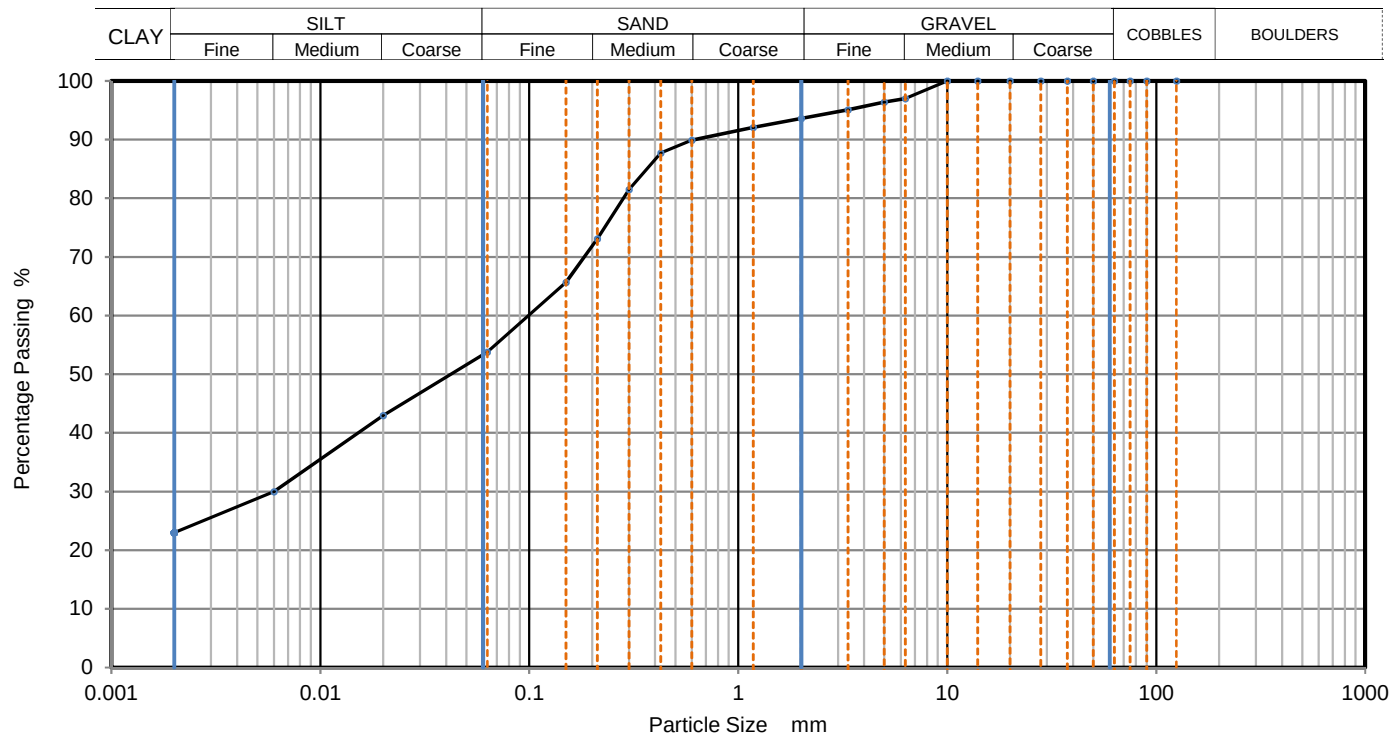
U

Test Method

BS1377:Part 2:1990 Clause 9.2 & 9.4

KeyLAB ID

CCGL201911061



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	43
90	100	0.0060	30
75	100	0.0020	23
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	97		
5	96		
3.35	95		
2	94		
1.18	92		
0.6	90		
0.425	88		
0.3	82		
0.212	73		
0.15	66		
0.063	54		

Dry Mass of sample, g

Sample Proportions	% dry mass
Very coarse	0
Gravel	6
Sand	40
Silt	31
Clay	23

Grading Analysis	
D ₁₀₀	mm
D ₆₀	mm
D ₃₀	mm
D ₁₀	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	Fig
JE	DK	DK	08/11/2019 16:40	Sheet



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PARTICLE SIZE DISTRIBUTION

Job Ref

CCG-C-19-11195

Borehole/Pit No.

BH02

Site Name

CITY LABS, MANCHESTER

Sample No.

1

Specimen
Description

Brown sandy slightly gravelly silty CLAY

Depth, m

9.00

Specimen
Reference

Specimen
Depth

m

Sample Type

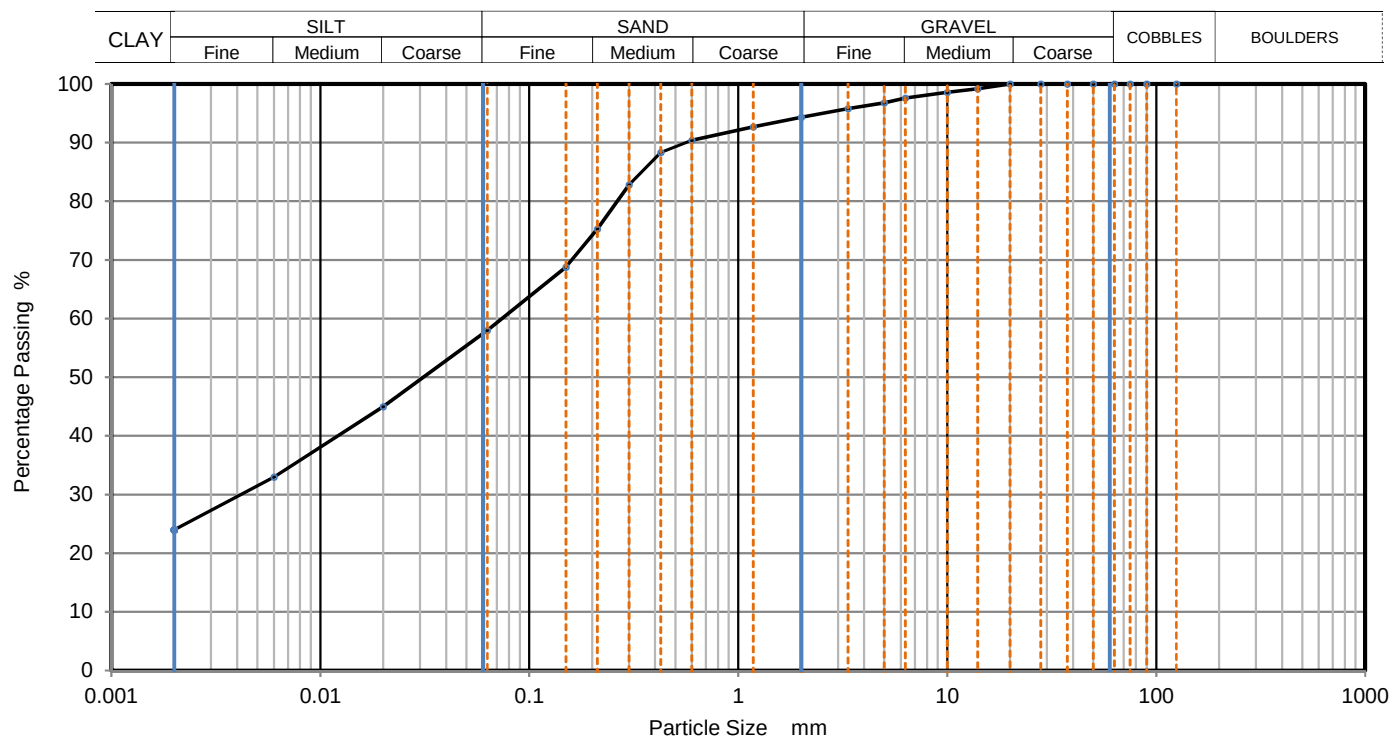
B

Test Method

BS1377:Part 2:1990 Clause 9.2 & 9.4

KeyLAB ID

CCGL201911076



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	45
90	100	0.0060	33
75	100	0.0020	24
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	99		
10	99		
6.3	98		
5	97		
3.35	96		
2	94		
1.18	93		
0.6	90		
0.425	88		
0.3	83		
0.212	75		
0.15	69		
0.063	58		

Dry Mass of sample, g

Sample Proportions	% dry mass
Very coarse	0
Gravel	6
Sand	36
Silt	34
Clay	24

Grading Analysis	
D ₁₀₀	mm
D ₆₀	mm
D ₃₀	mm
D ₁₀	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	Fig
JE	DK	DK	08/11/2019 16:42	Sheet



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PARTICLE SIZE DISTRIBUTION

Job Ref

CCG-C-19-11195

Borehole/Pit No.

BH02

Site Name

CITY LABS, MANCHESTER

Sample No.

1

Specimen
Description

Brown silty clayey gravelly fine to coarse grained SAND

Depth, m

10.50

Specimen
Reference

Specimen
Depth

m

Sample Type

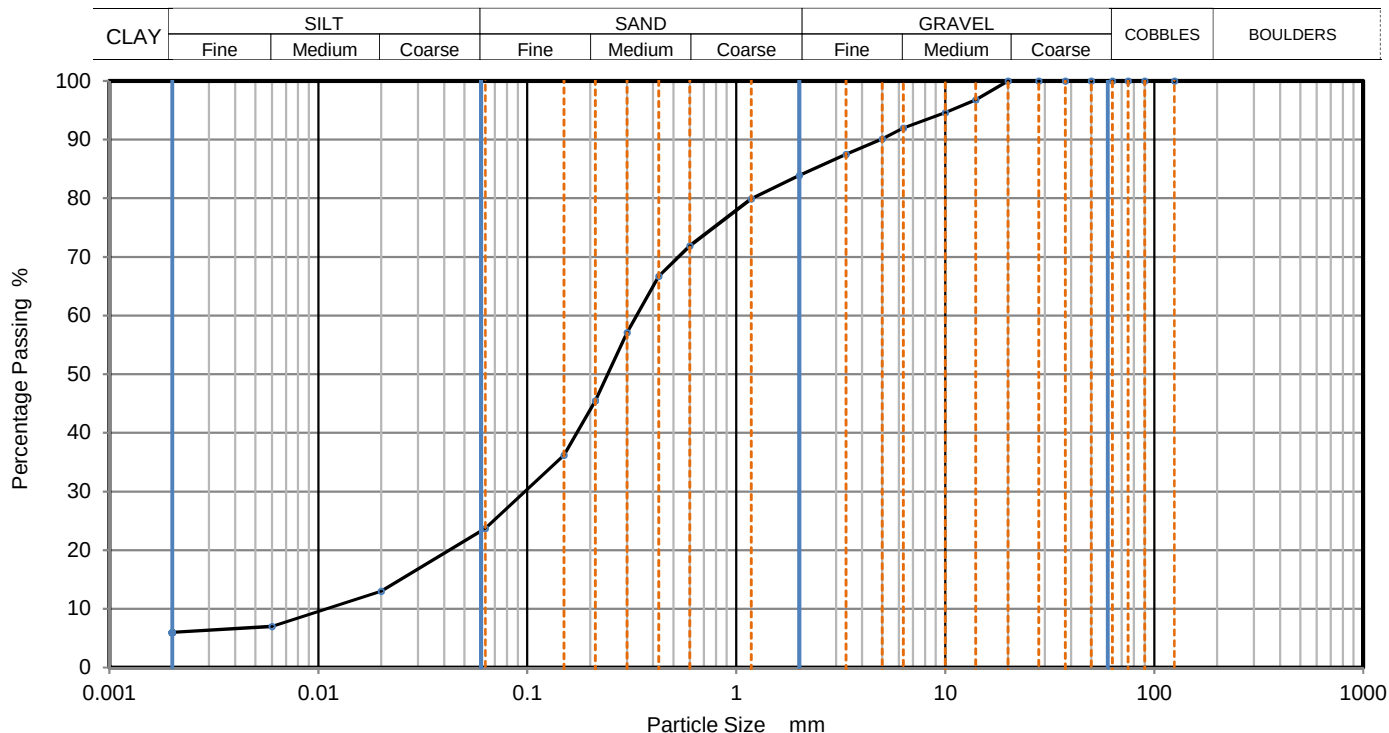
B

Test Method

BS1377:Part 2:1990 Clause 9.2 & 9.4

KeyLAB ID

CCGL201911077



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	13
90	100	0.0060	7
75	100	0.0020	6
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	97		
10	95		
6.3	92		
5	90		
3.35	88		
2	84		
1.18	80		
0.6	72		
0.425	67		
0.3	57		
0.212	46		
0.15	36		
0.063	24		

Dry Mass of sample, g

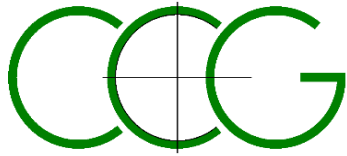
Sample Proportions	% dry mass
Very coarse	0
Gravel	16
Sand	60
Silt	18
Clay	6

Grading Analysis	
D ₁₀₀	mm
D ₆₀	mm
D ₃₀	mm
D ₁₀	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

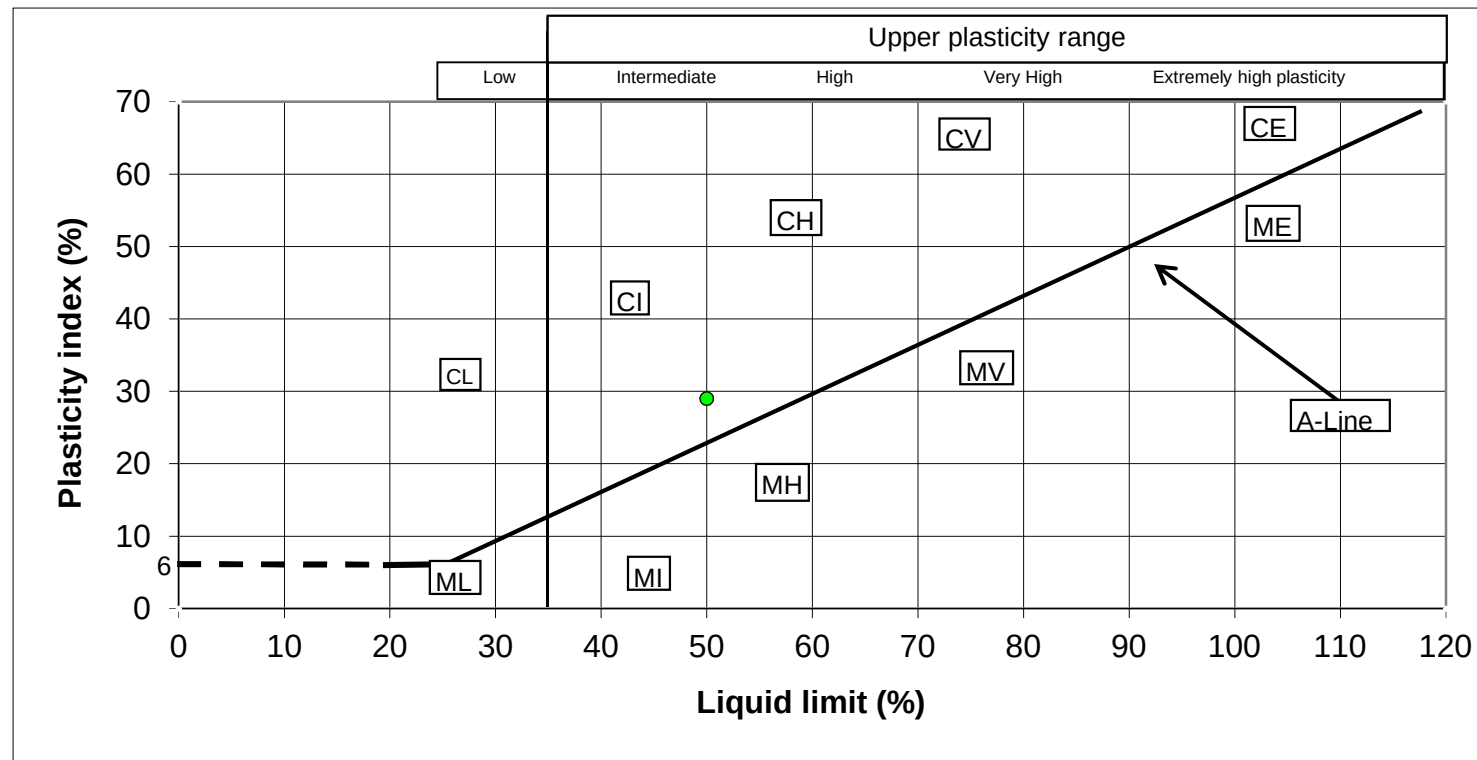
Operator	Checked	Approved	Sheet printed	Fig
JE	DK	DK	08/11/2019 16:47	Sheet



ATTERBERG TEST RESULT SHEET

BS 1377:Part 2:1990:cl 4.4,5

SILT (M-SOIL), M plots below A-Line , CLAY,C, plots above A-Line, M and C may be combined as FINE SOIL, F.



BH	Sample Depth	Liquid limit	Plasticity index
BH02	2.00	50.0	29.0



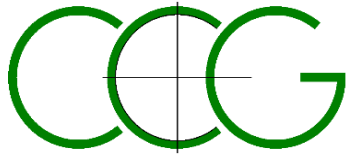
4514

APPROVED BY	DK
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CLIENT: BRUNTWOOD SCIENCE LTD

SITE: CITY LABS, MANCHESTER (CCG-C-19-11195)

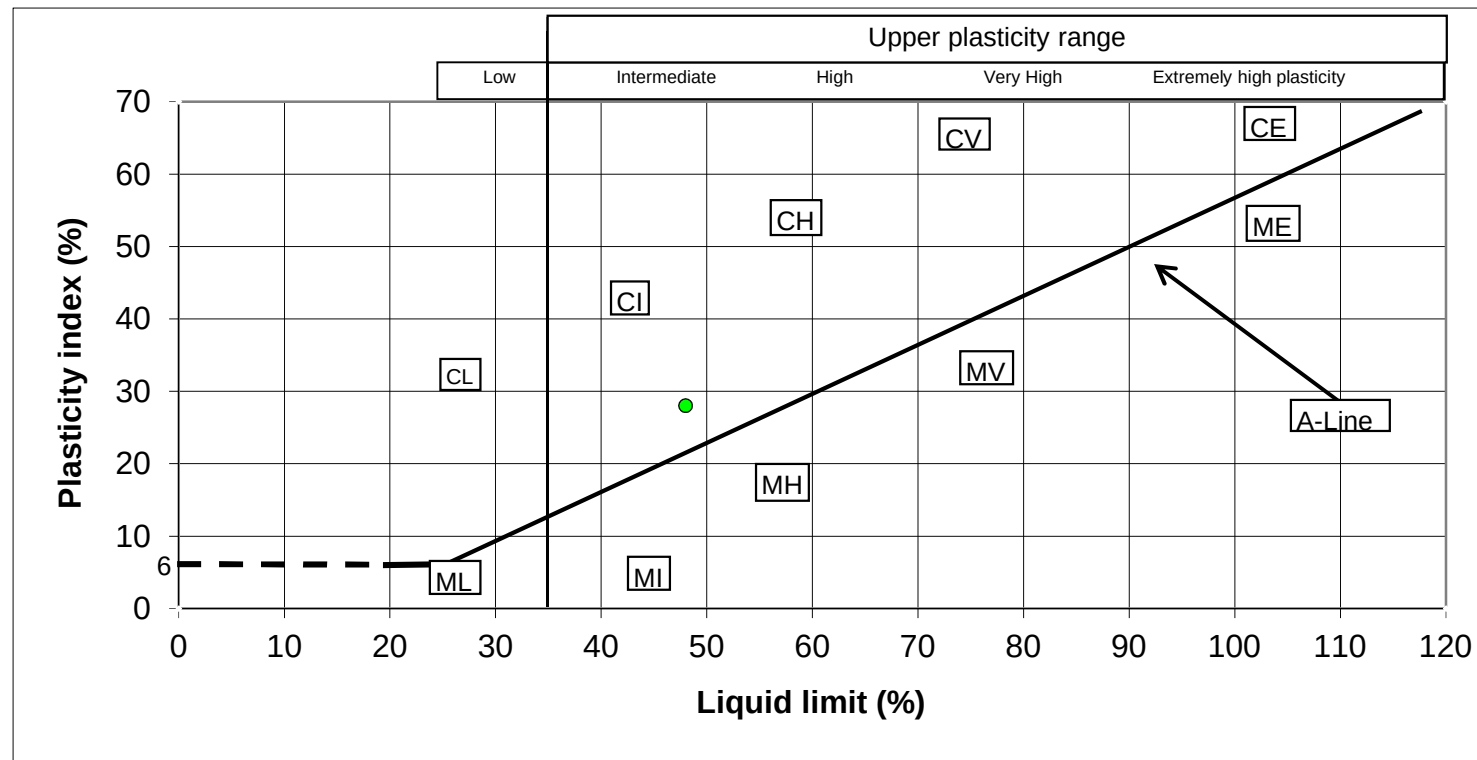
CCG-CMS-FO-204 Issue 2



ATTERBERG TEST RESULT SHEET

BS 1377:Part 2:1990:cl 4.4,5

SILT (M-SOIL), M plots below A-Line , CLAY,C, plots above A-Line, M and C may be combined as FINE SOIL, F.



BH	Sample Depth	Liquid limit	Plasticity index
BH02	4.00	48.0	28.0



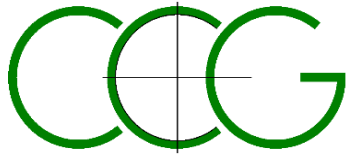
4514

APPROVED BY	DK
-------------	----

CLIENT: BRUNTWOOD SCIENCE LTD

SITE: CITY LABS, MANCHESTER (CCG-C-19-11195)

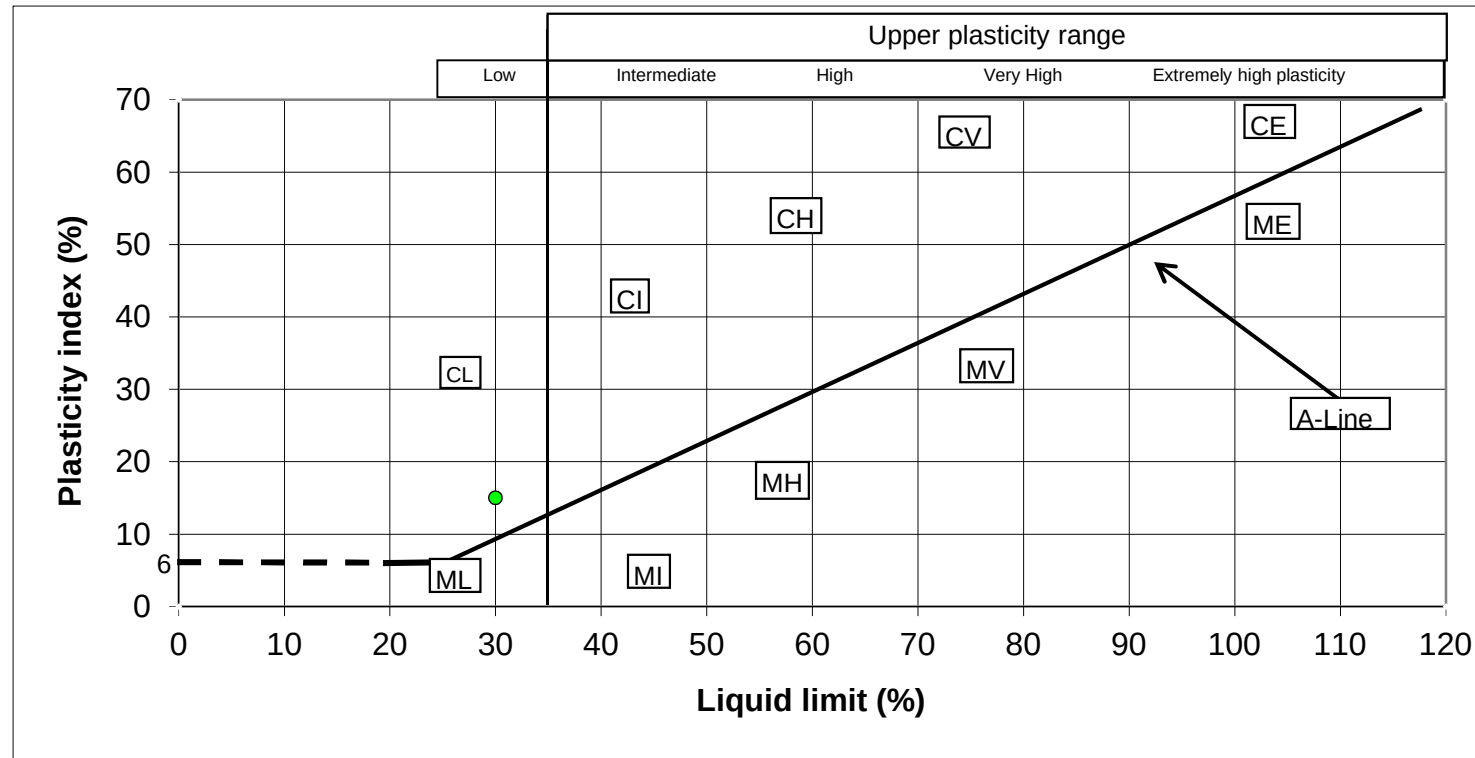
CCG-CMS-FO-204 Issue 2



ATTERBERG TEST RESULT SHEET

BS 1377:Part 2:1990:cl 4.4,5

SILT (M-SOIL), M plots below A-Line , CLAY,C, plots above A-Line, M and C may be combined as FINE SOIL, F.



BH	Sample Depth	Liquid limit	Plasticity index
BH02	6.50	30.0	15.0



4514

APPROVED BY	DK
-------------	----

CLIENT: BRUNTWOOD SCIENCE LTD

SITE: CITY LABS, MANCHESTER (CCG-C-19-11195)

CCG-CMS-FO-204 Issue 2



CC Geotechnical Ltd
Tel: 0151 545 2750
e: lab@ccgeotechnical.com

Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen

Job Ref CCG-C-19-11195

Borehole/Pit No. BH02

Site Name CITY LABS, MANCHESTER

Sample No. 1

Soil Description Brown slightly sandy slightly gravelly silty CLAY

Depth 2.00

Specimen Reference Specimen Depth 2.00 m

Sample Type U

Specimen Description

Date of test

Test Method BS 1377:1990:Part 7

31.10.19



Test Number

1

Length

203.8

mm

Diameter

102.6

mm

Bulk Density

2.02

Mg/m³

Moisture Content

24.8

%

Dry Density

1.62

Mg/m³

Rate of Strain

2.0

%/min

Cell Pressure

40

kPa

At failure

Axial Strain

15.7

%

Deviator Stress, $(\sigma_1 - \sigma_3)_f$

164

kPa

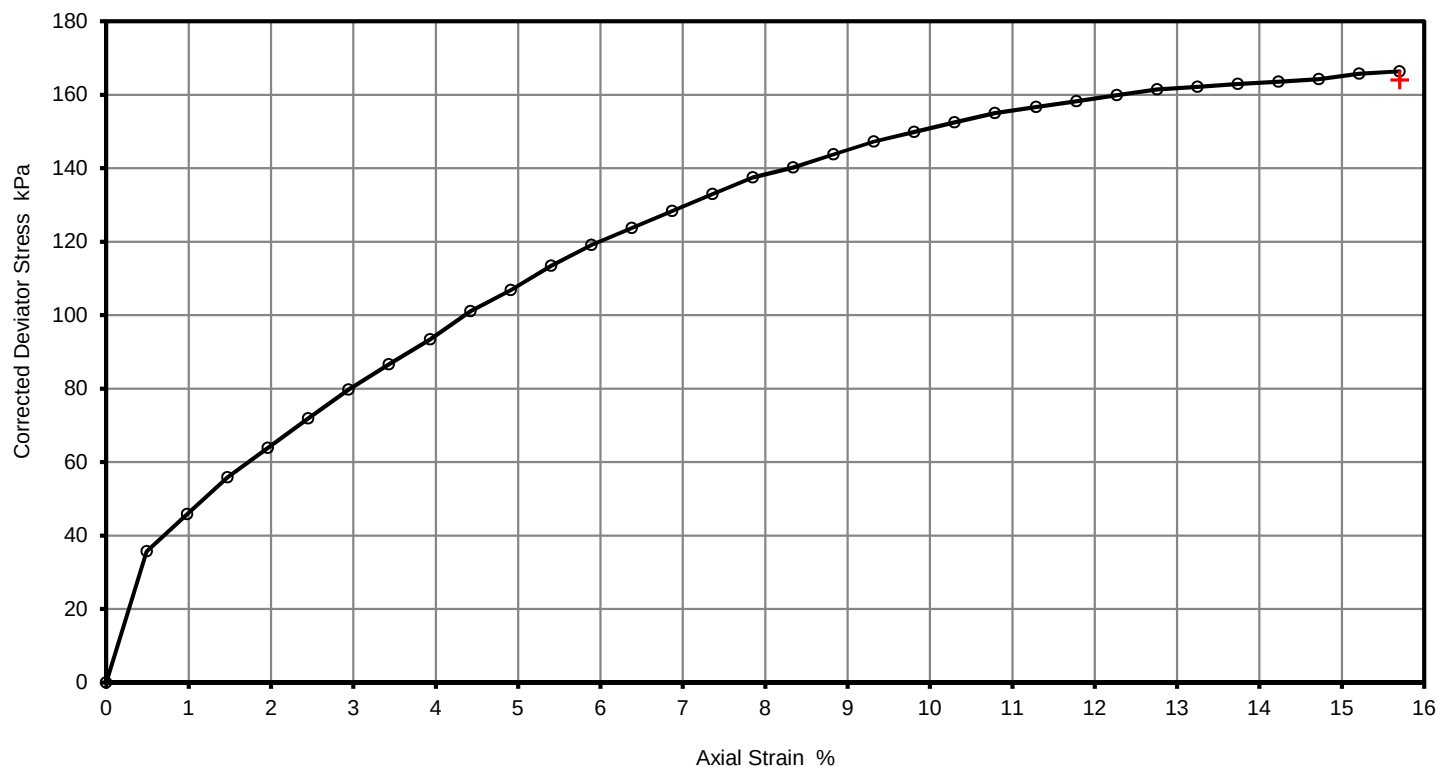
Undrained Shear Strength, c_u

82

kPa $\frac{1}{2}(\sigma_1 - \sigma_3)_f$

Mode of Failure

Deviator Stress v Axial Strain



Remarks

Approved

Printed

DK

06/11/2019 14:28

Fig. No.

1

Sheet

1



CC Geotechnical Ltd
Tel: 0151 545 2750
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Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen

Job Ref CCG-C-19-11195

Borehole/Pit No. BH02

Site Name CITY LABS, MANCHESTER

Sample No. 1

Soil Description Brown slightly sandy slightly gravelly silty CLAY

Depth 6.50

Specimen Reference Specimen Depth 6.50 m

Sample Type U

Specimen Description

Date of test

Test Method BS 1377:1990:Part 7

31.10.19



Test Number
Length
Diameter
Bulk Density
Moisture Content
Dry Density

1
202.6
103.7
2.28
10.9
2.05

mm
mm
Mg/m³
%
Mg/m³

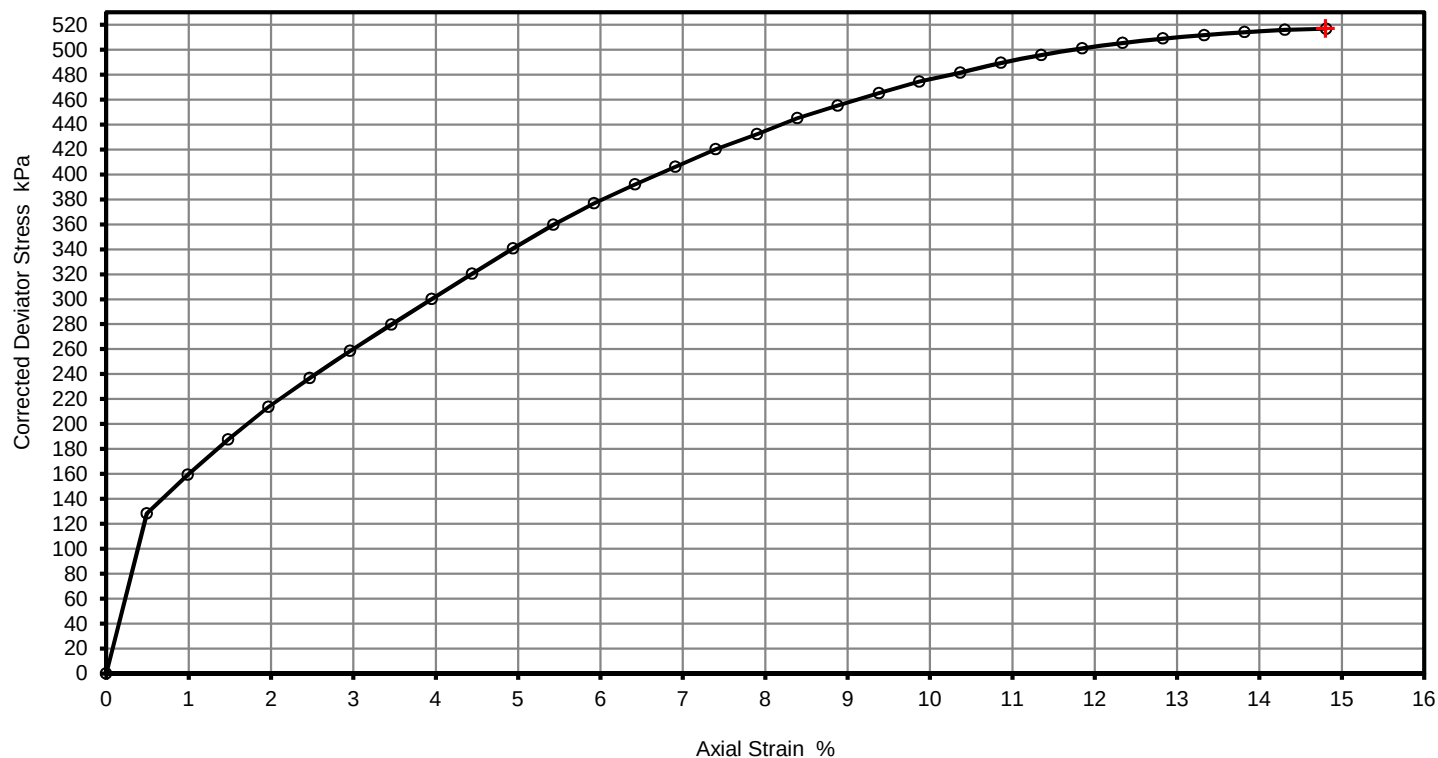
Rate of Strain
Cell Pressure
At failure

2.0
130
14.8
517
258
compound

%/min
kPa
%
kPa
kPa $\frac{1}{2}(\sigma_1 - \sigma_3)_f$

Axial Strain
Deviator Stress, $(\sigma_1 - \sigma_3)_f$
Undrained Shear Strength, c_u
Mode of Failure

Deviator Stress v Axial Strain



Remarks

Approved

Printed

06/11/2019 15:44

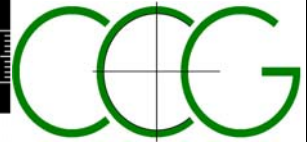
Fig. No.

1

Sheet

1

One Dimensional Consolidation Properties (Oedometer)

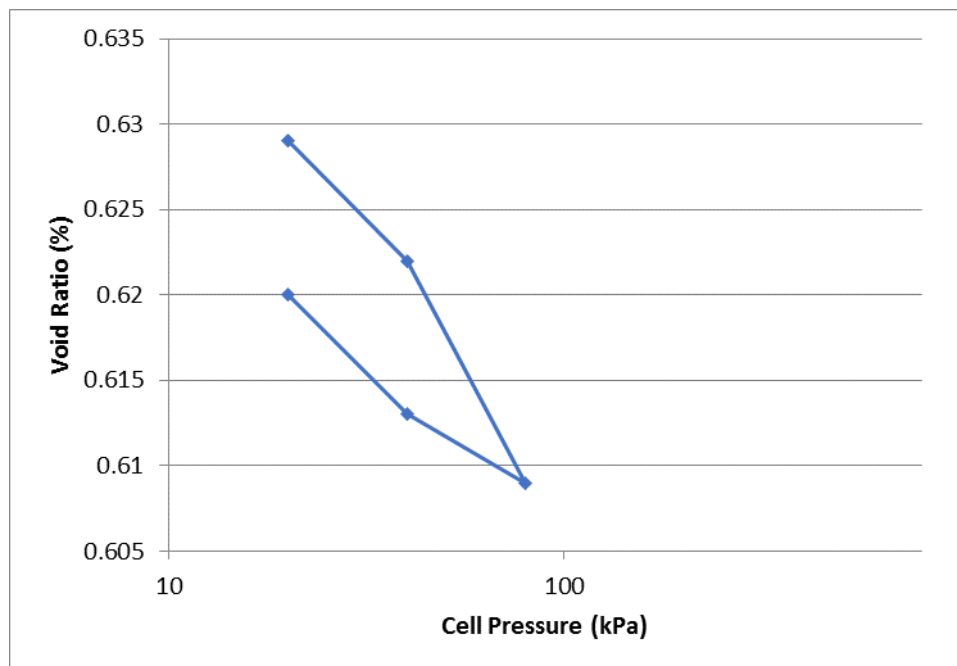


Client	BRUNTWOOD SCIENCE LTD	Lab Ref	
Project	CITY LABS, MANCHESTER	Job	CCG C 19 11195
Borehole	BH02	Sample	1

Test Details			
Standard	BS 1377: Part 5: 1990: Clause 3	Particle Density	2.65 Mg/m ³
Sample Type	Undisturbed sample - open drive	Lab Temperature	20.0 deg.C
Sample Depth	2.00 m		
Sample Description	Brown slightly sandy slightly gravelly silty CLAY		
Variations from Procedure	None		

Specimen Details			
Specimen Reference	A	Description	
Depth within Sample	0.00 mm	Orientation within Sample	
Specimen Mass	180.80 g	Condition	Natural Moisture
Specimen Height	20.22 mm	Preparation	
Comments			

Test Apparatus			
Ring Number	9	Ring Diameter	75.01 mm
Ring Height	20.01 mm	Ring Weight	127.43 g
Lever Ratio	9.00: 1		



Height of Solid Particles	12.37 mm	Swelling Pressure	
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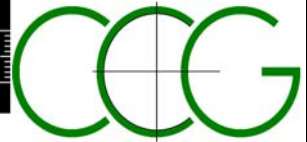
Initial Moisture Content*	24.8 %	Final Moisture Content	25.9 %
Initial Bulk Density	2.02 Mg/m ³	Final Bulk Density	2.06 Mg/m ³
Initial Dry Density	1.62 Mg/m ³	Final Dry Density	1.64 Mg/m ³
Initial Void Ratio	0.6346	Final Void Ratio	0.6200
Initial Degree of Saturation	103.61 %	Final Degree of Saturation	110.76 %

[illegible]

Method of Time Fitting Used	Log time
------------------------------------	----------

Tested by and Date:	DK 12.11.19
Checked by and Date:	DK 12.11.19
Approved by and Date:	CB 12.11.19

One Dimensional Consolidation Properties (Oedometer)

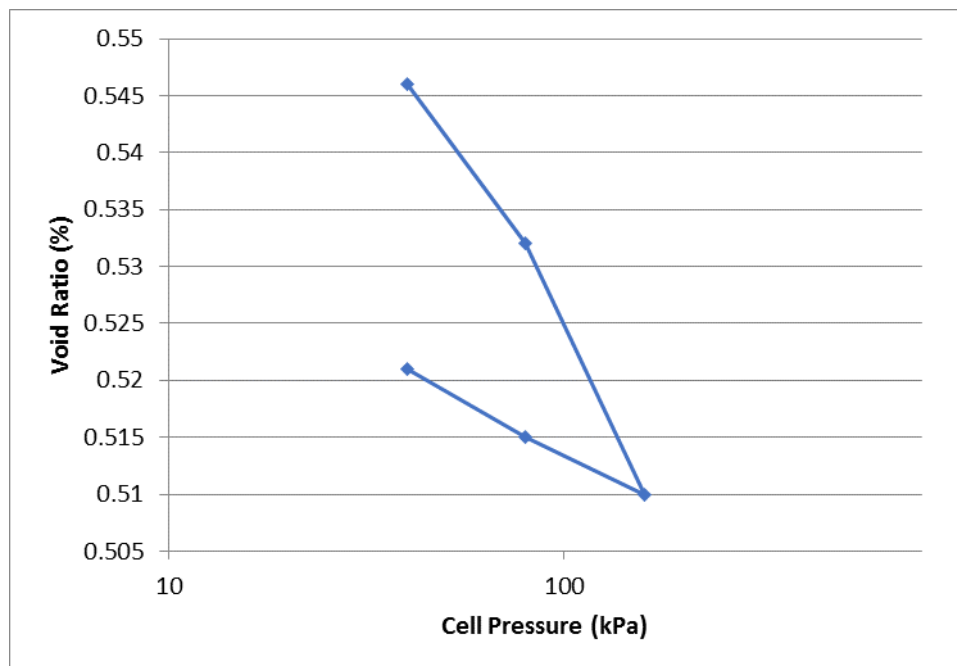


Client	BRUNTWOOD SCIENCE LTD	Lab Ref	
Project	CITY LABS, MANCHESTER	Job	CCG C 19 11195
Borehole	BH02	Sample	1

Test Details			
Standard	BS 1377: Part 5: 1990: Clause 3	Particle Density	2.65 Mg/m ³
Sample Type	Undisturbed sample - open drive	Lab Temperature	20.0 deg.C
Sample Depth	4.00 m		
Sample Description	Brown slightly sandy slightly gravelly silty CLAY		
Variations from Procedure	None		

Specimen Details			
Specimen Reference	A	Description	
Depth within Sample	0.00 mm	Orientation within Sample	
Specimen Mass	185.37 g	Condition	Natural Moisture
Specimen Height	20.20 mm	Preparation	
Comments			

Test Apparatus			
Ring Number	10	Ring Diameter	75.08 mm
Ring Height	20.20 mm	Ring Weight	126.76 g
Lever Ratio	9.00: 1		



Height of Solid Particles	12.92 mm	Swelling Pressure	
----------------------------------	----------	--------------------------	--



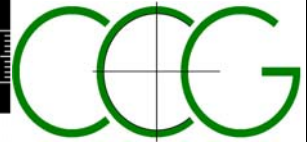
Initial Moisture Content*	22.3 %	Final Moisture Content	22.5 %
Initial Bulk Density	2.07 Mg/m ³	Final Bulk Density	2.14 Mg/m ³
Initial Dry Density	1.70 Mg/m ³	Final Dry Density	1.74 Mg/m ³
Initial Void Ratio	0.5631	Final Void Ratio	0.5210
Initial Degree of Saturation	104.76 %	Final Degree of Saturation	114.70 %

[illegible]

Method of Time Fitting Used	Log time
------------------------------------	----------

Tested by and Date:	DK 12.11.19
Checked by and Date:	DK 12.11.19
Approved by and Date:	CB 12.11.19

One Dimensional Consolidation Properties (Oedometer)

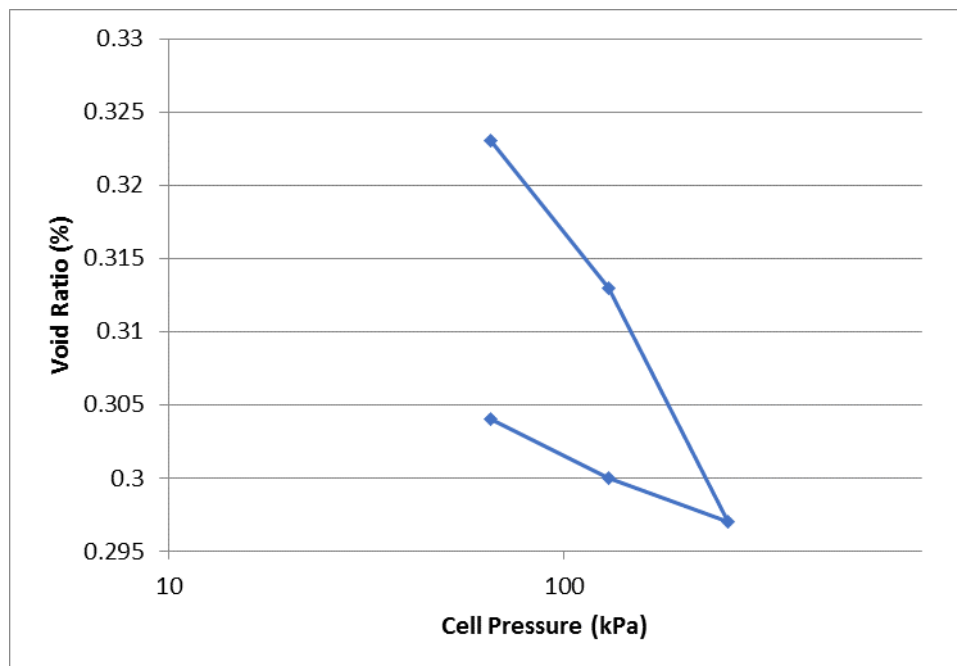


Client	BRUNTWOOD SCIENCE LTD	Lab Ref	
Project	CITY LABS, MANCHESTER	Job	CCG C 19 11195
Borehole	BH02	Sample	1

Test Details			
Standard	BS 1377: Part 5: 1990: Clause 3	Particle Density	2.65 Mg/m ³
Sample Type	Undisturbed sample - open drive	Lab Temperature	20.0 deg.C
Sample Depth	6.50 m		
Sample Description	Brown slightly sandy slightly gravelly silty CLAY		
Variations from Procedure	None		

Specimen Details			
Specimen Reference	A	Description	
Depth within Sample	0.00 mm	Orientation within Sample	
Specimen Mass	197.50 g	Condition	Natural Moisture
Specimen Height	20.35 mm	Preparation	
Comments			

Test Apparatus			
Ring Number	5	Ring Diameter	74.96 mm
Ring Height	20.35 mm	Ring Weight	128.83 g
Lever Ratio	9.00: 1		



Height of Solid Particles	15.18 mm	Swelling Pressure	
----------------------------------	----------	--------------------------	--

UKAS
TESTING
4514





POINT LOAD TEST RESULTS

ISRM 1985: Suggested Method

PROJECT No.:-

CCG-C-19-11195

SITE:-

CITYLABS, MANCHESTER

DATE:

07.11.19

Borehole Number	Depth (m)	Type of Test*			Width (W) (mm)	Platen Separation (D) (mm)	Failure Load (P) (kN)	Equivalent Diameter (D _e) (mm)	Point Load (I _s) (MPa)	Size Factor (F)	Point Load Index (I _{s(50)}) (MPa)	Estimated Uniaxial Compressive Strength (MPa)	Water Content (NAT/SAT)	Orientation to plane of weakness
		a	d	i										
BH02	14.35	a			85	48	0.40	72	0.08	1.18	0.09	1.82	NAT	p
BH02	14.70	a			85	70	0.90	87	0.12	1.28	0.15	3.05	NAT	p
BH02	15.10	a			85	61	0.60	81	0.09	1.24	0.11	2.26	NAT	p
BH02	15.90	a			85	70	2.00	87	0.26	1.28	0.34	6.78	NAT	p
BH02	16.10	a			85	74	1.40	89	0.17	1.30	0.23	4.54	NAT	p
BH02	16.55	a			85	66	0.40	85	0.06	1.27	0.07	1.42	NAT	p
BH02	17.15	a			85	75	1.70	90	0.21	1.30	0.27	5.46	NAT	p
BH02	18.20	a			85	82	2.70	94	0.30	1.33	0.40	8.09	NAT	p
BH02	18.65	a			85	58	2.00	79	0.32	1.23	0.39	7.84	NAT	p
BH02	19.20	a			85	54	2.40	76	0.41	1.21	0.50	9.94	NAT	p
BH02	19.80	a			85	46	0.70	71	0.14	1.17	0.16	3.28	NAT	p
BH02	20.95	a			85	60	2.40	81	0.37	1.24	0.46	9.16	NAT	p
BH02	21.30		d		62	85	3.00	-	0.42	1.27	0.53	10.54	NAT	l
BH02	21.35	a			85	62	4.50	82	0.67	1.25	0.84	16.75	NAT	p

*NOTE- a = axial ; d = diametral ; i = irregular lump or block (see diagrams, right, for details)

p = perpendicular; l = parallel, u = unknown

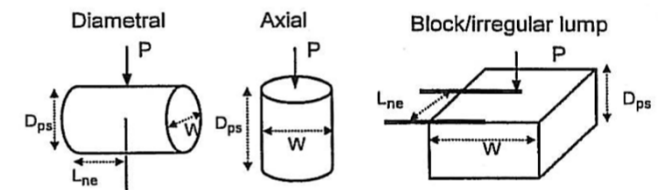
DIA. KEY- P = load ; Dps = platen separation ;

W = width of shortest dimension perpendicular to load ;

Lne = length from platens to nearest free end

TESTED BY: JE

APPROVED BY: DK



SUMMARY OF LABORATORY SOIL TEST RESULTS

BH / TP / WS Number	Sample Type	Depth From (m)	Depth To (m)	Moisture Content (%)	Bulk Density (Mg/m ³)	Dry Density (Mg/m ³)	Shear Strength (kN/m ²)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 0.425mm (%)	Soil Classification	UKAS accredited test (Y/N)	Description / Test Method Samples described in accordance with BS EN ISO 14688-2 2004
BH03	B	1.50	1.50	28	-	-	-	-	-	-	-	-	Y	Greyish brown slightly sandy slightly gravelly silty CLAY with organic inclusions. Gravel is angular to subangular brick and sandstone. (MADE GROUND) (BS1377Pt2:3.2)
BH03	U	3.00	3.45	12	-	-	>110*	30	15	15	92	CL	Y	Brown sandy slightly gravelly silty CLAY. Gravel is fine to medium subangular sandstone. (BS1377Pt2:3.2,4.4,5,9.2,9.4)
BH03	U	5.00	5.45	11	-	-	>110*	31	16	15	89	CL	Y	Brown sandy slightly gravelly silty CLAY. Gravel is fine to medium subangular sandstone. (BS1377Pt2:3.2,4.4,5,9.2,9.4)
BH03	B	6.00	6.00	12	-	-	-	29	14	15	91	CL	Y	Brown sandy slightly gravelly silty CLAY. Gravel is fine to medium subangular sandstone. (BS1377Pt2:3.2,4.4,5)
BH03	U	8.00	8.45	12	2.28	2.04	>305	29	15	14	88	CL	Y	Brown sandy slightly gravelly silty CLAY. Gravel is fine to medium subangular sandstone. (BS1377Pt2:3.2,4.4,5,9.2,9.4,Pt7:8)
BH03	B	10.50	10.50	-	-	-	-	-	-	-	-	-	Y	Brown very sandy slightly silty GRAVEL. Gravel is fine to coarse subrounded sandstone and quartz. (BS1377Pt2:9.2)
BH03	B	12.00	12.00	5.6	-	-	-	-	-	-	-	-	Y	Brown very sandy slightly silty GRAVEL. Gravel is fine to coarse subrounded sandstone and quartz. (BS1377Pt2:3.2,9.2)

SITE: CITY LABS, MANCHESTER (CCG-C-19-11195)
CLIENT: BRUNTWOOD SCIENCE LTD

DATE: 09.11.19

Key:- BD = Bulk Disturbed; SD = Small Disturbed; U100 = Undisturbed 100mm; WS = Window Sample

CL = Low Plasticity; CI = Intermediate; CH = High; CV = Very high; CE = Extremely high; NP = Non-plastic

(* Denotes Hand Shear Vane test result)

Sample description not accredited by UKAS



11195 BH03 RES.xls



CC Geotechnical Ltd
Tel: 0151 545 2750
e: lab@ccgeotechnical.com

PARTICLE SIZE DISTRIBUTION

Job Ref

CCG-C-19-11195

Borehole/Pit No.

BH03

Site Name

CITY LABS, MANCHESTER

Sample No.

1

Specimen
Description

Brown sandy slightly gravelly silty CLAY

Depth, m

3.00

Specimen
Reference

Specimen
Depth

m

Sample Type

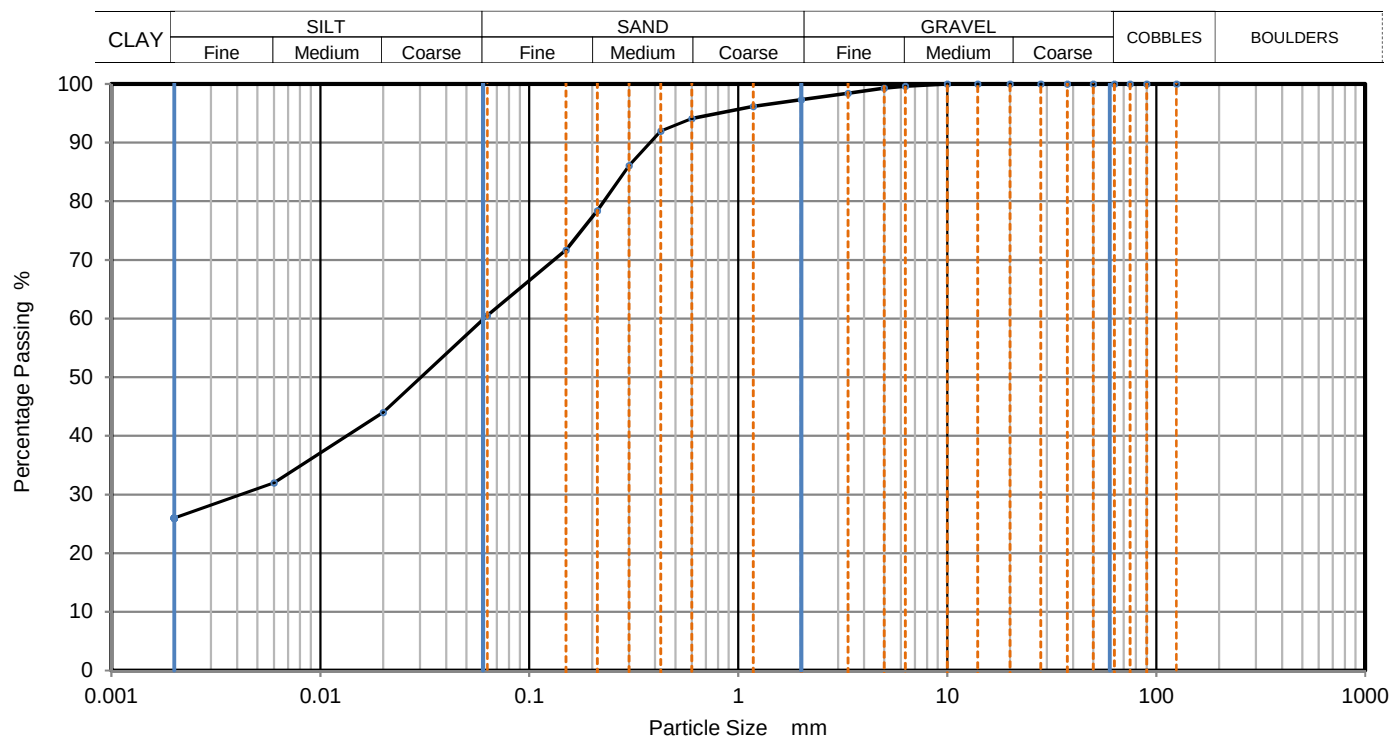
U

Test Method

BS1377:Part 2:1990 Clause 9.2 & 9.4

KeyLAB ID

CCGL201911078



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	44
90	100	0.0060	32
75	100	0.0020	26
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	99		
3.35	98		
2	97		
1.18	96		
0.6	94		
0.425	92		
0.3	86		
0.212	78		
0.15	72		
0.063	61		

Dry Mass of sample, g

Sample Proportions	% dry mass
Very coarse	0
Gravel	3
Sand	36
Silt	35
Clay	26

Grading Analysis	
D ₁₀₀	mm
D ₆₀	mm
D ₃₀	mm
D ₁₀	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	Fig
JE	DK	DK	09/11/2019 10:37	Sheet



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PARTICLE SIZE DISTRIBUTION

Job Ref

CCG-C-19-11195

Borehole/Pit No.

BH03

Site Name

CITY LABS, MANCHESTER

Sample No.

1

Specimen
Description

Brown sandy slightly gravelly silty CLAY

Depth, m

5.00

Specimen
Reference

Specimen
Depth

m

Sample Type

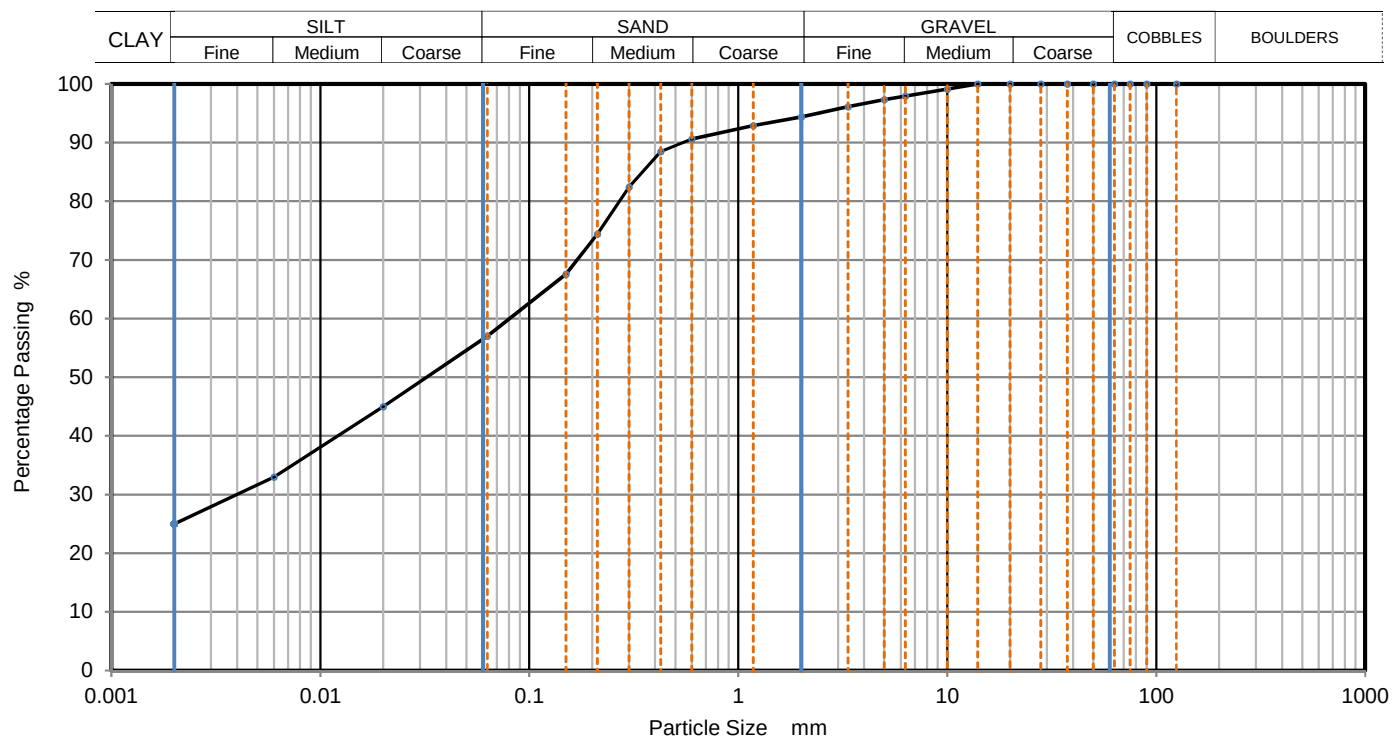
U

Test Method

BS1377:Part 2:1990 Clause 9.2 & 9.4

KeyLAB ID

CCGL201911079



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	45
90	100	0.0060	33
75	100	0.0020	25
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	99		
6.3	98		
5	97		
3.35	96		
2	94		
1.18	93		
0.6	91		
0.425	89		
0.3	82		
0.212	74		
0.15	68		
0.063	57		

Dry Mass of sample, g

Sample Proportions	% dry mass
Very coarse	0
Gravel	6
Sand	37
Silt	32
Clay	25

Grading Analysis	
D ₁₀₀	mm
D ₆₀	mm
D ₃₀	mm
D ₁₀	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	Fig
JE	DK	DK	09/11/2019 10:42	Sheet



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PARTICLE SIZE DISTRIBUTION

Job Ref

CCG-C-19-11195

Borehole/Pit No.

BH03

Site Name

CITY LABS, MANCHESTER

Sample No.

1

Specimen Description

Brown slightly sandy slightly gravelly silty CLAY

Depth, m

8.00

Specimen Reference

Specimen Depth

m

Sample Type

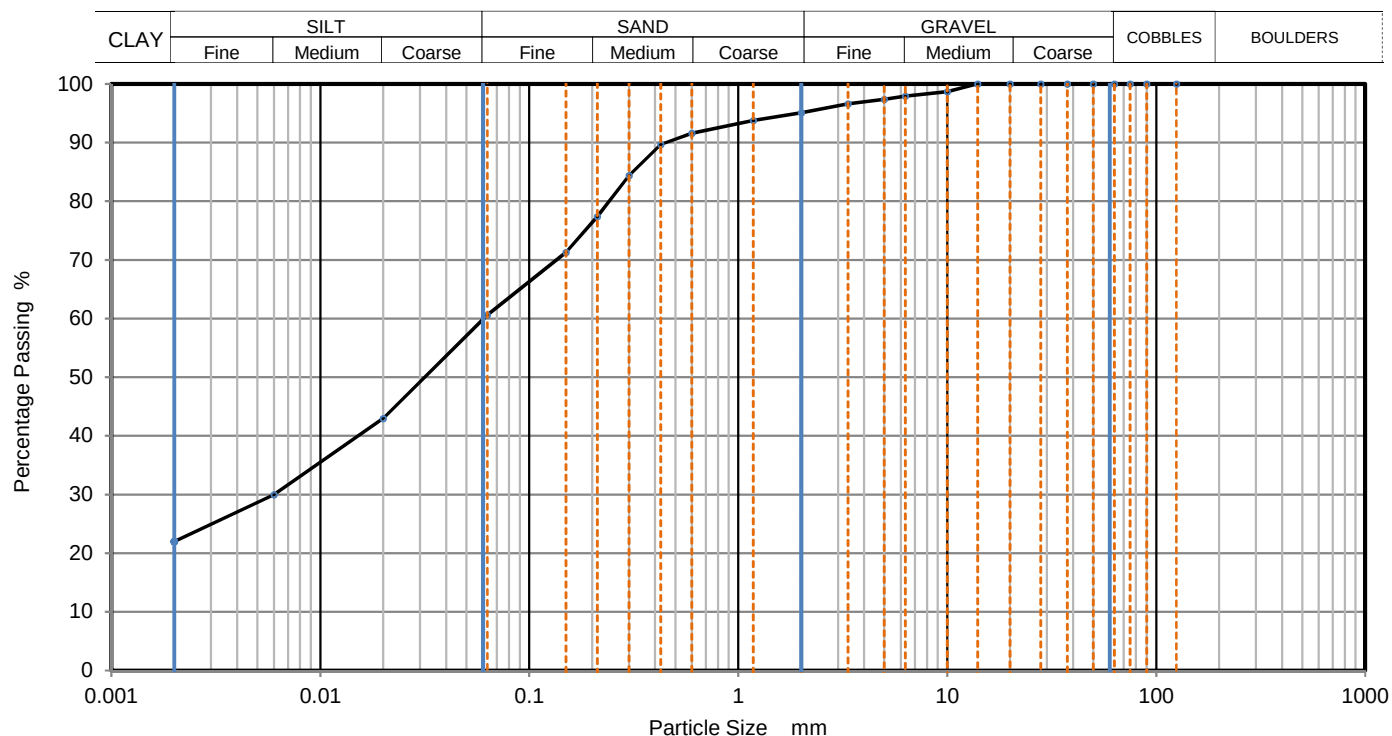
U

Test Method

BS1377:Part 2:1990 Clause 9.2 & 9.4

KeyLAB ID

CCGL201911062



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	43
90	100	0.0060	30
75	100	0.0020	22
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	99		
6.3	98		
5	97		
3.35	97		
2	95		
1.18	94		
0.6	92		
0.425	90		
0.3	84		
0.212	77		
0.15	71		
0.063	61		

Dry Mass of sample, g

Sample Proportions	% dry mass
Very coarse	0
Gravel	5
Sand	34
Silt	39
Clay	22

Grading Analysis	
D ₁₀₀	mm
D ₆₀	mm
D ₃₀	mm
D ₁₀	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	Fig
JE	DK	DK	09/11/2019 10:45	Sheet



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PARTICLE SIZE DISTRIBUTION

Job Ref

CCG-C-19-11195

Borehole/Pit No.

BH03

Site Name

CITY LABS, MANCHESTER

Sample No.

1

Specimen
Description

Brown very sandy slightly silty GRAVEL

Depth, m

10.50

Specimen
Reference

Specimen
Depth

m

Sample Type

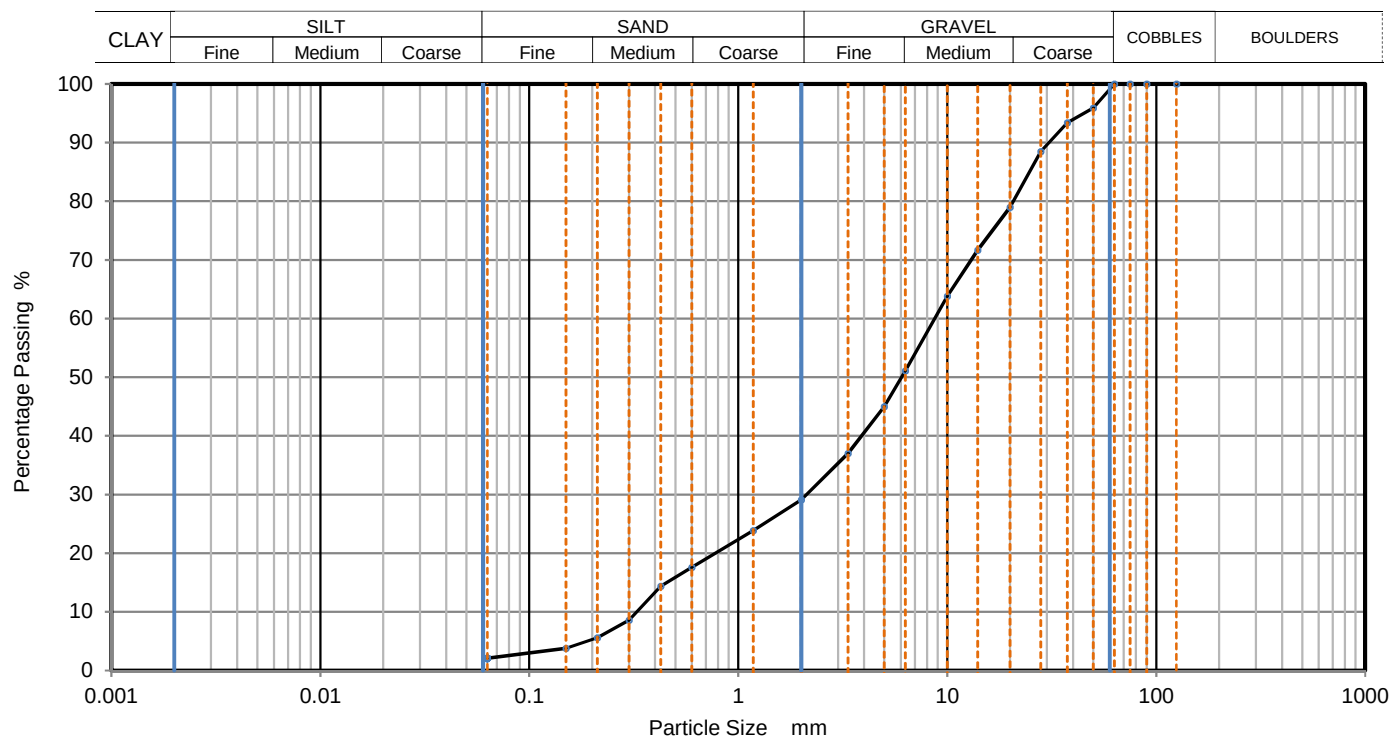
B

Test Method

BS1377:Part 2:1990 Clause 9.2

KeyLAB ID

CCGL2019110710



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	96		
37.5	93		
28	89		
20	79		
14	72		
10	64		
6.3	51		
5	45		
3.35	37		
2	29		
1.18	24		
0.6	18		
0.425	14		
0.3	9		
0.212	6		
0.15	4		
0.063	2		

Dry Mass of sample, g

Sample Proportions	% dry mass
Very coarse	0
Gravel	71
Sand	27
Fines <0.063mm	2

Grading Analysis	
D ₁₀₀	mm
D ₆₀	mm
D ₃₀	mm
D ₁₀	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	Fig
JE	DK	DK	09/11/2019 10:52	Sheet



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PARTICLE SIZE DISTRIBUTION

Job Ref

CCG-C-19-11195

Borehole/Pit No.

BH03

Site Name

CITY LABS, MANCHESTER

Sample No.

1

Specimen Description

Brown very sandy slightly silty GRAVEL

Depth, m

12.00

Specimen Reference

Specimen Depth

m

Sample Type

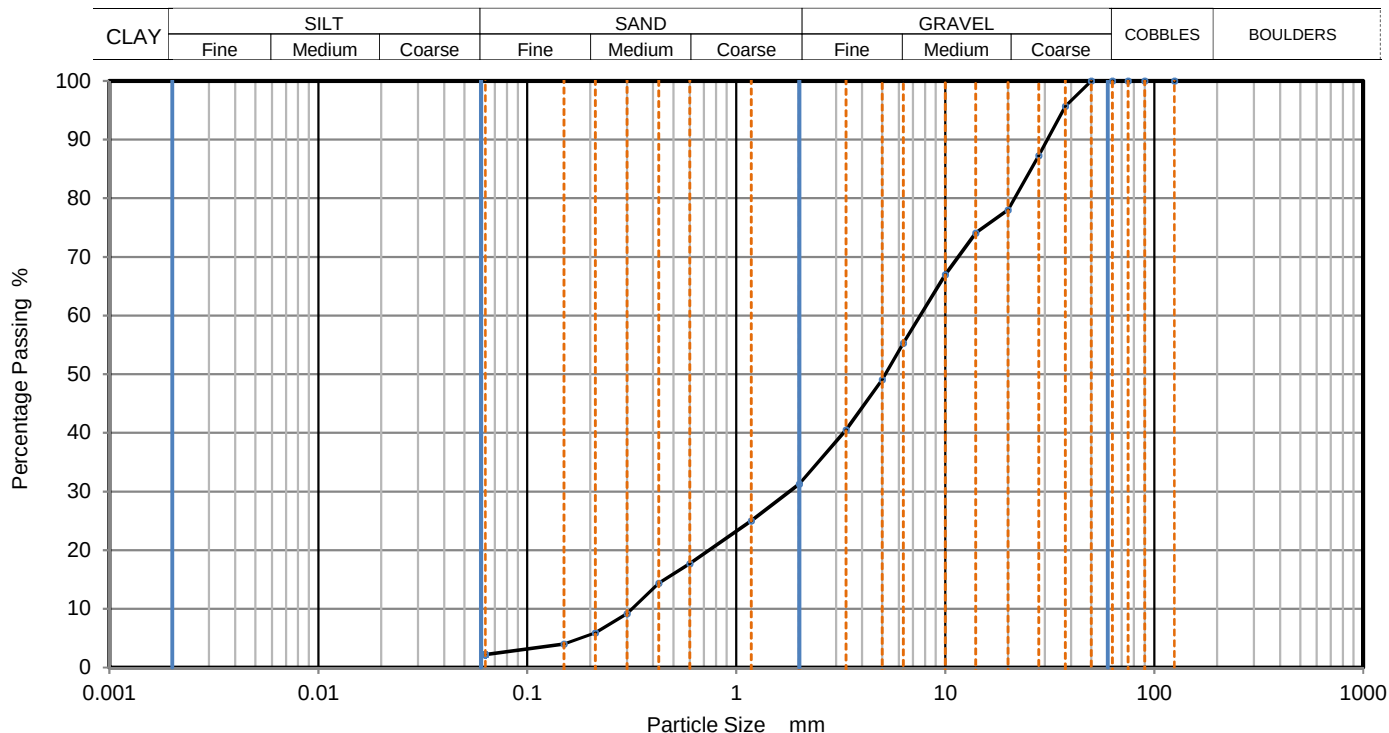
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Test Method

BS1377:Part 2:1990 Clause 9.2

KeyLAB ID

CCGL2019110711



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	96		
28	87		
20	78		
14	74		
10	67		
6.3	55		
5	49		
3.35	41		
2	31		
1.18	25		
0.6	18		
0.425	14		
0.3	9		
0.212	6		
0.15	4		
0.063	2		

Dry Mass of sample, g

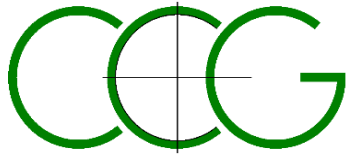
Sample Proportions	% dry mass
Very coarse	0
Gravel	69
Sand	29
Fines <0.063mm	2

Grading Analysis	
D ₁₀₀	mm
D ₆₀	mm
D ₃₀	mm
D ₁₀	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

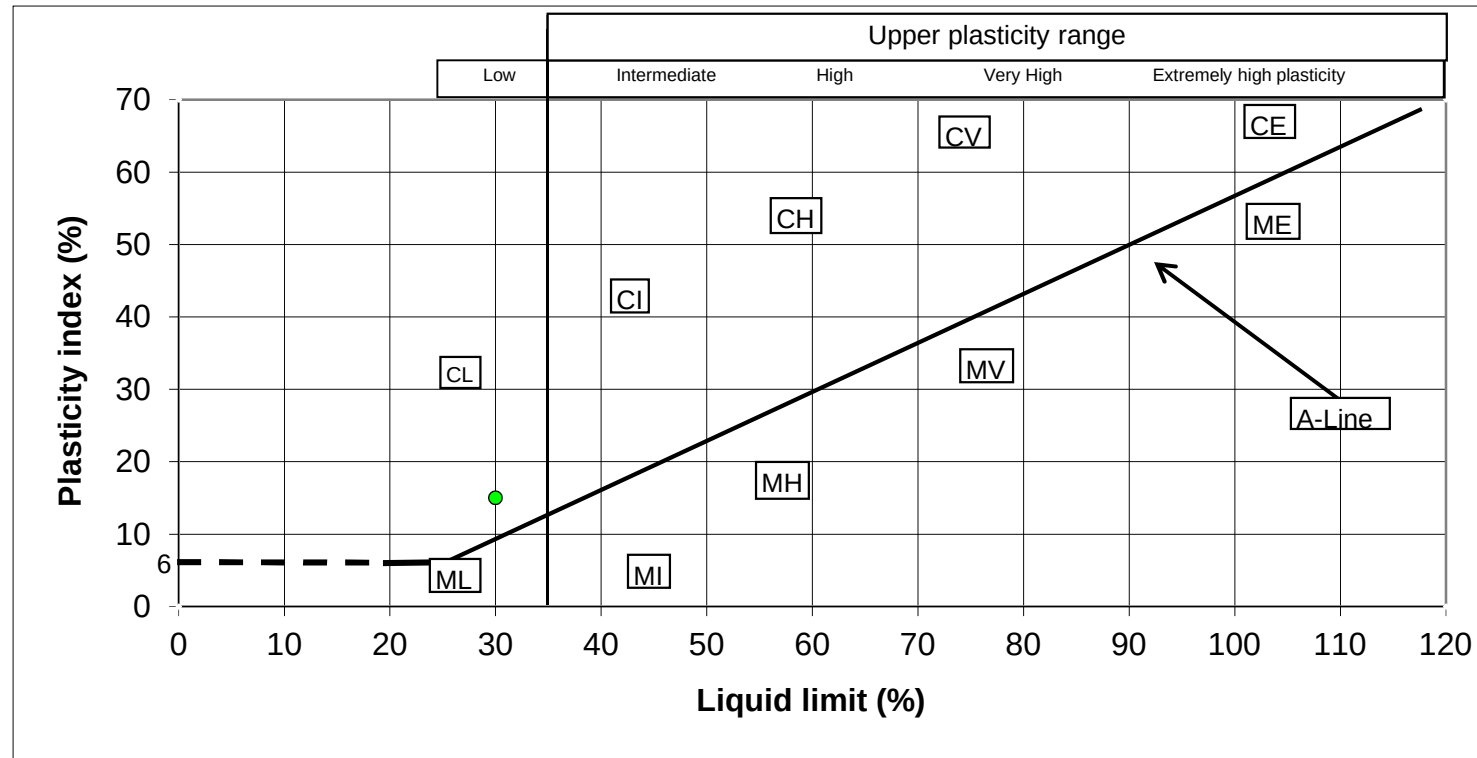
Operator	Checked	Approved	Sheet printed	Fig
JE	DK	DK	09/11/2019 10:53	Sheet



ATTERBERG TEST RESULT SHEET

BS 1377:Part 2:1990:cl 4.4,5

SILT (M-SOIL), M plots below A-Line , CLAY,C, plots above A-Line, M and C may be combined as FINE SOIL, F.



BH	Sample Depth	Liquid limit	Plasticity index
BH03	3.00	30.0	15.0



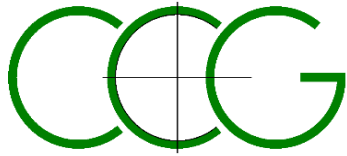
4514

APPROVED BY	DK
-------------	----

CLIENT: BRUNTWOOD SCIENCE LTD

SITE: CITY LABS, MANCHESTER (CCG-C-19-11195)

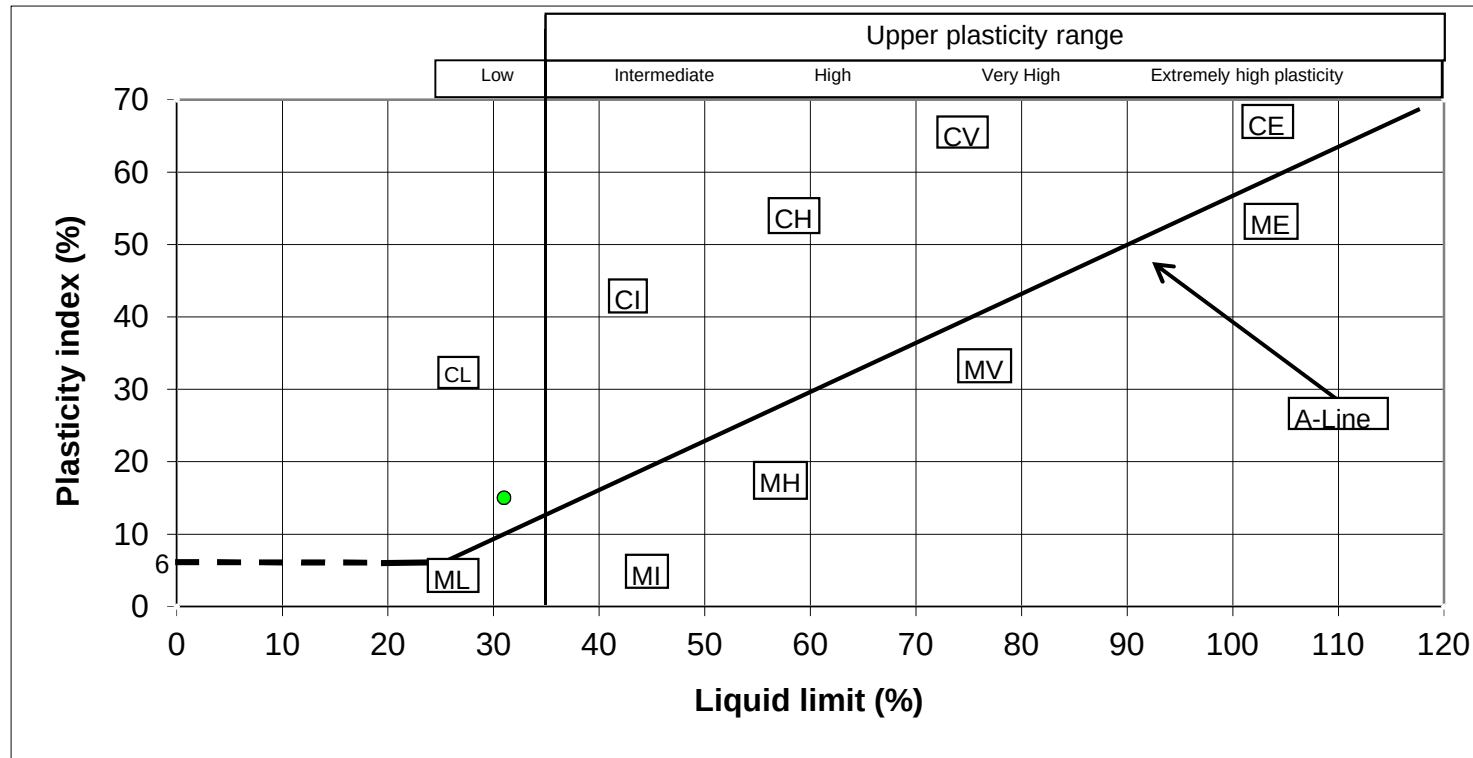
CCG-CMS-FO-204 Issue 2



ATTERBERG TEST RESULT SHEET

BS 1377:Part 2:1990:cl 4.4,5

SILT (M-SOIL), M plots below A-Line , CLAY,C, plots above A-Line, M and C may be combined as FINE SOIL, F.



BH	Sample Depth	Liquid limit	Plasticity index
BH03	5.00	31.0	15.0

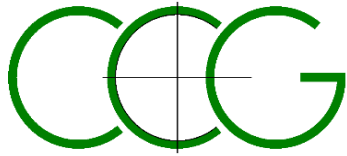


4514

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CLIENT: BRUNTWOOD SCIENCE LTD

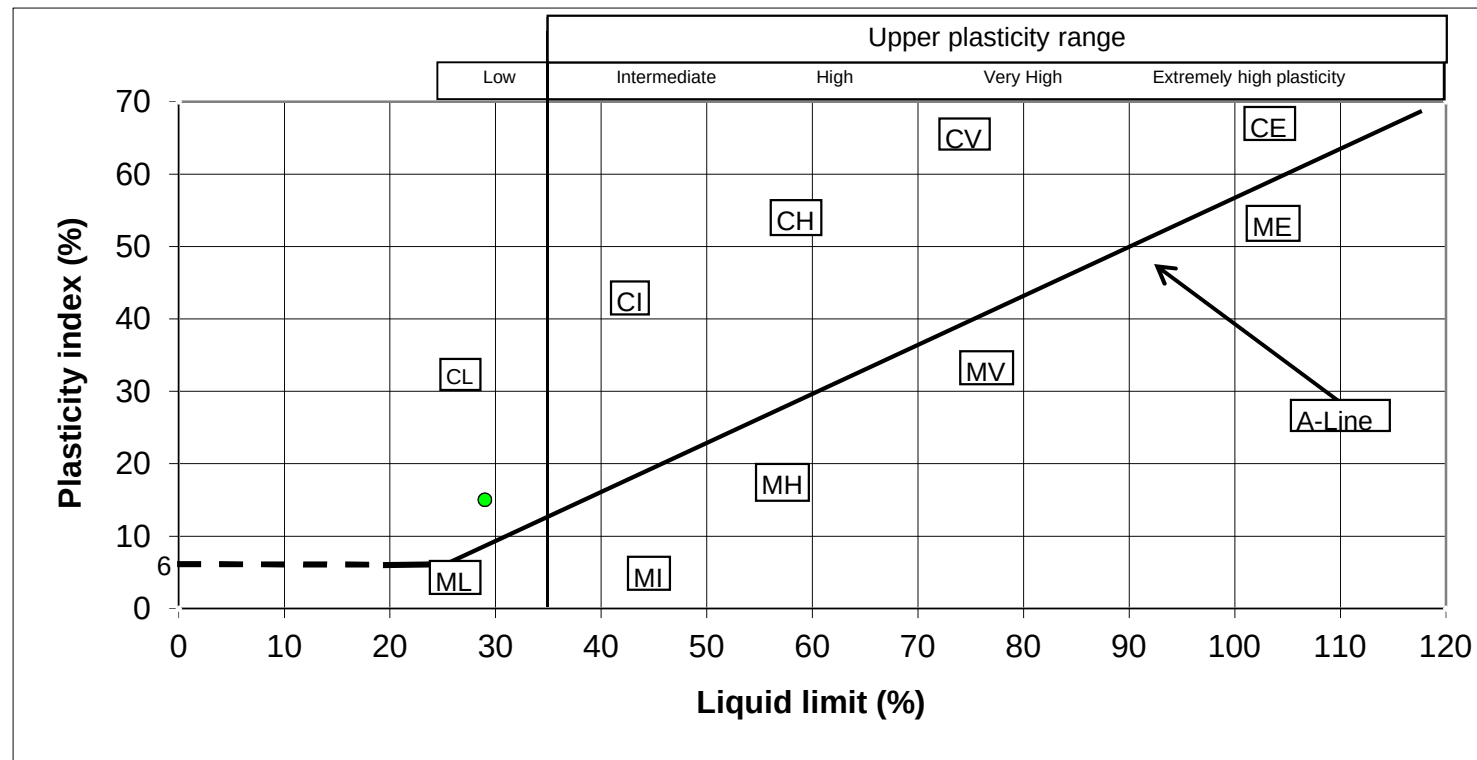
SITE: CITY LABS, MANCHESTER (CCG-C-19-11195)



ATTERBERG TEST RESULT SHEET

BS 1377:Part 2:1990:cl 4.4,5

SILT (M-SOIL), M plots below A-Line , CLAY,C, plots above A-Line, M and C may be combined as FINE SOIL, F.



BH	Sample Depth	Liquid limit	Plasticity index
BH03	6.00	29.0	15.0



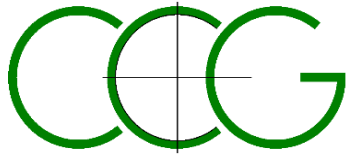
4514

APPROVED BY	DK
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CLIENT: BRUNTWOOD SCIENCE LTD

SITE: CITY LABS, MANCHESTER (CCG-C-19-11195)

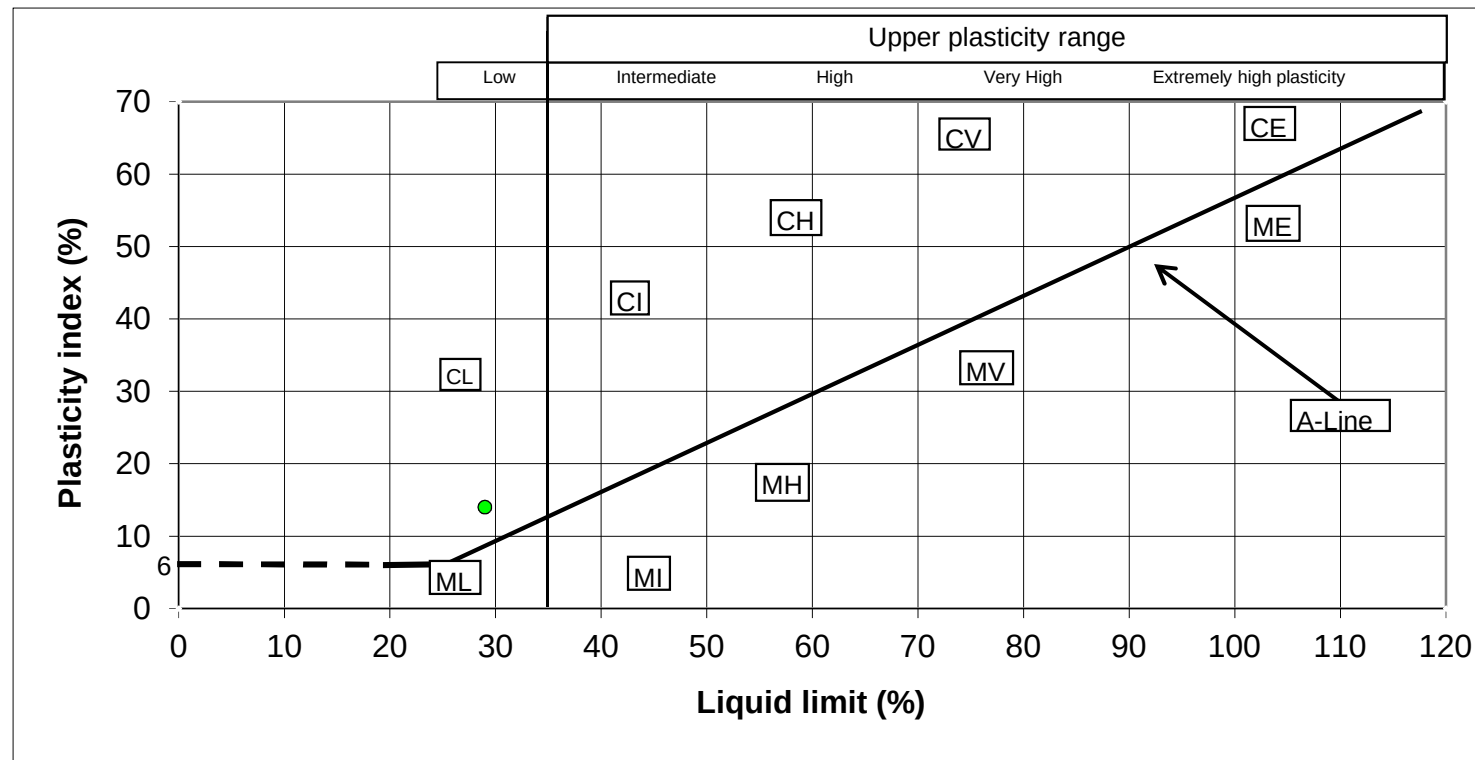
CCG-CMS-FO-204 Issue 2



ATTERBERG TEST RESULT SHEET

BS 1377:Part 2:1990:cl 4.4,5

SILT (M-SOIL), M plots below A-Line , CLAY,C, plots above A-Line, M and C may be combined as FINE SOIL, F.



BH	Sample Depth	Liquid limit	Plasticity index
BH03	8.00	29.0	14.0



4514

APPROVED BY	DK
-------------	----

CLIENT: BRUNTWOOD SCIENCE LTD

SITE: CITY LABS, MANCHESTER (CCG-C-19-11195)



CC Geotechnical Ltd
Tel: 0151 545 2750
e: lab@ccgeotechnical.com

Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen

Job Ref CCG-C-19-11195

Borehole/Pit No. BH03

Site Name CITY LABS, MANCHESTER

Sample No. 1

Soil Description Brown slightly sandy slightly gravelly silty CLAY

Depth 8.00

Specimen Reference Specimen Depth 8.00 m

Sample Type U

Specimen Description

Date of test

Test Method BS 1377:1990:Part 7

31.10.19



Test Number

1

Length

204.0 mm

Diameter

104.0 mm

Bulk Density

2.28 Mg/m³

Moisture Content

11.6 %

Dry Density

2.04 Mg/m³

Rate of Strain

2.0 %/min

Cell Pressure

160 kPa

At failure

Axial Strain

10.8 %

Deviator Stress, $(\sigma_1 - \sigma_3)_f$

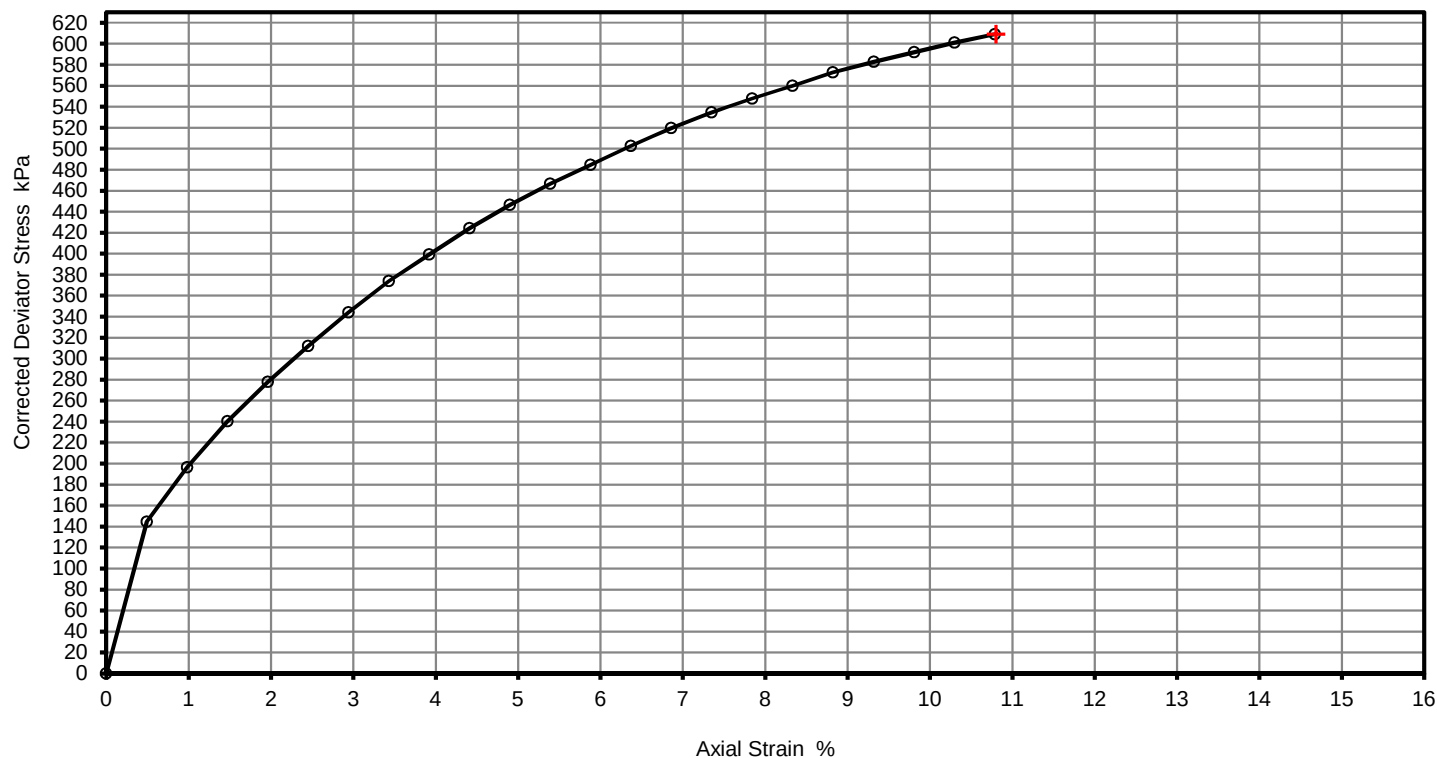
609 kPa

Undrained Shear Strength, c_u

>305* kPa $\frac{1}{2}(\sigma_1 - \sigma_3)_f$

Mode of Failure

Deviator Stress v Axial Strain



Remarks

*Test ceased - reached limitations of equipment

Approved

DK

Printed

06/11/2019 15:49

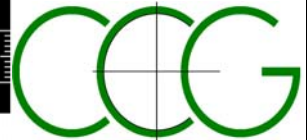
Fig. No.

1

Sheet

1

One Dimensional Consolidation Properties (Oedometer)

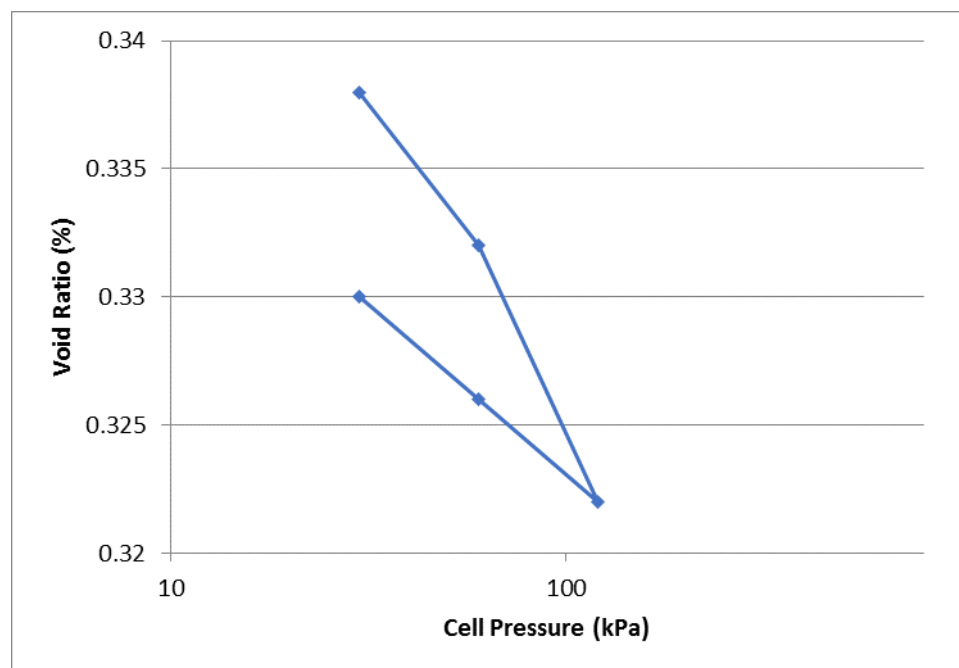


Client	BRUNTWOOD SCIENCE LTD	Lab Ref	
Project	CITY LABS, MANCHESTER	Job	CCG C 19 11195
Borehole	BH03	Sample	1

Test Details			
Standard	BS 1377: Part 5: 1990: Clause 3	Particle Density	2.65 Mg/m ³
Sample Type	Undisturbed sample - open drive	Lab Temperature	20.0 deg.C
Sample Depth	3.00 m		
Sample Description	Brown slightly sandy slightly gravelly silty CLAY		
Variations from Procedure	None		

Specimen Details			
Specimen Reference	A	Description	
Depth within Sample	0.00 mm	Orientation within Sample	
Specimen Mass	186.80 g	Condition	Natural Moisture
Specimen Height	19.08 mm	Preparation	
Comments			

Test Apparatus			
Ring Number	8	Ring Diameter	74.92 mm
Ring Height	19.08 mm	Ring Weight	117.39 g
Lever Ratio	9.00: 1		



Height of Solid Particles	14.19 mm	Swelling Pressure	
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UKAS
TESTING
4514



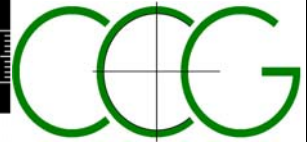
Initial Moisture Content*	12.7 %	Final Moisture Content	14.5 %
Initial Bulk Density	2.22 Mg/m ³	Final Bulk Density	2.28 Mg/m ³
Initial Dry Density	1.97 Mg/m ³	Final Dry Density	1.99 Mg/m ³
Initial Void Ratio	0.3450	Final Void Ratio	0.3296
Initial Degree of Saturation	97.67 %	Final Degree of Saturation	116.90 %

[illegible]

Method of Time Fitting Used	Log time
------------------------------------	----------

Tested by and Date:	DK 07.11.19
Checked by and Date:	DK 07.11.19
Approved by and Date:	CB 07.11.19

One Dimensional Consolidation Properties (Oedometer)

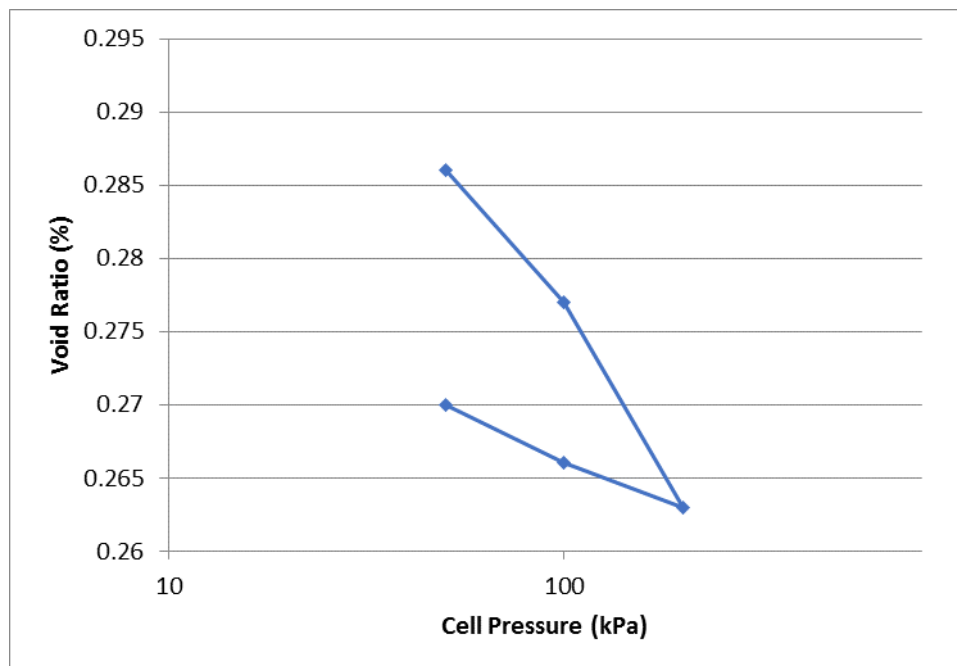


Client	BRUNTWOOD SCIENCE LTD	Lab Ref	
Project	CITY LABS, MANCHESTER	Job	CCG C 19 11195
Borehole	BH03	Sample	1

Test Details			
Standard	BS 1377: Part 5: 1990: Clause 3	Particle Density	2.65 Mg/m ³
Sample Type	Undisturbed sample - open drive	Lab Temperature	20.0 deg.C
Sample Depth	5.00 m		
Sample Description	Brown sandy slightly gravelly silty CLAY		
Variations from Procedure	None		

Specimen Details			
Specimen Reference	A	Description	
Depth within Sample	0.00 mm	Orientation within Sample	
Specimen Mass	201.31 g	Condition	Natural Moisture
Specimen Height	20.01 mm	Preparation	
Comments			

Test Apparatus			
Ring Number	1	Ring Diameter	74.95 mm
Ring Height	19.08 mm	Ring Weight	129.34 g
Lever Ratio	9.00: 1		



Height of Solid Particles	15.43 mm	Swelling Pressure	
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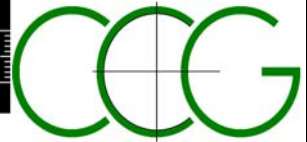
Initial Moisture Content*	11.6 %	Final Moisture Content	13.3 %
Initial Bulk Density	2.28 Mg/m ³	Final Bulk Density	2.36 Mg/m ³
Initial Dry Density	2.04 Mg/m ³	Final Dry Density	2.09 Mg/m ³
Initial Void Ratio	0.2968	Final Void Ratio	0.2697
Initial Degree of Saturation	103.47 %	Final Degree of Saturation	130.32 %

[illegible]

Method of Time Fitting Used	Log time
------------------------------------	----------

Tested by and Date:	DK 07.11.19
Checked by and Date:	DK 07.11.19
Approved by and Date:	CB 07.11.19

One Dimensional Consolidation Properties (Oedometer)

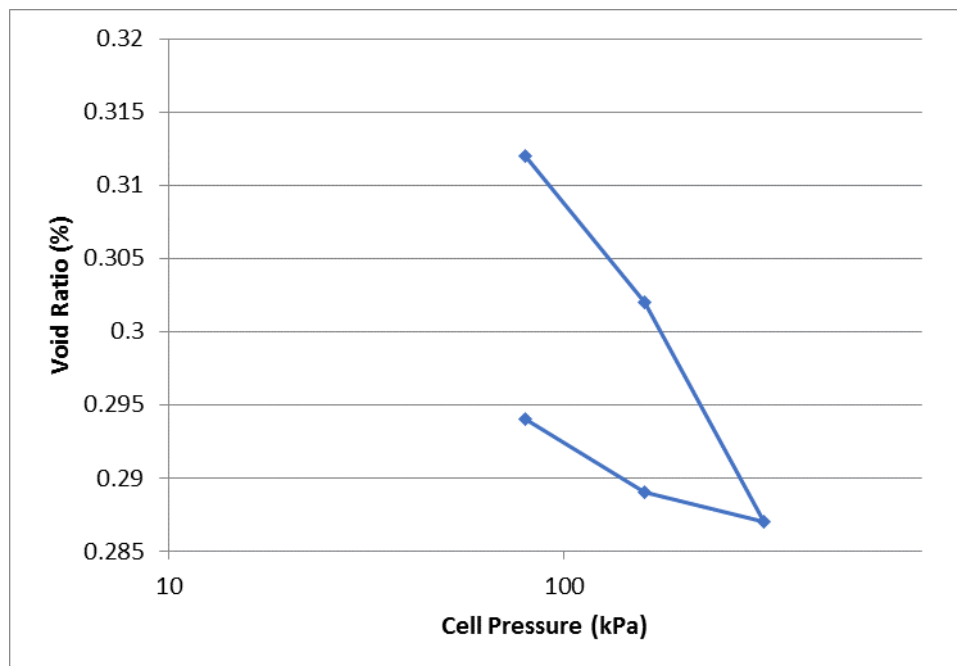


Client	BRUNTWOOD SCIENCE LTD	Lab Ref	
Project	CITY LABS, MANCHESTER	Job	CCG C 19 11195
Borehole	BH03	Sample	1

Test Details			
Standard	BS 1377: Part 5: 1990: Clause 3	Particle Density	2.65 Mg/m ³
Sample Type	Undisturbed sample - open drive	Lab Temperature	20.0 deg.C
Sample Depth	8.00 m		
Sample Description	Brown slightly sandy slightly gravelly silty CLAY		
Variations from Procedure	None		

Specimen Details			
Specimen Reference	A	Description	
Depth within Sample	0.00 mm	Orientation within Sample	
Specimen Mass	201.31 g	Condition	Natural Moisture
Specimen Height	20.01 mm	Preparation	
Comments			

Test Apparatus			
Ring Number	9	Ring Diameter	745.01 mm
Ring Height	20.22 mm	Ring Weight	127.43 g
Lever Ratio	9.00: 1		



Height of Solid Particles	15.22 mm	Swelling Pressure	
----------------------------------	----------	--------------------------	--

UKAS
TESTING
4514



Initial Moisture Content*	11.8 %	Final Moisture Content	13.0 %
Initial Bulk Density	2.23 Mg/m ³	Final Bulk Density	2.31 Mg/m ³
Initial Dry Density	2.00 Mg/m ³	Final Dry Density	2.05 Mg/m ³
Initial Void Ratio	0.3282	Final Void Ratio	0.2939
Initial Degree of Saturation	95.03 %	Final Degree of Saturation	117.33 %

[illegible]

Method of Time Fitting Used	Log time
------------------------------------	----------

Tested by and Date:	DK 07.11.19
Checked by and Date:	DK 07.11.19
Approved by and Date:	CB 07.11.19

POINT LOAD TEST RESULTS

ISRM 1985: Suggested Method

PROJECT No.:-

CCG-C-19-11195

SITE:-

CITYLABS, MANCHESTER

DATE:

07.11.19

[illegible]

*NOTE- a = axial ; d = diametral ; i = irregular lump or block (see diagrams, right, for details)

p = perpendicular; l = parallel, u = unknown

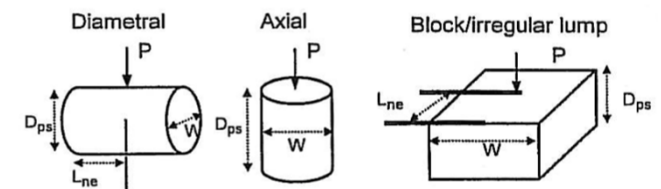
DIA. KEY- P = load ; Dps = platen seperation ;

W = width of shortest dimension perpendicular to load ;

Lne = length from platens to nearest free end

TESTED BY: JE

APPROVED BY: DK



SUMMARY OF LABORATORY SOIL TEST RESULTS

BH / TP / WS Number	Sample Type	Depth From (m)	Depth To (m)	Moisture Content (%)	Bulk Density (Mg/m ³)	Dry Density (Mg/m ³)	Shear Strength (kN/m ²)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 0.425m m (%)	Soil Classification	UKAS accredited test (Y/N)	Description / Test Method Samples described in accordance with BS EN ISO 14688-2 2004
TP01	B	0.50	0.50	15	-	-	-	-	-	-	-	-	Y	Brown gravelly slightly silty SAND. Gravel is fine to coarse angular to subangular brick and sandstone. (MADE GROUND) (BS1377Pt2:3.2)

SITE: CITY LABS, MANCHESTER (CCG-C-19-11195)
 CLIENT: BRUNTWOOD SCIENCE LTD

DATE: 07.11.19

Key:- BD = Bulk Disturbed; SD = Small Disturbed; U100 = Undisturbed 100mm; WS = Window Sample

CL = Low Plasticity; CI = Intermediate; CH = High; CV = Very high; CE = Extremely high; NP = Non-plastic

(* Denotes Hand Shear Vane test result)

Sample description not accredited by UKAS



11195 TP01 RES.xls

SUMMARY OF LABORATORY SOIL TEST RESULTS

BH / TP / WS Number	Sample Type	Depth From (m)	Depth To (m)	Moisture Content (%)	Bulk Density (Mg/m ³)	Dry Density (Mg/m ³)	Shear Strength (kN/m ²)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 0.425mm (%)	Soil Classification	UKAS accredited test (Y/N)	Description / Test Method Samples described in accordance with BS EN ISO 14688-2 2004
TP02	B	0.50	0.50	25	-	-	-	-	-	-	-	-	Y	Brown very gravelly silty slightly clayey fine to coarse grained SAND. Gravel is fine to coarse angular to subangular coal, sandstone, cinders, tarmac, concrete. (MADE GROUND) (BS1377Pt2:3.2,9.2,9.4)

SITE: CITY LABS, MANCHESTER (CCG-C-19-11195)
 CLIENT: BRUNTWOOD SCIENCE LTD

DATE: 09.11.19

Key:- BD = Bulk Disturbed; SD = Small Disturbed; U100 = Undisturbed 100mm; WS = Window Sample

CL = Low Plasticity; CI = Intermediate; CH = High; CV = Very high; CE = Extremely high; NP = Non-plastic

(* Denotes Hand Shear Vane test result)

Sample description not accredited by UKAS



11195 TP02 RES.xls



CC Geotechnical Ltd
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PARTICLE SIZE DISTRIBUTION

Job Ref

CCG-C-19-11195

Borehole/Pit No.

TP02

Site Name

CITY LABS, MANCHESTER

Sample No.

1

Specimen Description

Brown very gravelly silty slightly clayey fine to coarse grained SAND

Depth, m

0.50

Specimen Reference

Specimen Depth

m

Sample Type

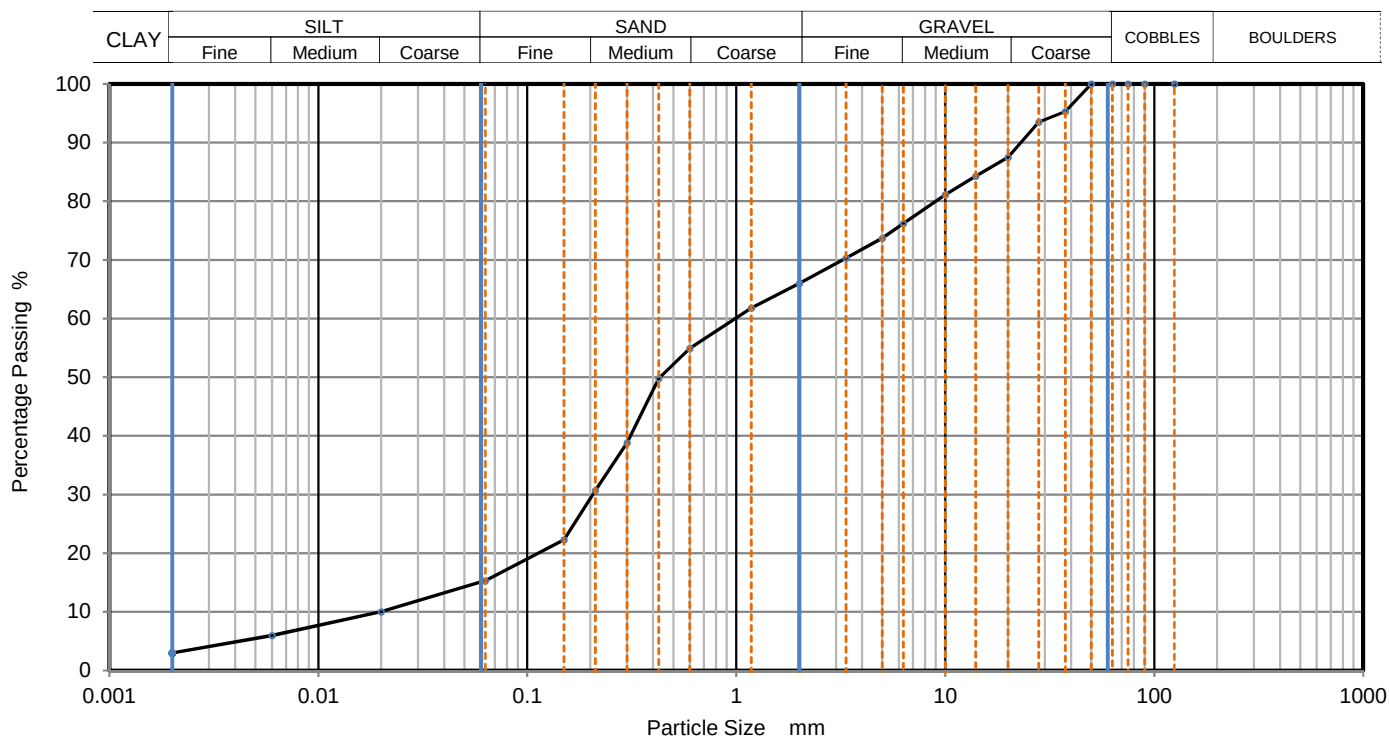
B

Test Method

BS1377:Part 2:1990 Clause 9.2 & 9.4

KeyLAB ID

CCGL201911091



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	10
90	100	0.0060	6
75	100	0.0020	3
63	100		
50	100		
37.5	95		
28	94		
20	88		
14	84		
10	81		
6.3	76		
5	74		
3.35	70		
2	66		
1.18	62		
0.6	55		
0.425	50		
0.3	39		
0.212	31		
0.15	22		
0.063	15		

Dry Mass of sample, g

Sample Proportions	% dry mass
Very coarse	0
Gravel	34
Sand	51
Silt	12
Clay	3

Grading Analysis	
D ₁₀₀	mm
D ₆₀	mm
D ₃₀	mm
D ₁₀	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	Fig
JE	DK	DK	09/11/2019 12:19	Sheet

SUMMARY OF LABORATORY SOIL TEST RESULTS

BH / TP / WS Number	Sample Type	Depth From (m)	Depth To (m)	Moisture Content (%)	Bulk Density (Mg/m ³)	Dry Density (Mg/m ³)	Shear Strength (kN/m ²)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 0.425m m (%)	Soil Classification	UKAS accredited test (Y/N)	Description / Test Method Samples described in accordance with BS EN ISO 14688-2 2004
TP03	B	1.00	1.00	17	-	-	-	-	-	-	-	-	Y	Brown gravelly slightly silty SAND with medium cobble content. Gravel is fine to coarse angular to subangular brick, coal, cinders, glass. (MADE GROUND) (BS1377Pt2:3.2)

SITE: CITY LABS, MANCHESTER (CCG-C-19-11195)
 CLIENT: BRUNTWOOD SCIENCE LTD

DATE: 07.11.19

Key:- BD = Bulk Disturbed; SD = Small Disturbed; U100 = Undisturbed 100mm; WS = Window Sample

CL = Low Plasticity; CI = Intermediate; CH = High; CV = Very high; CE = Extremely high; NP = Non-plastic

(* Denotes Hand Shear Vane test result)

Sample description not accredited by UKAS



11195 TP03 RES.xls

SUMMARY OF LABORATORY SOIL TEST RESULTS

BH / TP / WS Number	Sample Type	Depth From (m)	Depth To (m)	Moisture Content (%)	Bulk Density (Mg/m ³)	Dry Density (Mg/m ³)	Shear Strength (kN/m ²)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 0.425m m (%)	Soil Classification	UKAS accredited test (Y/N)	Description / Test Method Samples described in accordance with BS EN ISO 14688-2 2004
TP04	B	0.50	0.50	24	-	-	-	-	-	-	-	-	Y	Black very sandy silty GRAVEL. Gravel is fine to coarse subangular to subrounded concrete, coal, cinders, brick, glass. (MADE GROUND) (BS1377Pt2:3.2,9.2,9.4)
TP04	B	3.60	3.60	18	-	-	-	-	-	-	-	-	Y	Brown slightly sandy slightly gravelly silty CLAY. Gravel is fine to medium subrounded sandstone. (BS1377Pt2:3.2)

SITE: CITY LABS, MANCHESTER (CCG-C-19-11195)
CLIENT: BRUNTWOOD SCIENCE LTD

DATE: 09.11.19

Key:- BD = Bulk Disturbed; SD = Small Disturbed; U100 = Undisturbed 100mm; WS = Window Sample

CL = Low Plasticity; CI = Intermediate; CH = High; CV = Very high; CE = Extremely high; NP = Non-plastic

(* Denotes Hand Shear Vane test result)

Sample description not accredited by UKAS



11195 TP04 RES.xls



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PARTICLE SIZE DISTRIBUTION

Job Ref

CCG-C-19-11195

Borehole/Pit No.

TP04

Site Name

CITY LABS, MANCHESTER

Sample No.

1

Specimen
Description

Black very sandy silty GRAVEL

Depth, m

0.50

Specimen
Reference

Specimen
Depth

m

Sample Type

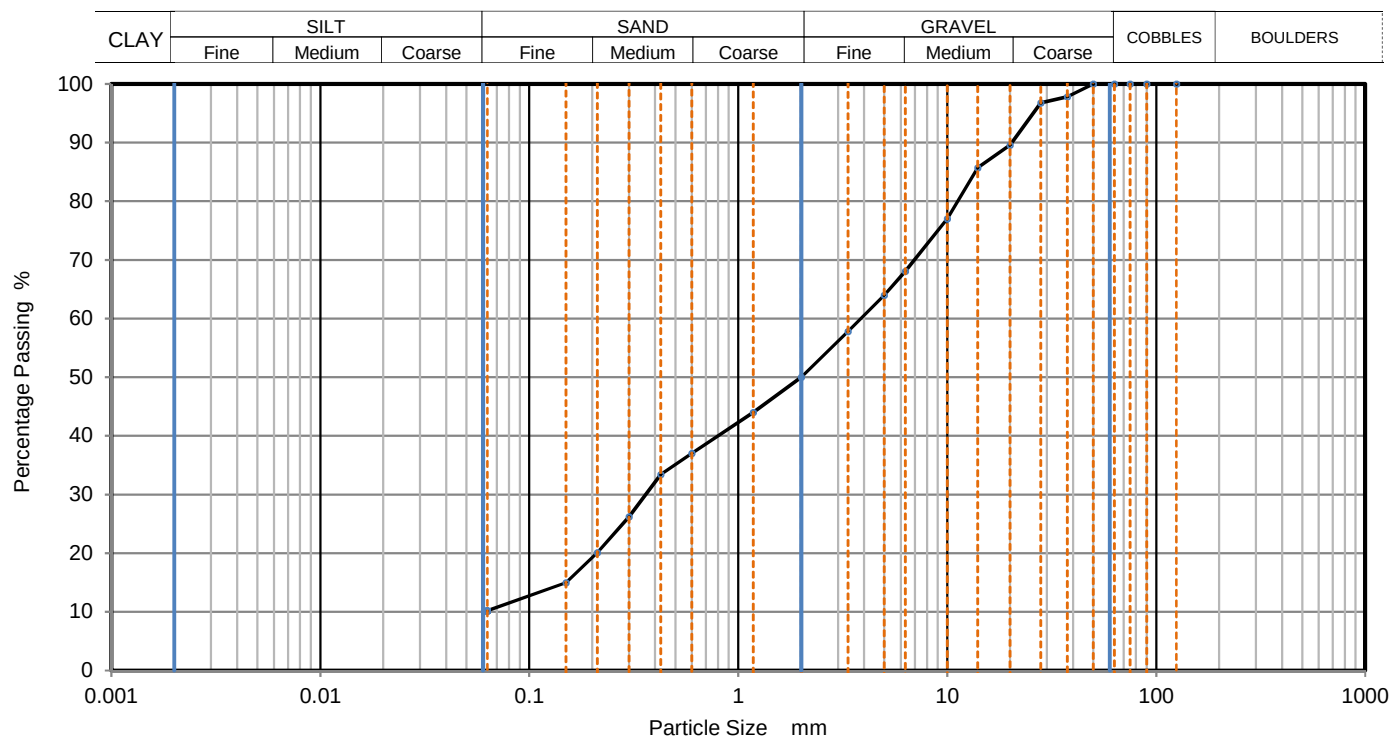
B

Test Method

BS1377:Part 2:1990 Clause 9.2

KeyLAB ID

CCGL201911092



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	98		
28	97		
20	90		
14	86		
10	77		
6.3	68		
5	64		
3.35	58		
2	50		
1.18	44		
0.6	37		
0.425	33		
0.3	26		
0.212	20		
0.15	15		
0.063	10		

Dry Mass of sample, g

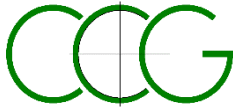
Sample Proportions	% dry mass
Very coarse	0
Gravel	50
Sand	40
Fines <0.063mm	10

Grading Analysis	
D ₁₀₀	mm
D ₆₀	mm
D ₃₀	mm
D ₁₀	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	Fig
JE	DK	DK	09/11/2019 13:25	Sheet



Laboratory Determination of California Bearing Ratio
B.S. 1377 (1990) : Part 4 : Clause 7

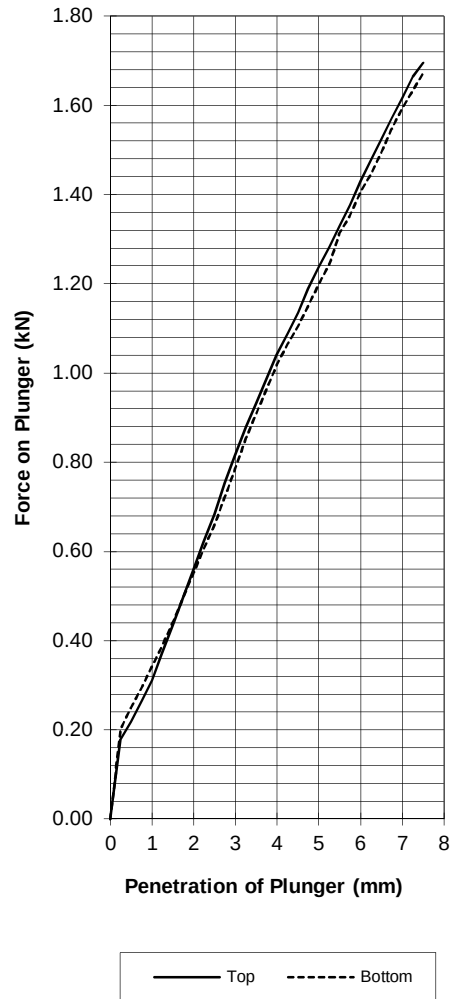
PROJECT No.: CCG-C-19-11195
SITE: CITY LABS, MANCHESTER
CLIENT: BRUNTWOOD SCIENCE LTD
BH / TP : TP04 DEPTH: 0.5 m

Proving ring No. 1155-8-1513
Division interval 0.0077736 kN/division
Surcharge 2 kg
Seating Load 10 N

MATERIAL DESCRIPTION Black very sandy silty GRAVEL

Mass of mould 4805 g
Mass of mould & compacted soil 9097 g
Depth of mould 127 mm
Diameter of mould 152 mm

Penetration of plunger	TOP		BOTTOM	
	mm	kN	mm	kN
0.00	0.00	0.00	0.00	0.00
0.25	0.18	23.00	0.20	26.00
0.50	0.22	28.00	0.25	32.00
0.75	0.26	34.00	0.30	38.00
1.00	0.31	40.00	0.34	44.00
1.25	0.37	48.00	0.39	50.00
1.50	0.44	56.00	0.44	57.00
1.75	0.50	64.00	0.50	64.00
2.00	0.56	72.00	0.55	71.00
2.25	0.62	80.00	0.61	78.00
2.50	0.68	88.00	0.66	85.00
2.75	0.75	97.00	0.72	93.00
3.00	0.82	105.00	0.79	101.00
3.25	0.88	113.00	0.86	110.00
3.50	0.93	120.00	0.91	117.00
3.75	0.99	127.00	0.96	124.00
4.00	1.04	134.00	1.02	131.00
4.25	1.09	140.00	1.06	137.00
4.50	1.13	146.00	1.10	142.00
4.75	1.19	153.00	1.15	148.00
5.00	1.24	159.00	1.20	154.00
5.25	1.28	165.00	1.24	160.00
5.50	1.33	171.00	1.31	169.00
5.75	1.38	177.00	1.35	174.00
6.00	1.43	184.00	1.41	181.00
6.25	1.48	190.00	1.45	186.00
6.50	1.52	196.00	1.49	192.00
6.75	1.57	202.00	1.55	199.00
7.00	1.62	208.00	1.59	205.00
7.25	1.66	214.00	1.63	210.00
7.50	1.69	218.00	1.67	215.00



RESULTS

Penetration (mm)	Force		Standard Force (kN)	CBR	
	Top (kN)	Bottom (kN)		Top (%)	Bottom (%)
2.50	0.68	0.66	13.2	5.2	5.0
5.00	1.24	1.20	20	6.2	6.0

Mass of compacted soil 4292 g

Volume of mould 2305 cm³

M/C of sample 24 %

Bulk density of compacted specimen 1.862 Mg/m³

Dry density of compacted specimen 1.502 Mg/m³

CBR Values 6.2 6.0 %

CBR result 6.2 %

SUMMARY OF LABORATORY SOIL TEST RESULTS

BH / TP / WS Number	Sample Type	Depth From (m)	Depth To (m)	Moisture Content (%)	Bulk Density (Mg/m ³)	Dry Density (Mg/m ³)	Shear Strength (kN/m ²)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 0.425mm (%)	Soil Classification	UKAS accredited test (Y/N)	Description / Test Method Samples described in accordance with BS EN ISO 14688-2 2004
TP05	B	1.00	1.00	-	-	-	-	-	-	-	-	-	Y	Black very silty very gravelly fine to coarse grained SAND. Gravel is fine to coarse subangular coal, cinders, concrete, brick. (MADE GROUND) (BS1377Pt2:9.2)
TP05	B	2.00	2.00	21	-	-	-	-	-	-	-	-	Y	Greyish brown sandy slightly gravelly silty CLAY recovered as gravelly sand with frequent large pockets of clay. Gravel is fine to coarse subangular to subrounded sandstone, mudstone, quartz. (BS1377Pt2:3.2,9.2,9.4)

SITE: CITY LABS, MANCHESTER (CCG-C-19-11195)
 CLIENT: BRUNTWOOD SCIENCE LTD

DATE: 09.11.19

Key:- BD = Bulk Disturbed; SD = Small Disturbed; U100 = Undisturbed 100mm; WS = Window Sample

CL = Low Plasticity; CI = Intermediate; CH = High; CV = Very high; CE = Extremely high; NP = Non-plastic

(* Denotes Hand Shear Vane test result)

Sample description not accredited by UKAS



11195 TP05 RES.xls



CC Geotechnical Ltd
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PARTICLE SIZE DISTRIBUTION

Job Ref

CCG-C-19-11195

Borehole/Pit No.

TP05

Site Name

CITY LABS, MANCHESTER

Sample No.

1

Specimen Description

Black very silty very gravelly fine to coarse grained SAND

Depth, m

1.00

Specimen Reference

Specimen Depth

m

Sample Type

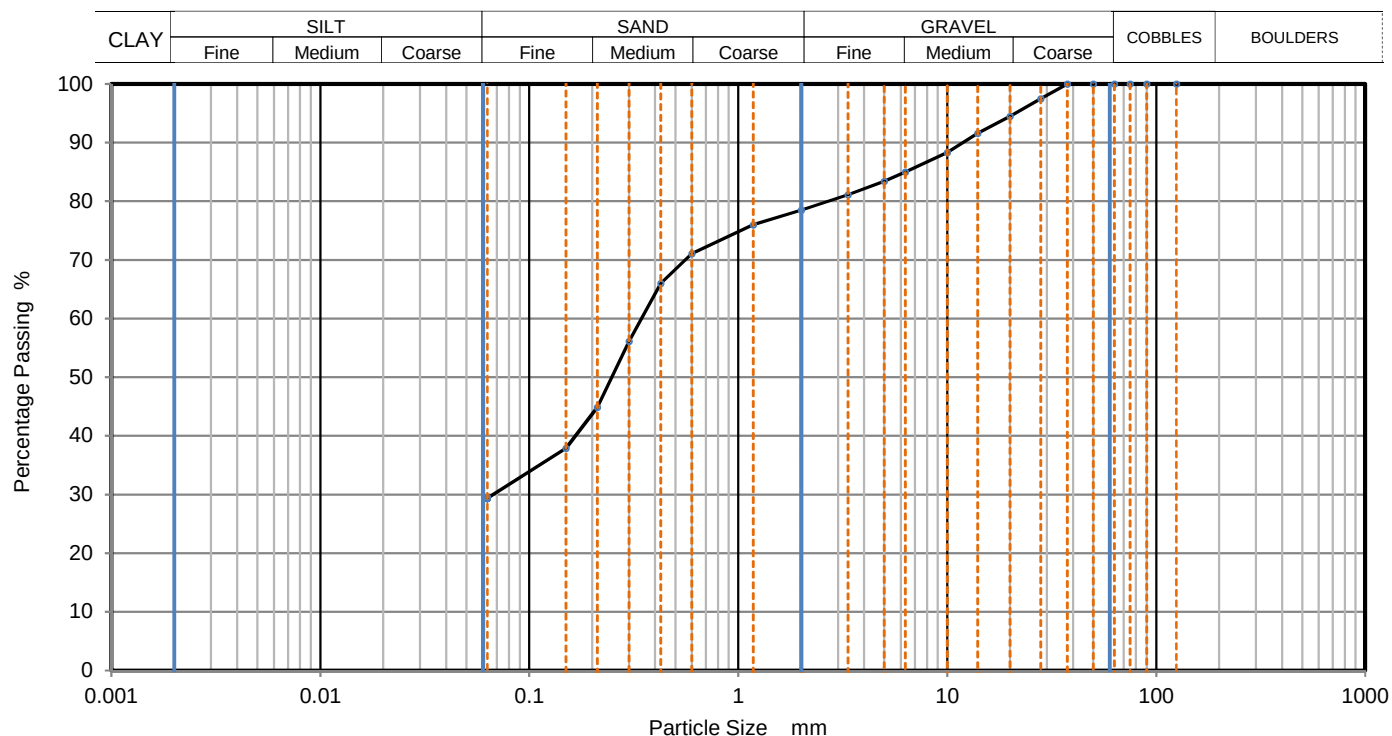
B

Test Method

BS1377:Part 2:1990 Clause 9.2

KeyLAB ID

CCGL201911094



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	98		
20	95		
14	92		
10	88		
6.3	85		
5	83		
3.35	81		
2	79		
1.18	76		
0.6	71		
0.425	66		
0.3	56		
0.212	45		
0.15	38		
0.063	29		

Dry Mass of sample, g

Sample Proportions	% dry mass
Very coarse	0
Gravel	21
Sand	50
Fines <0.063mm	29

Grading Analysis	
D ₁₀₀	mm
D ₆₀	mm
D ₃₀	mm
D ₁₀	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	Fig
JE	DK	DK	09/11/2019 12:08	Sheet



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PARTICLE SIZE DISTRIBUTION

Job Ref

CCG-C-19-11195

Borehole/Pit No.

TP05

Site Name

CITY LABS, MANCHESTER

Sample No.

1

Specimen Description

Greyish brown sandy slightly gravelly silty CLAY

Depth, m

2.00

Specimen Reference

Specimen Depth

m

Sample Type

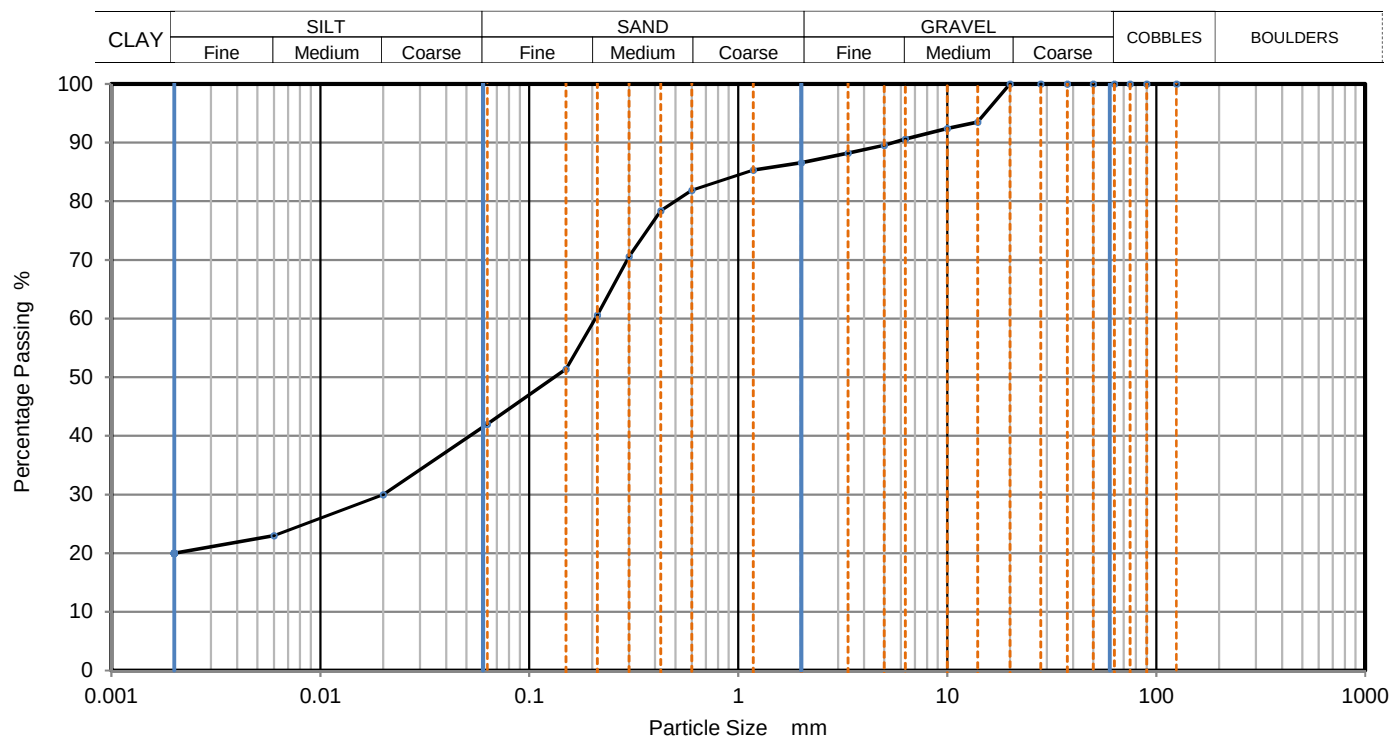
B

Test Method

BS1377:Part 2:1990 Clause 9.2 & 9.4

KeyLAB ID

CCGL201911095



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	30
90	100	0.0060	23
75	100	0.0020	20
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	94		
10	92		
6.3	91		
5	90		
3.35	88		
2	87		
1.18	85		
0.6	82		
0.425	78		
0.3	71		
0.212	61		
0.15	51		
0.063	42		

Dry Mass of sample, g

Sample Proportions	% dry mass
Very coarse	0
Gravel	13
Sand	45
Silt	22
Clay	20

Grading Analysis	
D ₁₀₀	mm
D ₆₀	mm
D ₃₀	mm
D ₁₀	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	Fig
JE	DK	DK	09/11/2019 12:12	Sheet



Laboratory Determination of California Bearing Ratio

B.S. 1377 (1990) : Part 4 : Clause 7

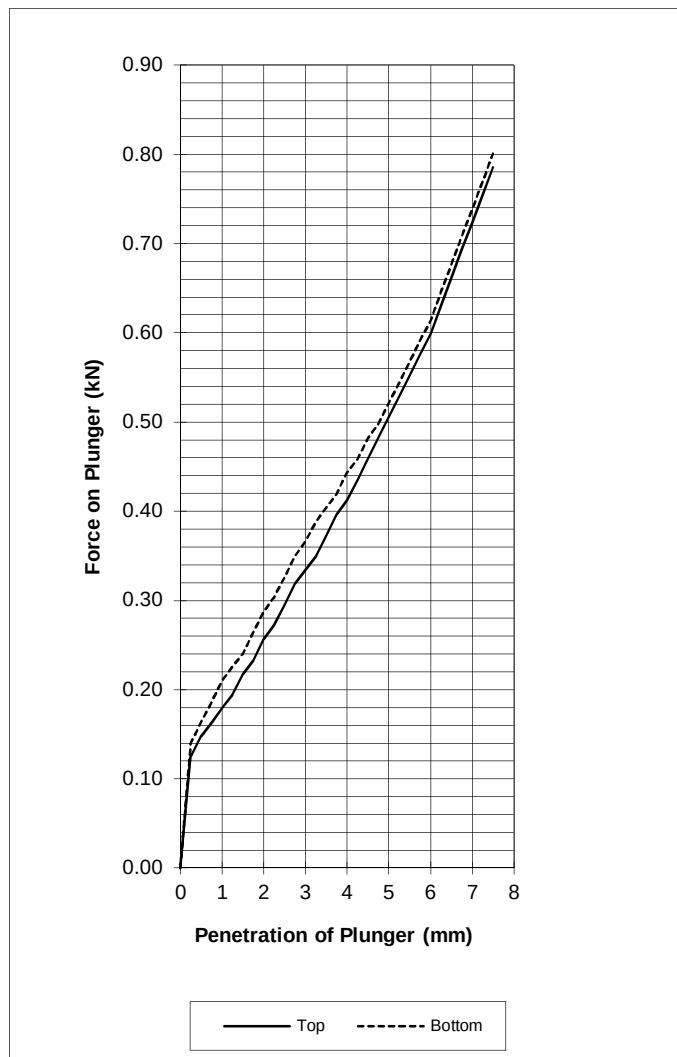
PROJECT No.:	CCG-C-19-11195
SITE:	CITY LABS, MANCHESTER
CLIENT:	BRUNTWOOD SCIENCE LTD
BH / TP :	TP5 DEPTH: 1.00 m

Proving ring No.	1155-8-1513
Division interval	0.0077736 kN/division
Surcharge	2 kg
Seating Load	10 N

MATERIAL DESCRIPTION

Mass of mould	4805 g	Depth of mould	127 mm
Mass of mould & compacted soil	9040 g	Diameter of mould	152 mm

Penetration of plunger	TOP		BOTTOM	
	mm	Load Gauge	mm	Load Gauge
0.00	0.00	0.00	0.00	0.00
0.25	0.12	16.00	0.14	18.00
0.50	0.15	19.00	0.16	21.00
0.75	0.16	21.00	0.19	24.00
1.00	0.18	23.00	0.21	27.00
1.25	0.19	25.00	0.23	29.00
1.50	0.22	28.00	0.24	31.00
1.75	0.23	30.00	0.26	34.00
2.00	0.26	33.00	0.29	37.00
2.25	0.27	35.00	0.30	39.00
2.50	0.30	38.00	0.33	42.00
2.75	0.32	41.00	0.35	45.00
3.00	0.33	43.00	0.37	47.00
3.25	0.35	45.00	0.39	50.00
3.50	0.37	48.00	0.40	52.00
3.75	0.40	51.00	0.42	54.00
4.00	0.41	53.00	0.44	57.00
4.25	0.44	56.00	0.46	59.00
4.50	0.46	59.00	0.48	62.00
4.75	0.48	62.00	0.50	64.00
5.00	0.51	65.00	0.52	67.00
5.25	0.53	68.00	0.54	70.00
5.50	0.55	71.00	0.57	73.00
5.75	0.58	74.00	0.59	76.00
6.00	0.60	77.00	0.61	79.00
6.25	0.63	81.00	0.65	83.00
6.50	0.66	85.00	0.68	87.00
6.75	0.69	89.00	0.71	91.00
7.00	0.72	93.00	0.74	95.00
7.25	0.75	97.00	0.77	99.00
7.50	0.79	101.00	0.80	103.00



RESULTS

Penetration (mm)	Force		Standard Force (kN)	CBR	
	Top (kN)	Bottom (kN)		Top (%)	Bottom (%)
2.50	0.30	0.33	13.2	2.2	2.5
5.00	0.51	0.52	20	2.5	2.6

Mass of compacted soil **4235 g**

Volume of mould **2305 cm³**

M/C of sample **23.8 %**

Bulk density of compacted specimen **1.838 Mg/m³**

Dry density of compacted specimen **1.484 Mg/m³**

CBR Values **2.5** **2.6 %**

CBR result **2.6 %**

SUMMARY OF LABORATORY SOIL TEST RESULTS

BH / TP / WS Number	Sample Type	Depth From (m)	Depth To (m)	Moisture Content (%)	Bulk Density (Mg/m ³)	Dry Density (Mg/m ³)	Shear Strength (kN/m ²)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 0.425mm (%)	Soil Classification	UKAS accredited test (Y/N)	Description / Test Method Samples described in accordance with BS EN ISO 14688-2 2004
TP06	B	0.50	0.50	24	-	-	-	-	-	-	-	-	Y	Brown very gravelly silty slightly clayey fine to coarse grained SAND. Gravel is fine to coarse subangular coal, concrete, ceramic, brick, glass. (MADE GROUND) (BS1377Pt2:3.2,9.2,9.4)

SITE: CITY LABS, MANCHESTER (CCG-C-19-11195)
 CLIENT: BRUNTWOOD SCIENCE LTD

DATE: 09.11.19

Key:- BD = Bulk Disturbed; SD = Small Disturbed; U100 = Undisturbed 100mm; WS = Window Sample

CL = Low Plasticity; CI = Intermediate; CH = High; CV = Very high; CE = Extremely high; NP = Non-plastic

(* Denotes Hand Shear Vane test result)

Sample description not accredited by UKAS



11195 TP06 RES.xls



CC Geotechnical Ltd
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PARTICLE SIZE DISTRIBUTION

Job Ref

CCG-C-19-11195

Borehole/Pit No.

TP06

Site Name

CITY LABS, MANCHESTER

Sample No.

1

Specimen Description

Brown very gravelly silty slightly clayey fine to coarse grained SAND

Depth, m

0.50

Specimen Reference

Specimen Depth

m

Sample Type

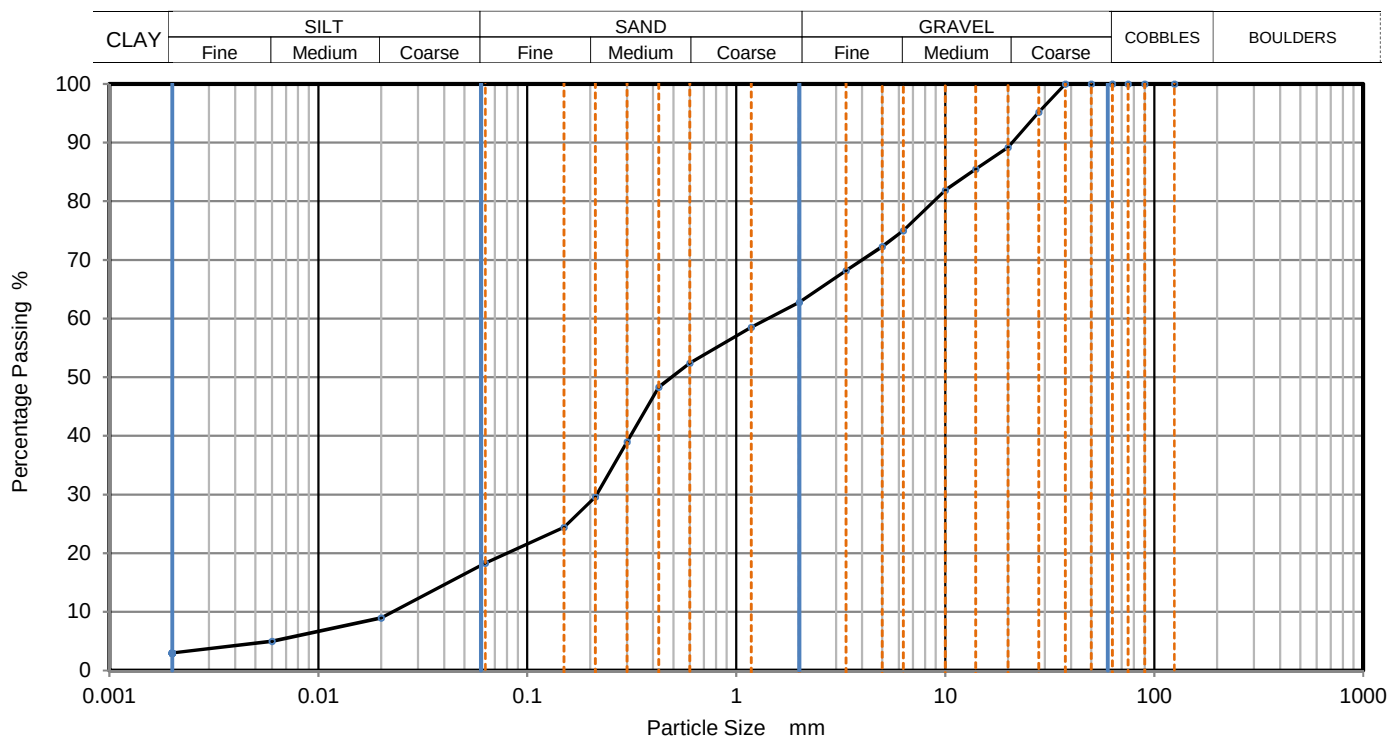
B

Test Method

BS1377:Part 2:1990 Clause 9.2 & 9.4

KeyLAB ID

CCGL201911096



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	9
90	100	0.0060	5
75	100	0.0020	3
63	100		
50	100		
37.5	100		
28	95		
20	89		
14	86		
10	82		
6.3	75		
5	72		
3.35	68		
2	63		
1.18	59		
0.6	52		
0.425	48		
0.3	39		
0.212	30		
0.15	24		
0.063	18		

Dry Mass of sample, g

Sample Proportions	% dry mass
Very coarse	0
Gravel	37
Sand	45
Silt	15
Clay	3

Grading Analysis	
D ₁₀₀	mm
D ₆₀	mm
D ₃₀	mm
D ₁₀	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	Fig
JE	DK	DK	09/11/2019 12:26	Sheet

SUMMARY OF LABORATORY SOIL TEST RESULTS

BH / TP / WS Number	Sample Type	Depth From (m)	Depth To (m)	Moisture Content (%)	Bulk Density (Mg/m ³)	Dry Density (Mg/m ³)	Shear Strength (kN/m ²)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 0.425mm (%)	Soil Classification	UKAS accredited test (Y/N)	Description / Test Method Samples described in accordance with BS EN ISO 14688-2 2004
TP07	B	1.50	1.50	21	-	-	-	-	-	-	-	-	Y	Brown very gravelly silty fine to coarse grained SAND. Gravel is fine to coarse subangular brick, concrete, cinders, glass, metal. (MADE GROUND) (BS1377Pt2:3.2,9.2)

SITE: CITY LABS, MANCHESTER (CCG-C-19-11195)
 CLIENT: BRUNTWOOD SCIENCE LTD

DATE: 09.11.19

Key:- BD = Bulk Disturbed; SD = Small Disturbed; U100 = Undisturbed 100mm; WS = Window Sample

CL = Low Plasticity; CI = Intermediate; CH = High; CV = Very high; CE = Extremely high; NP = Non-plastic

(* Denotes Hand Shear Vane test result)

Sample description not accredited by UKAS



11195 TP07 RES.xls



CC Geotechnical Ltd
Tel: 0151 545 2750
e: lab@ccgeotechnical.com

PARTICLE SIZE DISTRIBUTION

Job Ref

CCG-C-19-11195

Borehole/Pit No.

TP07

Site Name

CITY LABS, MANCHESTER

Sample No.

1

Specimen Description

Brown very gravelly silty fine to coarse grained SAND

Depth, m

1.50

Specimen Reference

Specimen Depth

m

Sample Type

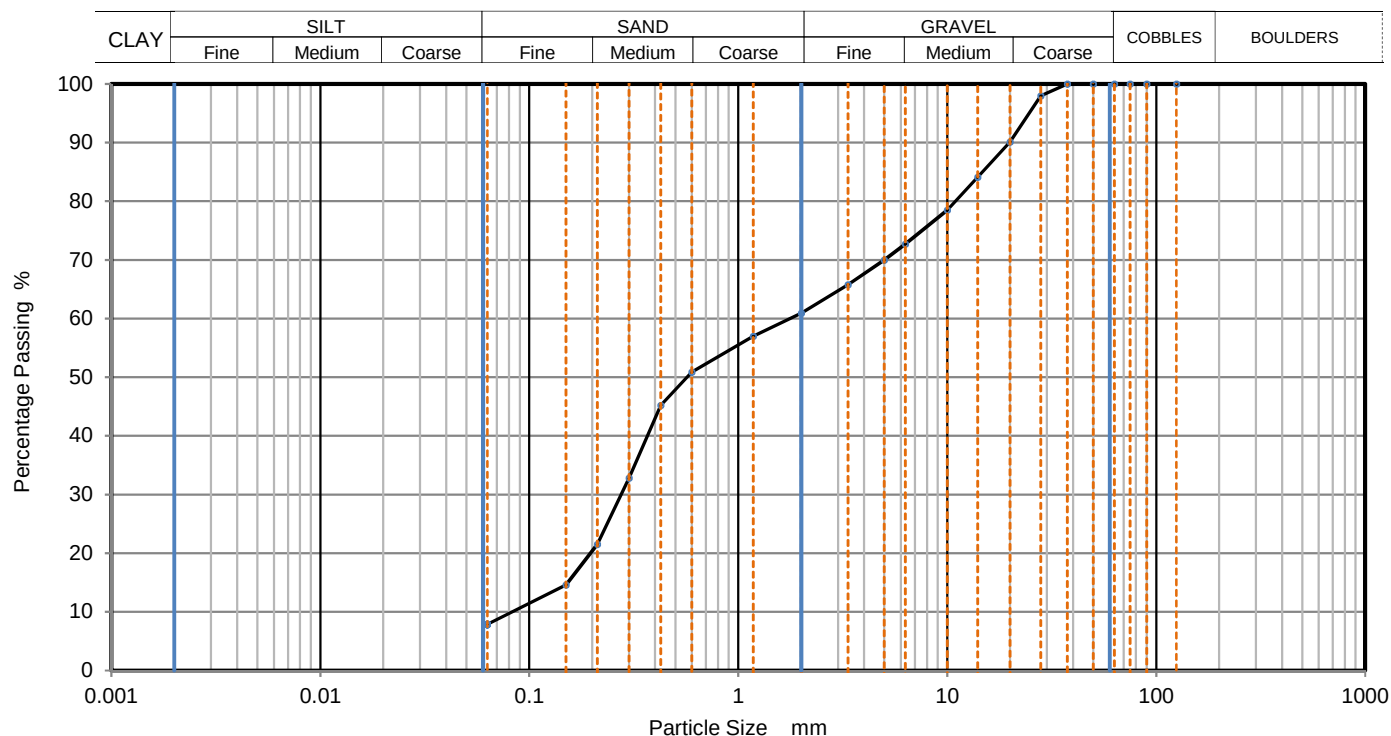
B

Test Method

BS1377:Part 2:1990 Clause 9.2

KeyLAB ID

CCGL201911093



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	98		
20	90		
14	84		
10	79		
6.3	73		
5	70		
3.35	66		
2	61		
1.18	57		
0.6	51		
0.425	45		
0.3	33		
0.212	22		
0.15	15		
0.063	8		

Dry Mass of sample, g

Sample Proportions	% dry mass
Very coarse	0
Gravel	39
Sand	53
Fines <0.063mm	8

Grading Analysis	
D ₁₀₀	mm
D ₆₀	mm
D ₃₀	mm
D ₁₀	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	Fig
JE	DK	DK	09/11/2019 12:01	Sheet

SUMMARY OF LABORATORY SOIL TEST RESULTS

BH / TP / WS Number	Sample Type	Depth From (m)	Depth To (m)	Moisture Content (%)	Bulk Density (Mg/m ³)	Dry Density (Mg/m ³)	Shear Strength (kN/m ²)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 0.425m m (%)	Soil Classification	UKAS accredited test (Y/N)	Description / Test Method Samples described in accordance with BS EN ISO 14688-2 2004
TP09	B	3.00	3.00	23	-	-	-	45	20	25	93	CI	Y	Brown slightly sandy slightly gravelly silty CLAY. Gravel is fine to medium subangular to subrounded sandstone. (BS1377Pt2:3.2,4.4,5)

SITE: CITY LABS, MANCHESTER (CCG-C-19-11195)
 CLIENT: BRUNTWOOD SCIENCE LTD

DATE: 09.11.19

Key:- BD = Bulk Disturbed; SD = Small Disturbed; U100 = Undisturbed 100mm; WS = Window Sample

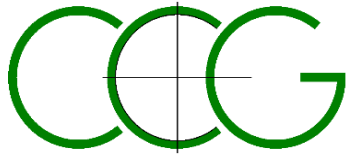
CL = Low Plasticity; CI = Intermediate; CH = High; CV = Very high; CE = Extremely high; NP = Non-plastic

(* Denotes Hand Shear Vane test result)

Sample description not accredited by UKAS



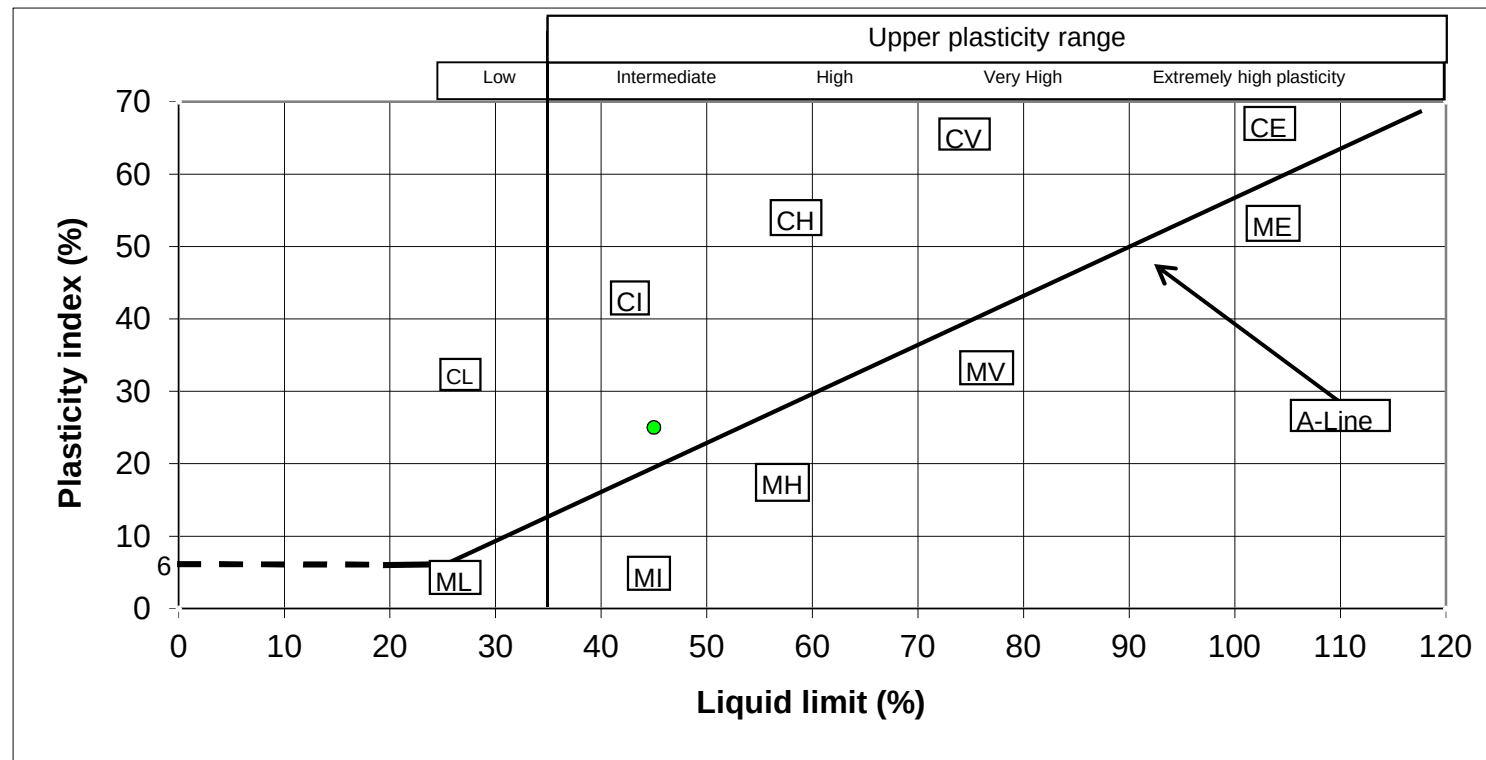
11195 TP09 RES.xls



ATTERBERG TEST RESULT SHEET

BS 1377:Part 2:1990:cl 4.4,5

SILT (M-SOIL), M plots below A-Line, CLAY, C, plots above A-Line, M and C may be combined as FINE SOIL, F.



BH	Sample Depth	Liquid limit	Plasticity index
TP09	3.00	45.0	25.0



4514

APPROVED BY	DK
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CLIENT: BRUNTWOOD SCIENCE LTD

SITE: CITY LABS, MANCHESTER (CCG-C-19-11195)

CCG-CMS-FO-204 Issue 2

SUMMARY OF LABORATORY SOIL TEST RESULTS

BH / TP / WS Number	Sample Type	Depth From (m)	Depth To (m)	Moisture Content (%)	Bulk Density (Mg/m ³)	Dry Density (Mg/m ³)	Shear Strength (kN/m ²)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 0.425m m (%)	Soil Classification	UKAS accredited test (Y/N)	Description / Test Method Samples described in accordance with BS EN ISO 14688-2 2004
TP10	B	3.50	3.50	23	-	-	-	33	16	17	93	CL	Y	Greyish brown slightly sandy slightly gravelly silty CLAY. Gravel is fine to medium subangular to subrounded sandstone. (BS1377Pt2:3.2,4.4,5)

SITE: CITY LABS, MANCHESTER (CCG-C-19-11195)
 CLIENT: BRUNTWOOD SCIENCE LTD

DATE: 07.11.19

Key:- BD = Bulk Disturbed; SD = Small Disturbed; U100 = Undisturbed 100mm; WS = Window Sample

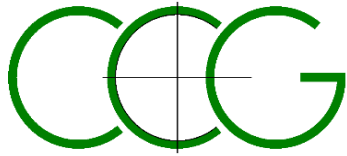
CL = Low Plasticity; CI = Intermediate; CH = High; CV = Very high; CE = Extremely high; NP = Non-plastic

(* Denotes Hand Shear Vane test result)

Sample description not accredited by UKAS



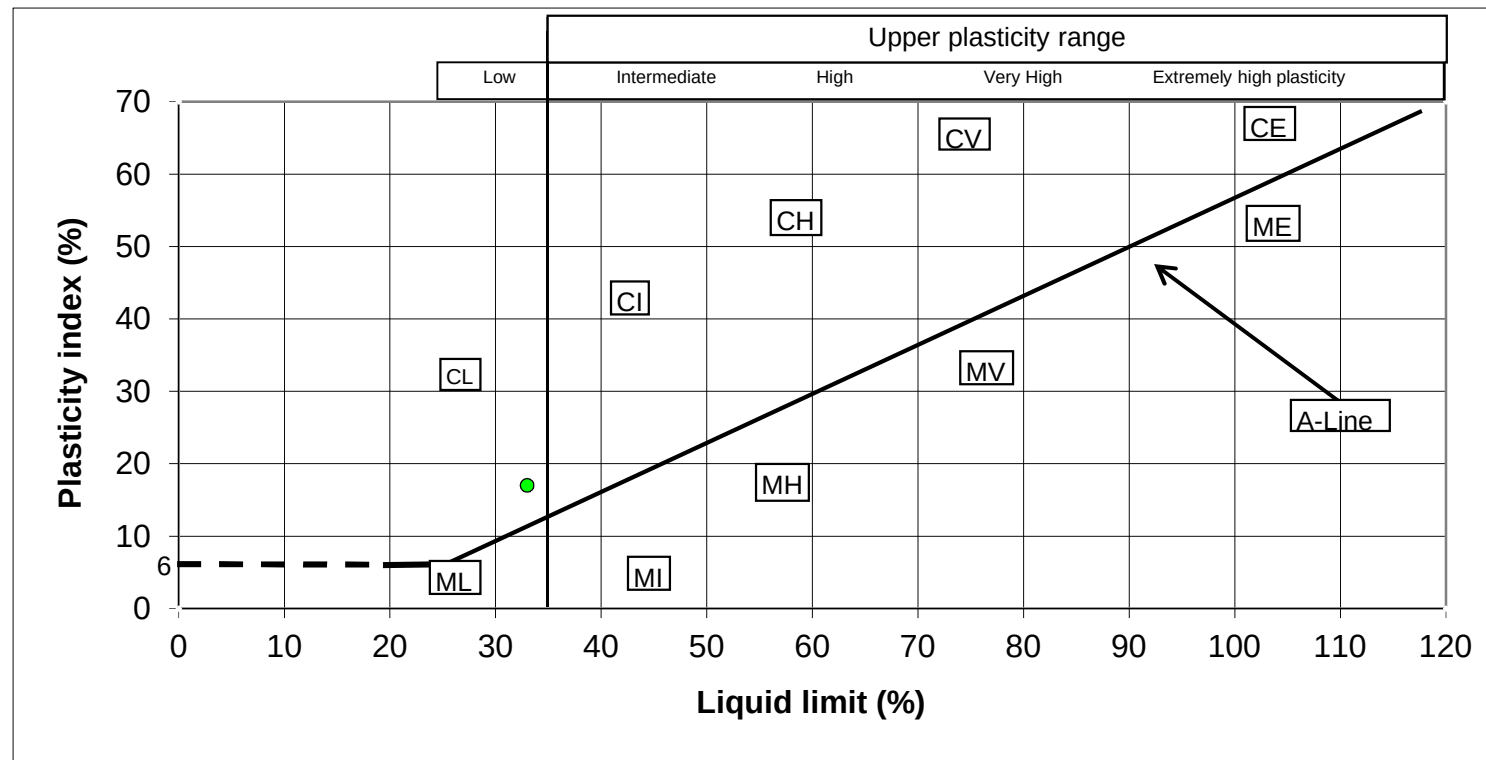
11195 TP10 RES.xls



ATTERBERG TEST RESULT SHEET

BS 1377:Part 2:1990:cl 4.4,5

SILT (M-SOIL), M plots below A-Line, CLAY, C, plots above A-Line, M and C may be combined as FINE SOIL, F.



BH	Sample Depth	Liquid limit	Plasticity index
TP10	3.50	33.0	17.0



4514

APPROVED BY	DK
-------------	----

CLIENT: BRUNTWOOD SCIENCE LTD

SITE: CITY LABS, MANCHESTER (CCG-C-19-11195)

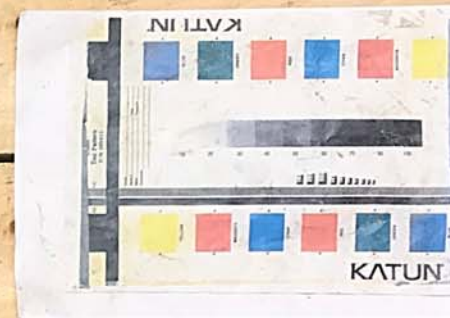
CCG-CMS-FO-204 Issue 2



APPENDIX F

ROCK CORE PHOTOGRAPHS

CCG REF: CCG-C-19-11195
SITE: CITYLABS,
MANCHESTER
CLIENT: BRUNTWOOD
BH1 13.5-16.5mbgl



13.5

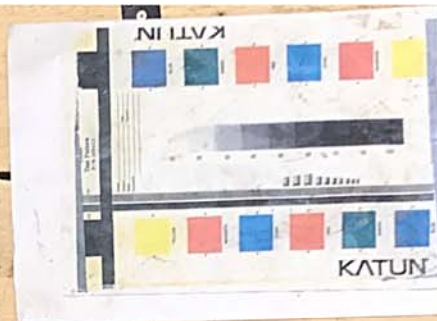
15.0

15.0

16.5



CCG REF: CCG-C-19-11195
SITE: CITYLABS,
MANCHESTER
CLIENT: BRUNTWOOD
BH1 16.5-19.5mbgl



16.5

18.0

18.0

19.5



REF: CCG-C-19-11195
SITE- CITYLABS,
MANCHESTER
CLIENT: BRUNTWOOD
BH2 14.0-17.0



14.0

15.5

15.5

17.0



REF: CCG-C-19-11195
SITE- CITYLABS,
MANCHESTER
CLIENT: BRUNTWOOD
BH2 17.0-20.0



17.0

18.5

18.5

20.0



REF: CCG-C-19-11195
SITE- CITYLABS,
MANCHESTER
CLIENT: BRUNTWOOD
BH2 20.0-21.5

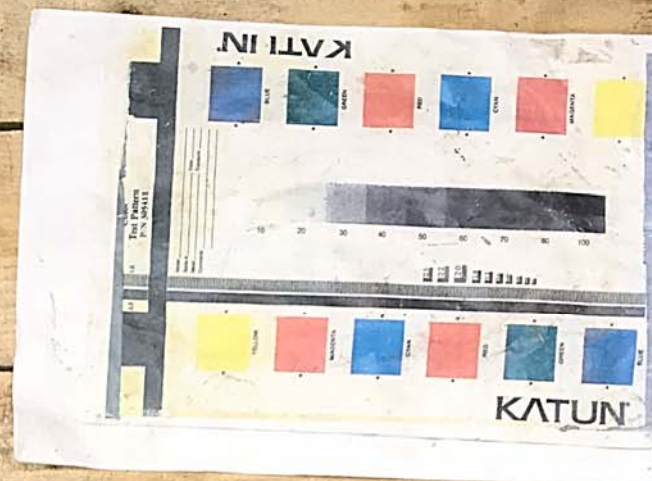


20.0

21.5



CCG REF: CCG-C-19-11195
SITE: CITYLABS,
MANCHESTER
CLIENT: BRUNTWOOD
BH3 19.0-21.0mbgl



19.0

20.0

19.5

20.0

20.5

21.0



CCG REF: CCG-C-19-11195
SITE: CITYLABS,
MANCHESTER
CLIENT: BRUNTWOOD
BH3 21.0-23.0mbgl



21.0

22.0

21.5

22.0

23.0





APPENDIX G

CHEMICAL TEST CERTIFICATES



Unit A2
Windmill Road
Ponswood Industrial Estate
St Leonards on Sea
East Sussex
TN38 9BY
Telephone: (01424) 718618

cs@elab-uk.co.uk
info@elab-uk.co.uk

THE ENVIRONMENTAL LABORATORY LTD

Analytical Report Number: 19-25268

Issue: 1

Date of Issue: 18/10/2019

Contact: Daniel O'Regan

Customer Details: CC Geotechnical Ltd
Unit 1 & 2 Deltic Place
Deltic Way
Liverpool
Merseyside L33 7BA

Quotation No: Q19-01561

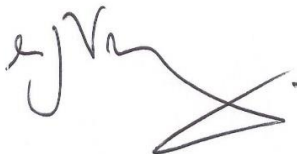
Order No: Not Supplied

Customer Reference: CCG-C-19-11195

Date Received: 10/10/2019

Date Approved: 18/10/2019

Details: City Labs, Manchester

Approved by: 

Mike Varley, Technical Manager

Any comments, opinions or interpretations expressed herein are outside the scope of UKAS accreditation (Accreditation Number 2683)

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Sample Summary

Report No.: 19-25268, issue number 1

Elab No.	Client's Ref.	Date Sampled	Date Scheduled	Description	Deviations
186576	TP06 0.20	08/10/2019	11/10/2019	Sandy silty loam	
186577	TP06 0.50	08/10/2019	11/10/2019	Sandy silty loam	
186578	TP06 1.00	08/10/2019	11/10/2019		
186579	TP09 0.20	08/10/2019	11/10/2019	Sandy silty loam	
186580	TP09 0.50	08/10/2019	11/10/2019	Sandy silty loam	
186581	TP09 1.00	08/10/2019	11/10/2019		
186582	TP09 1.50	08/10/2019	11/10/2019	Sandy loam	
186583	TP09 2.00	08/10/2019	11/10/2019		

Results Summary

2683

Report No.: 19-25268, issue number 1

ELAB Reference			186576	186577	186579
Customer Reference					
Sample ID					
Sample Type			SOIL	SOIL	SOIL
Sample Location			TP06	TP06	TP09
Sample Depth (m)			0.20	0.50	0.20
Sampling Date			08/10/2019	08/10/2019	08/10/2019
s	Units	LOD			
	%	0.1	33.7	32.2	25.4
		0	Stones,brick,clinker	Stones,brick,clinker	Stones,brick,clinker
	mg/kg	2.5	24.7	10.6	12.1
	mg/kg	1	43.5	42.0	35.7
	mg/kg	1	2.2	1.7	1.6
	mg/kg	0.5	2.5	1.4	1.0
	mg/kg	5	45.4	37.1	55.4
	mg/kg	5	300	207	196
	mg/kg	5	1240	1770	1470
	mg/kg	0.5	2.0	4.0	11.1
	mg/kg	5	88.5	40.3	34.7
	mg/kg	1	< 1.0	1.1	< 1.0
	mg/kg	5	67.2	48.1	43.7
	mg/kg	5	530	620	1290
	mg/kg	0.8	< 0.8	n/t	< 0.8
	mg/kg	1	< 1.0	< 1.0	< 1.0
	mg/kg	0.5	0.9	1.6	0.9
	pH units	0.1	8.2	8.3	8.8
	%	0.01	19	6.9	4.5
	mg/kg	6	< 6	< 6	< 6
	mg/kg	0.1	n/t	n/t	n/t
	mg/kg	0.1	n/t	n/t	n/t
	mg/kg	0.1	n/t	n/t	n/t
	mg/kg	0.1	n/t	n/t	n/t
	mg/kg	0.1	n/t	n/t	n/t
	mg/kg	0.1	n/t	n/t	n/t
	mg/kg	0.1	n/t	n/t	n/t
	mg/kg	0.1	n/t	n/t	n/t
	mg/kg	0.1	n/t	n/t	n/t
	mg/kg	0.1	n/t	n/t	n/t
	mg/kg	0.1	n/t	n/t	n/t
	mg/kg	0.1	n/t	n/t	n/t
	mg/kg	0.1	n/t	n/t	n/t
	mg/kg	0.1	n/t	n/t	n/t
	mg/kg	0.1	n/t	n/t	n/t
	mg/kg	0.1	n/t	n/t	n/t
	mg/kg	0.4	n/t	n/t	n/t
	mg/ka	2	n/t	n/t	n/t



Results Summary

2683

Report No.: 19-25268, issue number 1

ELAB Reference			186576	186577	186579
Customer Reference					
Sample ID					
Sample Type			SOIL	SOIL	SOIL
Sample Location			TP06	TP06	TP09
Sample Depth (m)			0.20	0.50	0.20
Sampling Date			08/10/2019	08/10/2019	08/10/2019
s	Units	LOD			
	mg/kg	0.01	n/t	n/t	n/t
	mg/kg	0.01	< 0.01	< 0.01	n/t
	mg/kg	0.01	< 0.01	< 0.01	n/t
	mg/kg	1	< 1.0	< 1.0	n/t
	mg/kg	1	< 1.0	< 1.0	n/t
	mg/kg	1	< 1.0	< 1.0	n/t
	mg/kg	1	< 1.0	2.6	n/t
	mg/kg	1	26.7	49.1	n/t
	mg/kg	1	8.5	7.3	n/t
	mg/kg	1	35.7	59.5	n/t
	mg/kg	0.01	< 0.01	< 0.01	n/t
	mg/kg	0.01	< 0.01	< 0.01	n/t
	mg/kg	1	< 1.0	< 1.0	n/t
	mg/kg	1	< 1.0	< 1.0	n/t
	mg/kg	1	< 1.0	3.9	n/t
	mg/kg	1	7.5	33.7	n/t
	mg/kg	1	62.6	193	n/t
	mg/kg	1	9.3	12.2	n/t
	mg/kg	1	79.4	243	n/t
	mg/kg	1	115	302	n/t
	mg/kg	5	n/t	n/t	n/t
	mg/kg	0.03	n/t	n/t	n/t

Results Summary

Report No.: 19-25268, issue number 1

ELAB Reference	186580	186582
Customer Reference		
Sample ID		
Sample Type	SOIL	SOIL
Sample Location	TP09	TP09
Sample Depth (m)	0.50	1.50
Sampling Date	08/10/2019	08/10/2019

Determinand	Codes	Units	LOD		
Soil sample preparation parameters					
Material removed	N	%	0.1	34.2	16.8
Description of Inert material removed	N		0	Stones,brick,clinker	Stones,brick,clinker
Metals					
Antimony	N	mg/kg	2.5	n/t	4.9
Arsenic	M	mg/kg	1	n/t	38.9
Beryllium	U	mg/kg	1	n/t	1.9
Cadmium	M	mg/kg	0.5	n/t	0.5
Chromium	M	mg/kg	5	n/t	78.8
Copper	M	mg/kg	5	n/t	127
Lead	M	mg/kg	5	n/t	1800
Mercury	M	mg/kg	0.5	n/t	1.6
Nickel	M	mg/kg	5	n/t	36.4
Selenium	M	mg/kg	1	n/t	< 1.0
Vanadium	M	mg/kg	5	n/t	55.7
Zinc	M	mg/kg	5	n/t	367
Inorganics					
Hexavalent Chromium	N	mg/kg	0.8	n/t	n/t
Total Cyanide	M	mg/kg	1	n/t	1.3
Water Soluble Boron	N	mg/kg	0.5	n/t	0.9
Miscellaneous					
pH	M	pH units	0.1	n/t	8.1
Total Organic Carbon	N	%	0.01	4.6	3.7
Phenols					
Total Phenols	N	mg/kg	6	n/t	< 6
Polyaromatic hydrocarbons					
Naphthalene	M	mg/kg	0.1	0.1	n/t
Acenaphthylene	M	mg/kg	0.1	0.3	n/t
Acenaphthene	M	mg/kg	0.1	0.2	n/t
Fluorene	M	mg/kg	0.1	0.2	n/t
Phenanthrene	M	mg/kg	0.1	2.1	n/t
Anthracene	M	mg/kg	0.1	0.9	n/t
Fluoranthene	M	mg/kg	0.1	6.9	n/t
Pyrene	M	mg/kg	0.1	5.8	n/t
Benzo(a)anthracene	M	mg/kg	0.1	3.2	n/t
Chrysene	M	mg/kg	0.1	3.5	n/t
Benzo(b)fluoranthene	M	mg/kg	0.1	4.0	n/t
Benzo(k)fluoranthene	M	mg/kg	0.1	3.5	n/t
Benzo(a)pyrene	M	mg/kg	0.1	3.6	n/t
Indeno(1,2,3-cd)pyrene	M	mg/kg	0.1	2.8	n/t
Dibenzo(a,h)anthracene	M	mg/kg	0.1	0.5	n/t
Benzo[g,h,i]perylene	M	mg/kg	0.1	2.7	n/t
Coronene	N	mg/kg	0.1	1.2	n/t
Total PAH(16)	M	mg/kg	0.4	40.3	n/t
Total PAH (Including Coronene GC-FID)	N	mg/kg	2	42	n/t



Results Summary

2683

Report No.: 19-25268, issue number 1

ELAB Reference			186580	186582
Customer Reference				
Sample ID				
Sample Type			SOIL	SOIL
Sample Location			TP09	TP09
Sample Depth (m)			0.50	1.50
Sampling Date			08/10/2019	08/10/2019
s	Units	LOD		
	mg/kg	0.01	< 0.01	n/t
	mg/kg	0.01	n/t	n/t
	mg/kg	0.01	n/t	n/t
	mg/kg	1	n/t	n/t
	mg/kg	1	n/t	n/t
	mg/kg	1	n/t	n/t
	mg/kg	1	n/t	n/t
	mg/kg	1	n/t	n/t
	mg/kg	1	n/t	n/t
	mg/kg	1	n/t	n/t
	mg/kg	0.01	n/t	n/t
	mg/kg	0.01	n/t	n/t
	mg/kg	1	n/t	n/t
	mg/kg	1	n/t	n/t
	mg/kg	1	n/t	n/t
	mg/kg	1	n/t	n/t
	mg/kg	1	n/t	n/t
	mg/kg	1	n/t	n/t
	mg/kg	1	n/t	n/t
	mg/kg	1	n/t	n/t
	mg/kg	5	^ 150	n/t
	mg/kg	0.03	< 0.03	n/t

Results Summary

2683

Report No.: 19-25268, issue number 1

WAC Analysis

Elab Ref:	186580					Landfill Waste Acceptance Criteria Limits*		
Sample Date:	08/10/2019					Inert Waste Landfill	Stable Non-reactive Hazardous waste in non-hazardous Landfill	Hazardous Waste Landfill
Sample ID:	TP09							
Depth (m)	0.5							
Site:	City Labs, Manchester							
Determinand		Code	Units					
Total Organic Carbon		N	%		4.60	3	5	6
Loss on Ignition		M	%			--	--	10
Total BTEX		M	mg/kg		< 0.01	6	--	--
Total PCBs (7 congeners)		M	mg/kg		< 0.03	1	--	--
TPH Total WAC		M	mg/kg		150	500	--	--
Total (of 17) PAHs		N	mg/kg		42.0	100	--	--
pH		M				--	>6	--
Acid Neutralisation Capacity		N	mol/kg			--	To evaluate	To evaluate

Eluate Analysis

			10:1	10:1	Limit values for compliance leaching test using BS EN 12457-2 at L/S 10 l/kg		
			mg/l	mg/kg			
Arsenic		N	0.017	0.17	0.5	2	25
Barium		N	0.088	0.88	20	100	300
Cadmium		N	< 0.001	< 0.01	0.04	1	5
Chromium		N	0.022	0.22	0.5	10	70
Copper		N	0.012	0.12	2	50	100
Mercury		N	< 0.005	< 0.01	0.01	0.2	2
Molybdenum		N	0.006	0.06	0.5	10	30
Nickel		N	0.002	< 0.05	0.4	10	40
Lead		N	0.045	0.45	0.5	10	50
Antimony		N	0.009	0.09	0.06	0.7	5
Selenium		N	< 0.005	< 0.05	0.1	0.5	7
Zinc		N	0.017	0.17	4	50	200
Chloride		N	25	249.00	800	15000	25000
Fluoride		N	< 5	< 10	10	150	500
Sulphate		N	14	136.00	1000	20000	50000
Total Dissolved Solids		N	168	1680.00	4000	60000	100000
Phenol Index		N	< 0.01	< 0.10	1	-	-
Dissolved Organic Carbon		N	19.600	196.00	500	800	1000

Leach Test Information

pH		N	8.1				
Conductivity (uS/cm)		N	251				
Dry mass of test portion (g)			100.000				
Dry Matter (%)			84				
Moisture (%)			20				
Eluent Volume (ml)			940				

Results are expressed on a dry weight basis, after correction for moisture content where applicable

* Stated limits are for guidance only, and not for conformity assessment.



2683

Unit A2, Windmill Road, Ponswood Industrial Estate, St Leonards on Sea, East Sussex, TN38 9BY
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Results Summary

Report No.: 19-25268, issue number 1

Asbestos Results

Analytical result only applies to the sample as submitted by the client. Any comments, opinions or interpretations (marked #) in this report are outside UKAS accreditation (Accreditation No2683). They are subjective comments only which must be verified by the client.

Elab No	Depth (m)	Clients Reference	Description of Sample Matrix #	Asbestos Identification	Gravimetric Analysis Total (%)	Gravimetric Analysis by ACM Type (%)	Free Fibre Analysis (%)	Total Asbestos (%)
186576	0.20	TP06	Brown sandy soil, clinker, stones	No asbestos detected	n/t	n/t	n/t	n/t
186577	0.50	TP06	Brown sandy soil, brick, glass, clinker, stones	No asbestos detected	n/t	n/t	n/t	n/t
186579	0.20	TP09	Brown sandy soil, mortar, brick, clinker/road-stone, pottery,	No asbestos detected	n/t	n/t	n/t	n/t
186582	1.50	TP09	Brown soil, mortar, brick, clinker, glass	No asbestos detected	n/t	n/t	n/t	n/t

Method Summary

Report No.: 19-25268, issue number 1

Parameter	Codes	Analysis Undertaken On	Date Tested	Method Number	Technique
Soil					
TOT PAH (GC-FID)	N	As submitted sample	16/10/2019		GC-FID
Hexavalent chromium	N	As submitted sample	15/10/2019	110	Colorimetry
pH	M	Air dried sample	16/10/2019	113	Electromeric
Total Petroleum Hydrocarbons in solids	M	As submitted sample	15/10/2019	117	GC-FID
Aqua regia extractable metals	M	Air dried sample	15/10/2019	118	ICPMS
PCB (ICES 7 congeners)	M	Air dried sample	15/10/2019	120	GC-MS
Phenols in solids	N	As submitted sample	15/10/2019	121	HPLC
PAH (GC-FID)	M	As submitted sample	15/10/2019	133	GC-FID
Low range Aliphatic hydrocarbons soil	N	As submitted sample	15/10/2019	181	GC-MS
Low range Aromatic hydrocarbons soil	N	As submitted sample	15/10/2019	181	GC-MS
BTEX in solids	M	As submitted sample	15/10/2019	181A	GC-MS
Water soluble boron	N	Air dried sample	15/10/2019	202	Colorimetry
Total cyanide	M	As submitted sample	16/10/2019	204	Colorimetry
Total organic carbon/Total sulphur	N	Air dried sample	16/10/2019	210	IR
TPH CWG soil by gc-gc	M	As submitted sample	15/10/2019	214	
Asbestos identification	U	Air dried sample	15/10/2019	PMAN	Microscopy

Leachate

Tests marked N are not UKAS accredited

Report Information

Report No.: 19-25268, issue number 1

Key

U	hold UKAS accreditation
M	hold MCERTS and UKAS accreditation
N	do not currently hold UKAS accreditation
^	MCERTS accreditation not applicable for sample matrix
*	UKAS accreditation not applicable for sample matrix
S	Subcontracted to approved laboratory UKAS Accredited for the test
SM	Subcontracted to approved laboratory MCERTS/UKAS Accredited for the test
NS	Subcontracted to approved laboratory. UKAS accreditation is not applicable.
I/S	Insufficient Sample
U/S	Unsuitable sample
n/t	Not tested
<	means "less than"
>	means "greater than"

Soil sample results are expressed on an air dried basis (dried at < 30°C), and are uncorrected for inert material removed.

ELAB are unable to provide an interpretation or opinion on the content of this report.

The results relate only to the sample received.

PCB congener results may include any coeluting PCBs

Uncertainty of measurement for the determinands tested are available upon request

Unless otherwise stated, sample information has been provided by the client

Deviation Codes

-
- | | |
|---|--|
| a | No date of sampling supplied |
| b | No time of sampling supplied (Waters Only) |
| c | Sample not received in appropriate containers |
| d | Sample not received in cooled condition |
| e | The container has been incorrectly filled |
| f | Sample age exceeds stability time (sampling to receipt) |
| g | Sample age exceeds stability time (sampling to analysis) |

Where a sample has a deviation code, the applicable test result may be invalid.

Sample Retention and Disposal

All soil samples will be retained for a period of one month

All water samples will be retained for 7 days following the date of the test report

Charges may apply to extended sample storage



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THE ENVIRONMENTAL LABORATORY LTD

Analytical Report Number: 19-25269

Issue: 1

Date of Issue: 17/10/2019

Contact: Daniel O'Regan

Customer Details: CC Geotechnical Ltd
Unit 1 & 2 Deltic Place
Deltic Way
Liverpool
Merseyside L33 7BA

Quotation No: Q19-01561

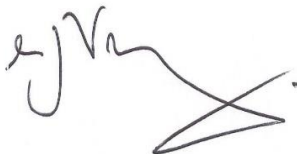
Order No: Not Supplied

Customer Reference: CCG-C-19-11195

Date Received: 10/10/2019

Date Approved: 17/10/2019

Details: City Labs, Manchester

Approved by: 

Mike Varley, Technical Manager

Any comments, opinions or interpretations expressed herein are outside the scope of UKAS accreditation (Accreditation Number 2683)

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Sample Summary

Report No.: 19-25269, issue number 1

Elab No.	Client's Ref.	Date Sampled	Date Scheduled	Description	Deviations
186584	TP05 0.20	07/10/2019	11/10/2019	Sandy silty loam	
186585	TP05 0.50	07/10/2019	11/10/2019		
186586	TP05 1.00	07/10/2019	11/10/2019	Sandy silty loam	

Results Summary

2683

Report No.: 19-25269, issue number 1

ELAB Reference	186584	186586
Customer Reference		
Sample ID		
Sample Type	SOIL	SOIL
Sample Location	TP05	TP05
Sample Depth (m)	0.20	1.00
Sampling Date	07/10/2019	07/10/2019

Determinand	Codes	Units	LOD		
Soil sample preparation parameters					
Material removed	N	%	0.1	21.3	26.6
Description of Inert material removed	N		0	Stones,brick,clinker	Stones,brick,clinker
Metals					
Antimony	N	mg/kg	2.5	8.5	8.4
Arsenic	M	mg/kg	1	29.0	41.0
Beryllium	U	mg/kg	1	1.4	1.8
Cadmium	M	mg/kg	0.5	5.3	1.1
Chromium	M	mg/kg	5	28.7	36.4
Copper	M	mg/kg	5	200	198
Lead	M	mg/kg	5	976	1820
Mercury	M	mg/kg	0.5	1.3	2.0
Nickel	M	mg/kg	5	43.5	34.4
Selenium	M	mg/kg	1	< 1.0	< 1.0
Vanadium	M	mg/kg	5	45.9	52.5
Zinc	M	mg/kg	5	498	568
Inorganics					
Hexavalent Chromium	N	mg/kg	0.8	< 0.8	n/t
Total Cyanide	M	mg/kg	1	< 1.0	< 1.0
Water Soluble Boron	N	mg/kg	0.5	0.6	0.9
Miscellaneous					
pH	M	pH units	0.1	8.9	8.3
Total Organic Carbon	N	%	0.01	9.3	4.4
Phenols					
Total Phenols	N	mg/kg	6	< 6	< 6
TPH CWG					
>C5-C6 Aliphatic	N	mg/kg	0.01	< 0.01	n/t
>C6-C8 Aliphatic	N	mg/kg	0.01	< 0.01	n/t
>C8-C10 Aliphatic	N	mg/kg	1	< 1.0	n/t
>C10-C12 Aliphatic	M	mg/kg	1	< 1.0	n/t
>C12-C16 Aliphatic	M	mg/kg	1	< 1.0	n/t
>C16-C21 Aliphatic	M	mg/kg	1	1.8	n/t
>C21-C35 Aliphatic	M	mg/kg	1	83.0	n/t
>C35-C40 Aliphatic	M	mg/kg	1	29.0	n/t
Total aliphatic hydrocarbons (>C5 - C40)	N	mg/kg	1	114	n/t
>C5-C7 Aromatic	N	mg/kg	0.01	< 0.01	n/t
>C7-C8 Aromatic	N	mg/kg	0.01	< 0.01	n/t
>C8-C10 Aromatic	N	mg/kg	1	< 1.0	n/t
>C10-C12 Aromatic	M	mg/kg	1	< 1.0	n/t
>C12-C16 Aromatic	M	mg/kg	1	< 1.0	n/t
>C16-C21 Aromatic	M	mg/kg	1	27.3	n/t
>C21-C35 Aromatic	M	mg/kg	1	185	n/t
>C35-C40 Aromatic	M	mg/kg	1	37.5	n/t
Total aromatic hydrocarbons (>C5 - C40)	N	mg/kg	1	251	n/t
Total petroleum hydrocarbons (>C5 - C40)	N	mg/kg	1	365	n/t



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Results Summary

Report No.: 19-25269, issue number 1

Asbestos Results

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Elab No	Depth (m)	Clients Reference	Description of Sample Matrix #	Asbestos Identification	Gravimetric Analysis Total (%)	Gravimetric Analysis by ACM Type (%)	Free Fibre Analysis (%)	Total Asbestos (%)
186584	0.20	TP05	Brown sandy soil, clinker, brick, stones	No asbestos detected	n/t	n/t	n/t	n/t
186586	1.00	TP05	Brown sandy soil, brick, mortar, clinker, road-	No asbestos detected	n/t	n/t	n/t	n/t

Method Summary

Report No.: 19-25269, issue number 1

Parameter	Codes	Analysis Undertaken On	Date Tested	Method Number	Technique
Soil					
Hexavalent chromium	N	As submitted sample	15/10/2019	110	Colorimetry
pH	M	Air dried sample	16/10/2019	113	Electromeric
Aqua regia extractable metals	M	Air dried sample	15/10/2019	118	ICPMS
Phenols in solids	N	As submitted sample	15/10/2019	121	HPLC
Low range Aliphatic hydrocarbons soil	N	As submitted sample	15/10/2019	181	GC-MS
Low range Aromatic hydrocarbons soil	N	As submitted sample	15/10/2019	181	GC-MS
Water soluble boron	N	Air dried sample	15/10/2019	202	Colorimetry
Total cyanide	M	As submitted sample	16/10/2019	204	Colorimetry
Total organic carbon/Total sulphur	N	Air dried sample	16/10/2019	210	IR
TPH CWG soil by gc-gc	M	As submitted sample	15/10/2019	214	
Asbestos identification	U	Air dried sample	15/10/2019	PMAN	Microscopy

Tests marked N are not UKAS accredited

Report Information

Report No.: 19-25269, issue number 1

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n/t	Not tested
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Deviation Codes

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- | | |
|---|--|
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| b | No time of sampling supplied (Waters Only) |
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| e | The container has been incorrectly filled |
| f | Sample age exceeds stability time (sampling to receipt) |
| g | Sample age exceeds stability time (sampling to analysis) |

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Sample Retention and Disposal

All soil samples will be retained for a period of one month

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Charges may apply to extended sample storage



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THE ENVIRONMENTAL LABORATORY LTD

Analytical Report Number: 19-25289

Issue: 1

Date of Issue: 21/10/2019

Contact: Daniel O'Regan

Customer Details: CC Geotechnical Ltd
Unit 1 & 2 Deltic Place
Deltic Way
Liverpool
Merseyside L33 7BA

Quotation No: Q19-01561

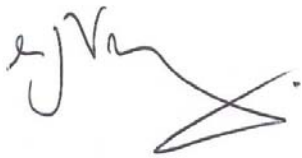
Order No: Not Supplied

Customer Reference: CCG-C-19-11195

Date Received: 15/10/2019

Date Approved: 21/10/2019

Details: City Labs, Manchester

Approved by: 

Mike Varley, Technical Manager

Any comments, opinions or interpretations expressed herein are outside the scope of UKAS accreditation (Accreditation Number 2683)

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Sample Summary

Report No.: 19-25289, issue number 1

Elab No.	Client's Ref.	Date Sampled	Date Scheduled	Description	Deviations
186706	BH03 0.30	07/10/2019	15/10/2019	Sandy loam	
186707	BH03 0.50	07/10/2019	15/10/2019	Sandy loam	

Results Summary

Report No.: 19-25289, issue number 1

ELAB Reference			186706	186707
Customer Reference				
Sample ID				
Sample Type			SOIL	SOIL
Sample Location			BH03	BH03
Sample Depth (m)			0.30	0.50
Sampling Date			07/10/2019	07/10/2019
s	Units	LOD		
	%	0.1	37.8	39.5
		0	Stones,brick,clinker	Stones,brick,clinker
	mg/kg	2.5	13.1	n/t
	mg/kg	1	34.5	n/t
	mg/kg	1	1.8	n/t
	mg/kg	0.5	1.6	n/t
	mg/kg	5	35.5	n/t
	mg/kg	5	170	n/t
	mg/kg	5	1300	n/t
	mg/kg	0.5	1.1	n/t
	mg/kg	5	64.4	n/t
	mg/kg	1	< 1.0	n/t
	mg/kg	5	61.5	n/t
	mg/kg	5	432	n/t
	mg/kg	0.8	< 0.8	n/t
	mg/kg	1	1.1	n/t
	mg/kg	0.5	0.7	n/t
	pH units	0.1	8.3	n/t
	%	0.01	12	16
	mg/kg	6	< 6	n/t
	mg/kg	0.1	n/t	0.3
	mg/kg	0.1	n/t	0.7
	mg/kg	0.1	n/t	2.5
	mg/kg	0.1	n/t	2.0
	mg/kg	0.1	n/t	19.0
	mg/kg	0.1	n/t	6.3
	mg/kg	0.1	n/t	52.4
	mg/kg	0.1	n/t	42.5
	mg/kg	0.1	n/t	23.9
	mg/kg	0.1	n/t	25.0
	mg/kg	0.1	n/t	25.4
	mg/kg	0.1	n/t	20.1
	mg/kg	0.1	n/t	25.0
	mg/kg	0.1	n/t	19.8
	mg/kg	0.1	n/t	3.1
	mg/kg	0.1	n/t	17.5
	mg/kg	0.1	n/t	7.3
	mg/kg	0.4	n/t	285
	mg/kg	2	n/t	293



Results Summary

2683

Report No.: 19-25289, issue number 1

ELAB Reference	186706	186707
Customer Reference		
Sample ID		
Sample Type	SOIL	SOIL
Sample Location	BH03	BH03
Sample Depth (m)	0.30	0.50
Sampling Date	07/10/2019	07/10/2019

Determinand	Codes	Units	LOD		
BTEX					
Total BTEX	M	mg/kg	0.01	n/t	< 0.01
TPH CWG					
>C5-C6 Aliphatic	N	mg/kg	0.01	< 0.01	n/t
>C6-C8 Aliphatic	N	mg/kg	0.01	< 0.01	n/t
>C8-C10 Aliphatic	N	mg/kg	1	< 1.0	n/t
>C10-C12 Aliphatic	M	mg/kg	1	< 1.0	n/t
>C12-C16 Aliphatic	M	mg/kg	1	< 1.0	n/t
>C16-C21 Aliphatic	M	mg/kg	1	1.2	n/t
>C21-C35 Aliphatic	M	mg/kg	1	37.8	n/t
>C35-C40 Aliphatic	M	mg/kg	1	2.9	n/t
Total aliphatic hydrocarbons (>C5 - C40)	N	mg/kg	1	41.9	n/t
>C5-C7 Aromatic	N	mg/kg	0.01	< 0.01	n/t
>C7-C8 Aromatic	N	mg/kg	0.01	< 0.01	n/t
>C8-C10 Aromatic	N	mg/kg	1	< 1.0	n/t
>C10-C12 Aromatic	M	mg/kg	1	< 1.0	n/t
>C12-C16 Aromatic	M	mg/kg	1	< 1.0	n/t
>C16-C21 Aromatic	M	mg/kg	1	7.6	n/t
>C21-C35 Aromatic	M	mg/kg	1	188	n/t
>C35-C40 Aromatic	M	mg/kg	1	12.9	n/t
Total aromatic hydrocarbons (>C5 - C40)	N	mg/kg	1	210	n/t
Total petroleum hydrocarbons (>C5 - C40)	N	mg/kg	1	252	n/t
Total Petroleum Hydrocarbons					
Mineral Oil	M	mg/kg	5	n/t	^ 299
PCB (ICES 7 congeners)					
PCB (Total of 7 Congeners)	M	mg/kg	0.03	n/t	< 0.03

Results Summary

Report No.: 19-25289, issue number 1

WAC Analysis

Elab Ref:	186707					Landfill Waste Acceptance Criteria Limits*		
Sample Date:	07/10/2019					Inert Waste Landfill	Stable Non-reactive Hazardous waste in non-hazardous Landfill	Hazardous Waste Landfill
Sample ID:	BH03							
Depth (m)	0.5							
Site:	City Labs, Manchester							
Determinand		Code	Units					
Total Organic Carbon		N	%		16.00	3	5	6
Loss on Ignition		M	%			--	--	10
Total BTEX		M	mg/kg		< 0.01	6	--	--
Total PCBs (7 congeners)		M	mg/kg		< 0.03	1	--	--
TPH Total WAC		M	mg/kg		299	500	--	--
Total (of 17) PAHs		N	mg/kg		293.0	100	--	--
pH		M				--	>6	--
Acid Neutralisation Capacity		N	mol/kg			--	To evaluate	To evaluate

Eluate Analysis

			10:1	10:1	Limit values for compliance leaching test using BS EN 12457-2 at L/S 10 l/kg		
			mg/l	mg/kg			
Arsenic		N	< 0.005	< 0.05	0.5	2	25
Barium		N	0.052	0.52	20	100	300
Cadmium		N	< 0.001	< 0.01	0.04	1	5
Chromium		N	< 0.005	< 0.05	0.5	10	70
Copper		N	0.009	0.09	2	50	100
Mercury		N	< 0.005	< 0.01	0.01	0.2	2
Molybdenum		N	0.019	0.19	0.5	10	30
Nickel		N	0.002	< 0.05	0.4	10	40
Lead		N	0.043	0.43	0.5	10	50
Antimony		N	0.015	0.15	0.06	0.7	5
Selenium		N	< 0.005	< 0.05	0.1	0.5	7
Zinc		N	0.012	0.12	4	50	200
Chloride		N	6	55.00	800	15000	25000
Fluoride		N	< 5	< 10	10	150	500
Sulphate		N	18	177.00	1000	20000	50000
Total Dissolved Solids		N	127	1270.00	4000	60000	100000
Phenol Index		N	< 0.01	< 0.10	1	-	-
Dissolved Organic Carbon		N	15.000	150.00	500	800	1000

Leach Test Information

pH		N	7.9				
Conductivity (uS/cm)		N	189				
Dry mass of test portion (g)			100.000				
Dry Matter (%)			80				
Moisture (%)			25				
Eluent Volume (ml)			928				

Results are expressed on a dry weight basis, after correction for moisture content where applicable

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Results Summary

Report No.: 19-25289, issue number 1

Asbestos Results

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Elab No	Depth (m)	Clients Reference	Description of Sample Matrix #	Asbestos Identification	Gravimetric Analysis Total (%)	Gravimetric Analysis by ACM Type (%)	Free Fibre Analysis (%)	Total Asbestos (%)
186706	0.30	BH03	Brown Soil, Stones, Clinker,	No asbestos detected	n/t	n/t	n/t	n/t

Method Summary

Report No.: 19-25289, issue number 1

Parameter	Codes	Analysis Undertaken On	Date Tested	Method Number	Technique
Soil					
TOT PAH (GC-FID)	N	As submitted sample	17/10/2019		GC-FID
Hexavalent chromium	N	As submitted sample	16/10/2019	110	Colorimetry
pH	M	Air dried sample	17/10/2019	113	Electromeric
Total Petroleum Hydrocarbons in solids	M	As submitted sample	16/10/2019	117	GC-FID
Aqua regia extractable metals	M	Air dried sample	16/10/2019	118	ICPMS
PCB (ICES 7 congeners)	M	Air dried sample	16/10/2019	120	GC-MS
Phenols in solids	N	As submitted sample	16/10/2019	121	HPLC
PAH (GC-FID)	M	As submitted sample	16/10/2019	133	GC-FID
Low range Aliphatic hydrocarbons soil	N	As submitted sample	16/10/2019	181	GC-MS
Low range Aromatic hydrocarbons soil	N	As submitted sample	16/10/2019	181	GC-MS
BTEX in solids	M	As submitted sample	16/10/2019	181A	GC-MS
Water soluble boron	N	Air dried sample	16/10/2019	202	Colorimetry
Total cyanide	M	As submitted sample	16/10/2019	204	Colorimetry
Total organic carbon/Total sulphur	N	Air dried sample	17/10/2019	210	IR
TPH CWG soil by gc-gc	M	As submitted sample	17/10/2019	214	
Asbestos identification	U	Air dried sample	16/10/2019	PMAN	Microscopy

Leachate

Tests marked N are not UKAS accredited

Report Information

Report No.: 19-25289, issue number 1

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U/S	Unsuitable sample
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THE ENVIRONMENTAL LABORATORY LTD

Analytical Report Number: 19-25370

Issue: 1

Date of Issue: 25/10/2019

Contact: Daniel O'Regan

Customer Details: CC Geotechnical Ltd
Unit 1 & 2 Deltic Place
Deltic Way
Liverpool
Merseyside L33 7BA

Quotation No: Q19-01561

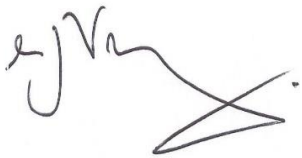
Order No: Not Supplied

Customer Reference: CCG-C-19-11195

Date Received: 17/10/2019

Date Approved: 25/10/2019

Details: City Labs, Manchester

Approved by: 

Mike Varley, Technical Manager

Any comments, opinions or interpretations expressed herein are outside the scope of UKAS accreditation (Accreditation Number 2683)

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Sample Summary

Report No.: 19-25370, issue number 1

Elab No.	Client's Ref.	Date Sampled	Date Scheduled	Description	Deviations
187144	TP01 0.20	15/10/2019	18/10/2019	Loamy sand	
187145	TP01 0.50	15/10/2019	18/10/2019		
187146	TP01 1.00	15/10/2019	18/10/2019	Sandy silty loam	
187147	TP01 1.50	15/10/2019	18/10/2019		

Results Summary

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ELAB Reference	187144	187146
Customer Reference		
Sample ID		
Sample Type	SOIL	SOIL
Sample Location	TP01	TP01
Sample Depth (m)	0.20	1.00
Sampling Date	15/10/2019	15/10/2019

Determinand	Codes	Units	LOD		
Soil sample preparation parameters					
Material removed	N	%	0.1	48.2	20.7
Description of Inert material removed	N		0	Stones,clinker	Stones,brick,clinker
Metals					
Antimony	N	mg/kg	2.5	4.1	6.7
Arsenic	M	mg/kg	1	25.5	21.4
Beryllium	U	mg/kg	1	1.7	1.1
Cadmium	M	mg/kg	0.5	0.9	0.6
Chromium	M	mg/kg	5	27.7	25.7
Copper	M	mg/kg	5	107	70.0
Lead	M	mg/kg	5	142	359
Mercury	M	mg/kg	0.5	< 0.5	< 0.5
Nickel	M	mg/kg	5	74.6	29.2
Selenium	M	mg/kg	1	< 1.0	< 1.0
Vanadium	M	mg/kg	5	64.7	47.7
Zinc	M	mg/kg	5	117	211
Inorganics					
Hexavalent Chromium	N	mg/kg	0.8	< 0.8	n/t
Total Cyanide	M	mg/kg	1	< 1.0	< 1.0
Water Soluble Boron	N	mg/kg	0.5	< 0.5	< 0.5
Miscellaneous					
pH	M	pH units	0.1	8.6	8.9
Total Organic Carbon	N	%	0.01	15	2.7
Phenols					
Total Phenols	N	mg/kg	6	< 6	< 6
TPH CWG					
>C5-C6 Aliphatic	N	mg/kg	0.01	< 0.01	< 0.01
>C6-C8 Aliphatic	N	mg/kg	0.01	< 0.01	< 0.01
>C8-C10 Aliphatic	N	mg/kg	1	< 1.0	< 1.0
>C10-C12 Aliphatic	M	mg/kg	1	< 1.0	< 1.0
>C12-C16 Aliphatic	M	mg/kg	1	3.4	< 1.0
>C16-C21 Aliphatic	M	mg/kg	1	9.1	< 1.0
>C21-C35 Aliphatic	M	mg/kg	1	11.0	2.2
>C35-C40 Aliphatic	M	mg/kg	1	3.3	< 1.0
Total aliphatic hydrocarbons (>C5 - C40)	N	mg/kg	1	27.0	2.6
>C5-C7 Aromatic	N	mg/kg	0.01	< 0.01	< 0.01
>C7-C8 Aromatic	N	mg/kg	0.01	< 0.01	< 0.01
>C8-C10 Aromatic	N	mg/kg	1	< 1.0	< 1.0
>C10-C12 Aromatic	M	mg/kg	1	< 1.0	< 1.0
>C12-C16 Aromatic	M	mg/kg	1	16.8	< 1.0
>C16-C21 Aromatic	M	mg/kg	1	130	3.4
>C21-C35 Aromatic	M	mg/kg	1	442	18.1
>C35-C40 Aromatic	M	mg/kg	1	21.2	1.3
Total aromatic hydrocarbons (>C5 - C40)	N	mg/kg	1	611	23.5
Total petroleum hydrocarbons (>C5 - C40)	N	mg/kg	1	638	26.1



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Results Summary
Report No.: 19-25370, issue number 1

Asbestos Results

Analytical result only applies to the sample as submitted by the client. Any comments, opinions or interpretations (marked #)
in this report are outside UKAS accreditation (Accreditation No2683). They are subjective comments only which must be verified by the client.

Elab No	Depth (m)	Clients Reference	Description of Sample Matrix #	Asbestos Identification	Gravimetric Analysis Total (%)	Gravimetric Analysis by ACM Type (%)	Free Fibre Analysis (%)	Total Asbestos (%)
187144	0.20	TP01	Brown Soil, Stones, Clinker	No asbestos detected	n/t	n/t	n/t	n/t
187146	1.00	TP01	Brown Soil, Stones, Clinker, Brick	No asbestos detected	n/t	n/t	n/t	n/t

Method Summary

Report No.: 19-25370, issue number 1

Parameter	Codes	Analysis Undertaken On	Date Tested	Method Number	Technique
Soil					
Hexavalent chromium	N	As submitted sample	22/10/2019	110	Colorimetry
pH	M	Air dried sample	24/10/2019	113	Electromeric
Aqua regia extractable metals	M	Air dried sample	22/10/2019	118	ICPMS
Phenols in solids	N	As submitted sample	21/10/2019	121	HPLC
Low range Aliphatic hydrocarbons soil	N	As submitted sample	23/10/2019	181	GC-MS
Low range Aromatic hydrocarbons soil	N	As submitted sample	23/10/2019	181	GC-MS
Water soluble boron	N	Air dried sample	23/10/2019	202	Colorimetry
Total cyanide	M	As submitted sample	22/10/2019	204	Colorimetry
Total organic carbon/Total sulphur	N	Air dried sample	23/10/2019	210	IR
TPH CWG soil by gc-gc	M	As submitted sample	21/10/2019	214	
Asbestos identification	U	Air dried sample	22/10/2019	PMAN	Microscopy

Tests marked N are not UKAS accredited

Report Information

Report No.: 19-25370, issue number 1

Key

U	hold UKAS accreditation
M	hold MCERTS and UKAS accreditation
N	do not currently hold UKAS accreditation
^	MCERTS accreditation not applicable for sample matrix
*	UKAS accreditation not applicable for sample matrix
S	Subcontracted to approved laboratory UKAS Accredited for the test
SM	Subcontracted to approved laboratory MCERTS/UKAS Accredited for the test
NS	Subcontracted to approved laboratory. UKAS accreditation is not applicable.
I/S	Insufficient Sample
U/S	Unsuitable sample
n/t	Not tested
<	means "less than"
>	means "greater than"

Soil sample results are expressed on an air dried basis (dried at < 30°C), and are uncorrected for inert material removed.

ELAB are unable to provide an interpretation or opinion on the content of this report.

The results relate only to the sample received.

PCB congener results may include any coeluting PCBs

Uncertainty of measurement for the determinands tested are available upon request

Unless otherwise stated, sample information has been provided by the client. This may affect the validity of the results.

Deviation Codes

-
- | | |
|---|--|
| a | No date of sampling supplied |
| b | No time of sampling supplied (Waters Only) |
| c | Sample not received in appropriate containers |
| d | Sample not received in cooled condition |
| e | The container has been incorrectly filled |
| f | Sample age exceeds stability time (sampling to receipt) |
| g | Sample age exceeds stability time (sampling to analysis) |

Where a sample has a deviation code, the applicable test result may be invalid.

Sample Retention and Disposal

All soil samples will be retained for a period of one month

All water samples will be retained for 7 days following the date of the test report

Charges may apply to extended sample storage



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THE ENVIRONMENTAL LABORATORY LTD

Analytical Report Number: 19-25371

Issue: 1

Date of Issue: 25/10/2019

Contact: Daniel O'Regan

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Merseyside L33 7BA

Quotation No: Q19-01561

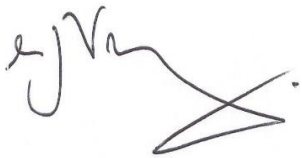
Order No: Not Supplied

Customer Reference: CCG-C-19-11195

Date Received: 17/10/2019

Date Approved: 25/10/2019

Details: City Labs, Manchester

Approved by: 

Mike Varley, Technical Manager

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Sample Summary

Report No.: 19-25371, issue number 1

Elab No.	Client's Ref.	Date Sampled	Date Scheduled	Description	Deviations
187148	TP02 0.20	15/10/2019	18/10/2019	Sandy silty loam	
187149	TP02 0.50	15/10/2019	18/10/2019	Sandy silty loam	

Results Summary

Report No.: 19-25371, issue number 1

ELAB Reference			187148	187149
Customer Reference				
Sample ID				
Sample Type			SOIL	SOIL
Sample Location			TP02	TP02
Sample Depth (m)			0.20	0.50
Sampling Date			15/10/2019	15/10/2019
s	Units	LOD		
	%	0.1	60.5	34.4
		0	Stones,clinker	Stones,brick,clinker
	mg/kg	2.5	4.7	7.9
	mg/kg	1	22.9	36.4
	mg/kg	1	2.6	2.8
	mg/kg	0.5	2.0	1.6
	mg/kg	5	27.8	37.6
	mg/kg	5	102	135
	mg/kg	5	508	941
	mg/kg	0.5	< 0.5	1.1
	mg/kg	5	66.3	60.1
	mg/kg	1	< 1.0	< 1.0
	mg/kg	5	56.4	61.5
	mg/kg	5	280	236
	mg/kg	0.8	< 0.8	n/t
	mg/kg	1	< 1.0	< 1.0
	mg/kg	0.5	< 0.5	0.7
	pH units	0.1	8.3	7.7
	%	0.01	13	8.4
	mg/kg	6	< 6	< 6
	mg/kg	0.01	< 0.01	n/t
	mg/kg	0.01	< 0.01	n/t
	mg/kg	1	< 1.0	n/t
	mg/kg	1	< 1.0	n/t
	mg/kg	1	< 1.0	n/t
	mg/kg	1	1.2	n/t
	mg/kg	1	9.8	n/t
	mg/kg	1	2.8	n/t
	mg/kg	1	13.9	n/t
	mg/kg	0.01	< 0.01	n/t
	mg/kg	0.01	< 0.01	n/t
	mg/kg	1	< 1.0	n/t
	mg/kg	1	< 1.0	n/t
	mg/kg	1	1.6	n/t
	mg/kg	1	28.2	n/t
	mg/kg	1	151	n/t
	mg/kg	1	11.4	n/t
	mg/kg	1	193	n/t
	mg/kg	1	207	n/t



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Elab No	Depth (m)	Clients Reference	Description of Sample Matrix #	Asbestos Identification	Gravimetric Analysis Total (%)	Gravimetric Analysis by ACM Type (%)	Free Fibre Analysis (%)	Total Asbestos (%)
187148	0.20	TP02	Brown Soil, Stones, Clinker	No asbestos detected	n/t	n/t	n/t	n/t
187149	0.50	TP02	Brown Soil, Stones, Clinker	No asbestos detected	n/t	n/t	n/t	n/t

Method Summary

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THE ENVIRONMENTAL LABORATORY LTD

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Issue: 1

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Contact: Daniel O'Regan

Customer Details: CC Geotechnical Ltd
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Quotation No: Q19-01561

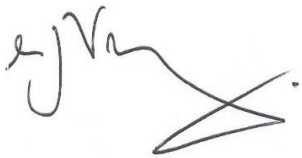
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Date Approved: 25/10/2019

Details: City Labs, Manchester

Approved by: 

Mike Varley, Technical Manager

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Sample Summary

Report No.: 19-25372, issue number 1

Elab No.	Client's Ref.	Date Sampled	Date Scheduled	Description	Deviations
187150	TP03 0.20	15/10/2019	18/10/2019	Sandy silty loam	
187151	TP03 0.50	15/10/2019	18/10/2019		
187152	TP03 1.00	15/10/2019	18/10/2019	Sandy silty loam	
187153	TP03 1.50	15/10/2019	18/10/2019		

Results Summary

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Report No.: 19-25372, issue number 1

ELAB Reference	187150	187152
Customer Reference		
Sample ID		
Sample Type	SOIL	SOIL
Sample Location	TP03	TP03
Sample Depth (m)	0.20	1.00
Sampling Date	15/10/2019	15/10/2019

Determinand	Codes	Units	LOD		
Soil sample preparation parameters					
Material removed	N	%	0.1	55.3	21.2
Description of Inert material removed	N		0	Stones,brick,clinker	Stones,brick,clinker
Metals					
Antimony	N	mg/kg	2.5	12.8	9.3
Arsenic	M	mg/kg	1	32.3	15.3
Beryllium	U	mg/kg	1	2.0	< 1.0
Cadmium	M	mg/kg	0.5	2.6	< 0.5
Chromium	M	mg/kg	5	35.8	20.2
Copper	M	mg/kg	5	200	47.9
Lead	M	mg/kg	5	1340	1010
Mercury	M	mg/kg	0.5	1.9	0.6
Nickel	M	mg/kg	5	67.1	19.5
Selenium	M	mg/kg	1	< 1.0	< 1.0
Vanadium	M	mg/kg	5	62.2	36.8
Zinc	M	mg/kg	5	468	167
Inorganics					
Hexavalent Chromium	N	mg/kg	0.8	n/t	< 0.8
Total Cyanide	M	mg/kg	1	< 1.0	< 1.0
Water Soluble Boron	N	mg/kg	0.5	< 0.5	< 0.5
Miscellaneous					
pH	M	pH units	0.1	9.0	8.8
Total Organic Carbon	N	%	0.01	11	0.84
Phenols					
Total Phenols	N	mg/kg	6	< 6	< 6
Polyaromatic hydrocarbons					
Naphthalene	M	mg/kg	0.1	n/t	< 0.1
Acenaphthylene	M	mg/kg	0.1	n/t	< 0.1
Acenaphthene	M	mg/kg	0.1	n/t	< 0.1
Fluorene	M	mg/kg	0.1	n/t	< 0.1
Phenanthrene	M	mg/kg	0.1	n/t	0.7
Anthracene	M	mg/kg	0.1	n/t	0.2
Fluoranthene	M	mg/kg	0.1	n/t	1.3
Pyrene	M	mg/kg	0.1	n/t	1.2
Benzo(a)anthracene	M	mg/kg	0.1	n/t	0.7
Chrysene	M	mg/kg	0.1	n/t	0.8
Benzo(b)fluoranthene	M	mg/kg	0.1	n/t	0.9
Benzo(k)fluoranthene	M	mg/kg	0.1	n/t	1.1
Benzo(a)pyrene	M	mg/kg	0.1	n/t	0.9
Indeno(1,2,3-cd)pyrene	M	mg/kg	0.1	n/t	0.8
Dibenzo(a,h)anthracene	M	mg/kg	0.1	n/t	0.1
Benzo[g,h,i]perylene	M	mg/kg	0.1	n/t	0.6
Coronene	N	mg/kg	0.1	n/t	0.4
Total PAH(16)	M	mg/kg	0.4	n/t	9.4
Total PAH (Including Coronene GC-FID)	N	mg/kg	2	n/t	10

Results Summary

2683

Report No.: 19-25372, issue number 1

ELAB Reference	187150	187152
Customer Reference		
Sample ID		
Sample Type	SOIL	SOIL
Sample Location	TP03	TP03
Sample Depth (m)	0.20	1.00
Sampling Date	15/10/2019	15/10/2019

Determinand	Codes	Units	LOD		
BTEX					
Total BTEX	M	mg/kg	0.01	n/t	< 0.01
TPH CWG					
>C5-C6 Aliphatic	N	mg/kg	0.01	< 0.01	< 0.01
>C6-C8 Aliphatic	N	mg/kg	0.01	< 0.01	< 0.01
>C8-C10 Aliphatic	N	mg/kg	1	< 1.0	< 1.0
>C10-C12 Aliphatic	M	mg/kg	1	< 1.0	< 1.0
>C12-C16 Aliphatic	M	mg/kg	1	< 1.0	< 1.0
>C16-C21 Aliphatic	M	mg/kg	1	3.8	< 1.0
>C21-C35 Aliphatic	M	mg/kg	1	11.5	< 1.0
>C35-C40 Aliphatic	M	mg/kg	1	4.0	< 1.0
Total aliphatic hydrocarbons (>C5 - C40)	N	mg/kg	1	19.9	1.0
>C5-C7 Aromatic	N	mg/kg	0.01	< 0.01	< 0.01
>C7-C8 Aromatic	N	mg/kg	0.01	< 0.01	< 0.01
>C8-C10 Aromatic	N	mg/kg	1	< 1.0	< 1.0
>C10-C12 Aromatic	M	mg/kg	1	< 1.0	< 1.0
>C12-C16 Aromatic	M	mg/kg	1	1.4	< 1.0
>C16-C21 Aromatic	M	mg/kg	1	17.3	2.2
>C21-C35 Aromatic	M	mg/kg	1	206	16.0
>C35-C40 Aromatic	M	mg/kg	1	21.9	< 1.0
Total aromatic hydrocarbons (>C5 - C40)	N	mg/kg	1	247	19.7
Total petroleum hydrocarbons (>C5 - C40)	N	mg/kg	1	267	20.7
Total Petroleum Hydrocarbons					
Mineral Oil	M	mg/kg	5	n/t	^ < 5
PCB (ICES 7 congeners)					
PCB (Total of 7 Congeners)	M	mg/kg	0.03	n/t	< 0.03

Results Summary

2683

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WAC Analysis								
Elab Ref:	187152					Landfill Waste Acceptance Criteria Limits*		
Sample Date:	15/10/2019					Inert Waste Landfill	Stable Non-reactive Hazardous waste in non-hazardous Landfill	Hazardous Waste Landfill
Sample ID:	TP03							
Depth (m)	1							
Site:	City Labs, Manchester							
Determinand		Code	Units					
Total Organic Carbon		N	%		0.84	3	5	6
Loss on Ignition		M	%			--	--	10
Total BTEX		M	mg/kg		< 0.01	6	--	--
Total PCBs (7 congeners)		M	mg/kg		< 0.03	1	--	--
TPH Total WAC		M	mg/kg		< 5	500	--	--
Total (of 17) PAHs		N	mg/kg		10.0	100	--	--
pH		M			8.8	--	>6	--
Acid Neutralisation Capacity		N	mol/kg			--	To evaluate	To evaluate
Eluate Analysis			10:1		10:1	Limit values for compliance leaching test using BS EN 12457-2 at L/S 10 l/kg		
			mg/l		mg/kg			
Arsenic		N	< 0.005		< 0.05	0.5	2	25
Barium		N	0.044		0.44	20	100	300
Cadmium		N	< 0.001		< 0.01	0.04	1	5
Chromium		N	0.013		0.13	0.5	10	70
Copper		N	< 0.005		< 0.05	2	50	100
Mercury		N	< 0.005		< 0.01	0.01	0.2	2
Molybdenum		N	< 0.005		< 0.05	0.5	10	30
Nickel		N	< 0.001		< 0.05	0.4	10	40
Lead		N	0.017		0.17	0.5	10	50
Antimony		N	0.019		0.19	0.06	0.7	5
Selenium		N	< 0.005		< 0.05	0.1	0.5	7
Zinc		N	< 0.005		< 0.05	4	50	200
Chloride		N	42		418.00	800	15000	25000
Fluoride		N	< 5		< 10	10	150	500
Sulphate		N	8		83.60	1000	20000	50000
Total Dissolved Solids		N	180		1800.00	4000	60000	100000
Phenol Index		N	< 0.01		< 0.10	1	-	-
Dissolved Organic Carbon		N	8.470		85.00	500	800	1000
Leach Test Information								
pH		N	7.9					
Conductivity (uS/cm)		N	269					
Dry mass of test portion (g)			103.000					
Dry Matter (%)			85					
Moisture (%)			17					
Eluent Volume (ml)			992					

Results are expressed on a dry weight basis, after correction for moisture content where applicable

* Stated limits are for guidance only, and not for conformity assessment.



Unit A2, Windmill Road, Ponswood Industrial Estate, St Leonards on Sea, East Sussex, TN38 9BY
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Results Summary

Report No.: 19-25372, issue number 1

Asbestos Results

Analytical result only applies to the sample as submitted by the client. Any comments, opinions or interpretations (marked #) in this report are outside UKAS accreditation (Accreditation No2683). They are subjective comments only which must be verified by the client.

Elab No	Depth (m)	Clients Reference	Description of Sample Matrix #	Asbestos Identification	Gravimetric Analysis Total (%)	Gravimetric Analysis by ACM Type (%)	Free Fibre Analysis (%)	Total Asbestos (%)
187150	0.20	TP03	Brown sandy soil, road-stone, stones, glass, brick	No asbestos detected	n/t	n/t	n/t	n/t
187152	1.00	TP03	Brown sandy soil, brick, mortar, stones	No asbestos detected	n/t	n/t	n/t	n/t

Method Summary

Report No.: 19-25372, issue number 1

Parameter	Codes	Analysis Undertaken On	Date Tested	Method Number	Technique
Soil					
TOT PAH (GC-FID)	N	As submitted sample	25/10/2019		GC-FID
Hexavalent chromium	N	As submitted sample	22/10/2019	110	Colorimetry
pH	M	Air dried sample	24/10/2019	113	Electromeric
Total Petroleum Hydrocarbons in solids	M	As submitted sample	22/10/2019	117	GC-FID
Aqua regia extractable metals	M	Air dried sample	22/10/2019	118	ICPMS
PCB (ICES 7 congeners)	M	Air dried sample	22/10/2019	120	GC-MS
Phenols in solids	N	As submitted sample	21/10/2019	121	HPLC
PAH (GC-FID)	M	As submitted sample	22/10/2019	133	GC-FID
Low range Aliphatic hydrocarbons soil	N	As submitted sample	23/10/2019	181	GC-MS
Low range Aromatic hydrocarbons soil	N	As submitted sample	23/10/2019	181	GC-MS
BTEX in solids	M	As submitted sample	23/10/2019	181A	GC-MS
Water soluble boron	N	Air dried sample	23/10/2019	202	Colorimetry
Total cyanide	M	As submitted sample	22/10/2019	204	Colorimetry
Total organic carbon/Total sulphur	N	Air dried sample	23/10/2019	210	IR
TPH CWG soil by gc-gc	M	As submitted sample	21/10/2019	214	
Asbestos identification	U	Air dried sample	22/10/2019	PMAN	Microscopy

Leachate

Tests marked N are not UKAS accredited

Report Information

Report No.: 19-25372, issue number 1

Key

U	hold UKAS accreditation
M	hold MCERTS and UKAS accreditation
N	do not currently hold UKAS accreditation
^	MCERTS accreditation not applicable for sample matrix
*	UKAS accreditation not applicable for sample matrix
S	Subcontracted to approved laboratory UKAS Accredited for the test
SM	Subcontracted to approved laboratory MCERTS/UKAS Accredited for the test
NS	Subcontracted to approved laboratory. UKAS accreditation is not applicable.
I/S	Insufficient Sample
U/S	Unsuitable sample
n/t	Not tested
<	means "less than"
>	means "greater than"

Soil sample results are expressed on an air dried basis (dried at < 30°C), and are uncorrected for inert material removed.

ELAB are unable to provide an interpretation or opinion on the content of this report.

The results relate only to the sample received.

PCB congener results may include any coeluting PCBs

Uncertainty of measurement for the determinands tested are available upon request

Unless otherwise stated, sample information has been provided by the client. This may affect the validity of the results.

Deviation Codes

-
- | | |
|---|--|
| a | No date of sampling supplied |
| b | No time of sampling supplied (Waters Only) |
| c | Sample not received in appropriate containers |
| d | Sample not received in cooled condition |
| e | The container has been incorrectly filled |
| f | Sample age exceeds stability time (sampling to receipt) |
| g | Sample age exceeds stability time (sampling to analysis) |

Where a sample has a deviation code, the applicable test result may be invalid.

Sample Retention and Disposal

All soil samples will be retained for a period of one month

All water samples will be retained for 7 days following the date of the test report

Charges may apply to extended sample storage



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THE ENVIRONMENTAL LABORATORY LTD

Analytical Report Number: 19-25373

Issue: 1

Date of Issue: 25/10/2019

Contact: Daniel O'Regan

Customer Details: CC Geotechnical Ltd
Unit 1 & 2 Deltic Place
Deltic Way
Liverpool
Merseyside L33 7BA

Quotation No: Q19-01561

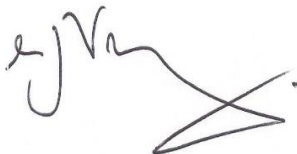
Order No: Not Supplied

Customer Reference: CCG-C-19-11195

Date Received: 17/10/2019

Date Approved: 25/10/2019

Details: City Labs, Manchester

Approved by: 

Mike Varley, Technical Manager

Any comments, opinions or interpretations expressed herein are outside the scope of UKAS accreditation (Accreditation Number 2683)

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Sample Summary

Report No.: 19-25373, issue number 1

Elab No.	Client's Ref.	Date Sampled	Date Scheduled	Description	Deviations
187154	BH02 0.20	15/10/2019	18/10/2019	Sandy silty loam	
187155	BH02 0.50	15/10/2019	18/10/2019	Sandy silty loam	
187156	BH02 1.00	15/10/2019	18/10/2019		
187157	BH02 1.50	15/10/2019	18/10/2019		
187158	BH02 2.50	15/10/2019	18/10/2019		



Results Summary

2683

Report No.: 19-25373, issue number 1

ELAB Reference	187154	187155
Customer Reference		
Sample ID		
Sample Type	SOIL	SOIL
Sample Location	BH02	BH02
Sample Depth (m)	0.20	0.50
Sampling Date	15/10/2019	15/10/2019

Determinand	Codes	Units	LOD		
Soil sample preparation parameters					
Material removed	N	%	0.1	34.6	38.4
Description of Inert material removed	N		0	Stones,brick,clinker	Stones,brick,clinker
Metals					
Antimony	N	mg/kg	2.5	5.2	4.8
Arsenic	M	mg/kg	1	37.0	35.6
Beryllium	U	mg/kg	1	2.0	1.7
Cadmium	M	mg/kg	0.5	8.5	21.0
Chromium	M	mg/kg	5	37.5	35.0
Copper	M	mg/kg	5	127	104
Lead	M	mg/kg	5	2750	4490
Mercury	M	mg/kg	0.5	2.3	1.9
Nickel	M	mg/kg	5	44.9	46.0
Selenium	M	mg/kg	1	1.0	< 1.0
Vanadium	M	mg/kg	5	58.9	55.3
Zinc	M	mg/kg	5	616	1090
Inorganics					
Hexavalent Chromium	N	mg/kg	0.8	< 0.8	< 0.8
Total Cyanide	M	mg/kg	1	< 1.0	< 1.0
Water Soluble Boron	N	mg/kg	0.5	0.5	< 0.5
Miscellaneous					
pH	M	pH units	0.1	8.2	8.4
Total Organic Carbon	N	%	0.01	4.8	4.2
Phenols					
Total Phenols	N	mg/kg	6	< 6	< 6
TPH CWG					
>C5-C6 Aliphatic	N	mg/kg	0.01	< 0.01	n/t
>C6-C8 Aliphatic	N	mg/kg	0.01	< 0.01	n/t
>C8-C10 Aliphatic	N	mg/kg	1	< 1.0	n/t
>C10-C12 Aliphatic	M	mg/kg	1	< 1.0	n/t
>C12-C16 Aliphatic	M	mg/kg	1	< 1.0	n/t
>C16-C21 Aliphatic	M	mg/kg	1	< 1.0	n/t
>C21-C35 Aliphatic	M	mg/kg	1	1.1	n/t
>C35-C40 Aliphatic	M	mg/kg	1	< 1.0	n/t
Total aliphatic hydrocarbons (>C5 - C40)	N	mg/kg	1	1.8	n/t
>C5-C7 Aromatic	N	mg/kg	0.01	< 0.01	n/t
>C7-C8 Aromatic	N	mg/kg	0.01	< 0.01	n/t
>C8-C10 Aromatic	N	mg/kg	1	< 1.0	n/t
>C10-C12 Aromatic	M	mg/kg	1	< 1.0	n/t
>C12-C16 Aromatic	M	mg/kg	1	< 1.0	n/t
>C16-C21 Aromatic	M	mg/kg	1	5.7	n/t
>C21-C35 Aromatic	M	mg/kg	1	22.6	n/t
>C35-C40 Aromatic	M	mg/kg	1	1.6	n/t
Total aromatic hydrocarbons (>C5 - C40)	N	mg/kg	1	30.8	n/t
Total petroleum hydrocarbons (>C5 - C40)	N	mg/kg	1	32.6	n/t



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Results Summary
Report No.: 19-25373, issue number 1

Asbestos Results

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in this report are outside UKAS accreditation (Accreditation No2683). They are subjective comments only which must be verified by the client.

Elab No	Depth (m)	Clients Reference	Description of Sample Matrix #	Asbestos Identification	Gravimetric Analysis Total (%)	Gravimetric Analysis by ACM Type (%)	Free Fibre Analysis (%)	Total Asbestos (%)
187154	0.20	BH02	Brown soil, clinker, stones, shell	No asbestos detected	n/t	n/t	n/t	n/t
187155	0.50	BH02	Brown soil, clinker, stones	No asbestos detected	n/t	n/t	n/t	n/t

Method Summary

Report No.: 19-25373, issue number 1

Parameter	Codes	Analysis Undertaken On	Date Tested	Method Number	Technique
Soil					
Hexavalent chromium	N	As submitted sample	22/10/2019	110	Colorimetry
pH	M	Air dried sample	24/10/2019	113	Electromeric
Aqua regia extractable metals	M	Air dried sample	22/10/2019	118	ICPMS
Phenols in solids	N	As submitted sample	21/10/2019	121	HPLC
Low range Aliphatic hydrocarbons soil	N	As submitted sample	23/10/2019	181	GC-MS
Low range Aromatic hydrocarbons soil	N	As submitted sample	23/10/2019	181	GC-MS
Water soluble boron	N	Air dried sample	23/10/2019	202	Colorimetry
Total cyanide	M	As submitted sample	22/10/2019	204	Colorimetry
Total organic carbon/Total sulphur	N	Air dried sample	23/10/2019	210	IR
TPH CWG soil by gc-gc	M	As submitted sample	21/10/2019	214	
Asbestos identification	U	Air dried sample	22/10/2019	PMAN	Microscopy

Tests marked N are not UKAS accredited

Report Information

Report No.: 19-25373, issue number 1

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n/t	Not tested
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- | | |
|---|--|
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| c | Sample not received in appropriate containers |
| d | Sample not received in cooled condition |
| e | The container has been incorrectly filled |
| f | Sample age exceeds stability time (sampling to receipt) |
| g | Sample age exceeds stability time (sampling to analysis) |

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Sample Retention and Disposal

All soil samples will be retained for a period of one month

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THE ENVIRONMENTAL LABORATORY LTD

Analytical Report Number: 19-25378

Issue: 2. Replaces Analytical Report number 19-25378; issue no.1

Date of Issue: 07/11/2019

Contact: Daniel O'Regan

Customer Details: CC Geotechnical Ltd
Unit 1 & 2 Deltic Place
Deltic Way
Liverpool
Merseyside L33 7BA

Quotation No: Q19-01561

Order No: Not Supplied

Customer Reference: CCG-C-19-11195

Date Received: 21/10/2019

Date Approved: 07/11/2019

Details: City Labs, Manchester

Approved by:

Mike Varley, Technical Manager

Any comments, opinions or interpretations expressed herein are outside the scope of UKAS accreditation (Accreditation Number 2683)

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Sample Summary

Report No.: 19-25378, issue number 2

Elab No.	Client's Ref.	Date Sampled	Date Scheduled	Description	Deviations
187187	TP04 0.20	16/10/2019	21/10/2019		
187188	TP04 0.50	16/10/2019	21/10/2019	Sandy silty loam	
187189	TP07 0.20	16/10/2019	21/10/2019	Sandy silty loam	
187190	TP07 0.50	16/10/2019	21/10/2019		
187191	TP07 1.00	16/10/2019	21/10/2019	Sandy silty loam	
187192	TP07 1.50	16/10/2019	21/10/2019		
187193	TP10 0.20	16/10/2019	21/10/2019	Sandy silty loam	
187194	TP10 0.50	16/10/2019	21/10/2019		
187195	TP10 1.00	16/10/2019	21/10/2019		
187196	TP10 1.50	16/10/2019	07/11/2019	Sandy silty loam	

Results Summary

Report No.: 19-25378, issue number 2

ELAB Reference	187188	187189	187191
Customer Reference			
Sample ID			
Sample Type	SOIL	SOIL	SOIL
Sample Location	TP04	TP07	TP07
Sample Depth (m)	0.50	0.20	1.00
Sampling Date	16/10/2019	16/10/2019	16/10/2019

Determinand	Codes	Units	LOD			
Soil sample preparation parameters						
Material removed	N	%	0.1	48.1	56.0	48.6
Description of Inert material removed	N		0	Stones,brick,clinker	Stones,brick,clinker	Stones,brick
Metals						
Antimony	N	mg/kg	2.5	13.0	4.9	31.9
Arsenic	M	mg/kg	1	33.6	29.5	23.7
Beryllium	U	mg/kg	1	1.6	1.7	< 1.0
Cadmium	M	mg/kg	0.5	1.4	1.5	0.5
Chromium	M	mg/kg	5	37.2	25.7	32.1
Copper	M	mg/kg	5	162	137	67.5
Lead	M	mg/kg	5	1440	319	11200
Mercury	M	mg/kg	0.5	1.5	< 0.5	1.9
Nickel	M	mg/kg	5	43.0	76.2	22.5
Selenium	M	mg/kg	1	< 1.0	< 1.0	< 1.0
Vanadium	M	mg/kg	5	54.6	61.1	45.6
Zinc	M	mg/kg	5	414	178	509
Inorganics						
Hexavalent Chromium	N	mg/kg	0.8	< 0.8	n/t	< 0.8
Total Cyanide	M	mg/kg	1	< 1.0	< 1.0	1.4
Water Soluble Boron	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5
Miscellaneous						
pH	M	pH units	0.1	8.9	8.7	8.6
Total Organic Carbon	N	%	0.01	5.3	13	2.1
Phenols						
Total Phenols	N	mg/kg	6	< 6	< 6	< 6
Polyaromatic hydrocarbons						
Naphthalene	M	mg/kg	0.1	n/t	n/t	< 0.1
Acenaphthylene	M	mg/kg	0.1	n/t	n/t	< 0.1
Acenaphthene	M	mg/kg	0.1	n/t	n/t	< 0.1
Fluorene	M	mg/kg	0.1	n/t	n/t	< 0.1
Phenanthrene	M	mg/kg	0.1	n/t	n/t	0.3
Anthracene	M	mg/kg	0.1	n/t	n/t	< 0.1
Fluoranthene	M	mg/kg	0.1	n/t	n/t	1.1
Pyrene	M	mg/kg	0.1	n/t	n/t	1.0
Benzo(a)anthracene	M	mg/kg	0.1	n/t	n/t	0.6
Chrysene	M	mg/kg	0.1	n/t	n/t	0.8
Benzo(b)fluoranthene	M	mg/kg	0.1	n/t	n/t	0.8
Benzo(k)fluoranthene	M	mg/kg	0.1	n/t	n/t	0.7
Benzo(a)pyrene	M	mg/kg	0.1	n/t	n/t	0.8
Indeno(1,2,3-cd)pyrene	M	mg/kg	0.1	n/t	n/t	0.6
Dibenzo(a,h)anthracene	M	mg/kg	0.1	n/t	n/t	0.1
Benzo[g,h,i]perylene	M	mg/kg	0.1	n/t	n/t	0.6
Coronene	N	mg/kg	0.1	n/t	n/t	0.2
Total PAH(16)	M	mg/kg	0.4	n/t	n/t	7.6
Total PAH (Including Coronene GC-FID)	N	mg/kg	2	n/t	n/t	8



Results Summary

2683

Report No.: 19-25378, issue number 2

ELAB Reference			187188	187189	187191
Customer Reference					
Sample ID					
Sample Type			SOIL	SOIL	SOIL
Sample Location			TP04	TP07	TP07
Sample Depth (m)			0.50	0.20	1.00
Sampling Date			16/10/2019	16/10/2019	16/10/2019
s	Units	LOD			
	mg/kg	0.01	n/t	n/t	< 0.01
	mg/kg	0.01	< 0.01	< 0.01	< 0.01
	mg/kg	0.01	< 0.01	< 0.01	< 0.01
	mg/kg	1	< 1.0	< 1.0	< 1.0
	mg/kg	1	< 1.0	< 1.0	< 1.0
	mg/kg	1	< 1.0	3.1	< 1.0
	mg/kg	1	2.6	10.8	< 1.0
	mg/kg	1	28.7	21.4	1.1
	mg/kg	1	8.3	10.8	< 1.0
	mg/kg	1	39.9	46.2	1.5
	mg/kg	0.01	< 0.01	< 0.01	< 0.01
	mg/kg	0.01	< 0.01	< 0.01	< 0.01
	mg/kg	1	< 1.0	< 1.0	< 1.0
	mg/kg	1	< 1.0	< 1.0	< 1.0
	mg/kg	1	3.1	2.5	< 1.0
	mg/kg	1	44.6	49.1	1.8
	mg/kg	1	198	337	14.4
	mg/kg	1	16.9	27.3	1.0
	mg/kg	1	263	416	17.7
	mg/kg	1	303	462	19.2
	mg/kg	5	n/t	n/t	^ < 5
	mg/kg	0.03	n/t	n/t	< 0.03

Results Summary

2683

Report No.: 19-25378, issue number 2

ELAB Reference	187193	187196
Customer Reference		
Sample ID		
Sample Type	SOIL	SOIL
Sample Location	TP10	TP10
Sample Depth (m)	0.20	1.50
Sampling Date	16/10/2019	16/10/2019

Determinand	Codes	Units	LOD		
Soil sample preparation parameters					
Material removed	N	%	0.1	50.8	39.2
Description of Inert material removed	N		0	Stones,clinker	Stones,brick,clinker
Metals					
Antimony	N	mg/kg	2.5	4.0	9.2
Arsenic	M	mg/kg	1	26.2	37.9
Beryllium	U	mg/kg	1	2.3	1.7
Cadmium	M	mg/kg	0.5	0.9	0.7
Chromium	M	mg/kg	5	24.2	33.8
Copper	M	mg/kg	5	110	108
Lead	M	mg/kg	5	413	2930
Mercury	M	mg/kg	0.5	< 0.5	1.4
Nickel	M	mg/kg	5	67.9	35.2
Selenium	M	mg/kg	1	< 1.0	< 1.0
Vanadium	M	mg/kg	5	62.3	77.2
Zinc	M	mg/kg	5	138	312
Inorganics					
Hexavalent Chromium	N	mg/kg	0.8	< 0.8	< 0.8
Total Cyanide	M	mg/kg	1	< 1.0	1.7
Water Soluble Boron	N	mg/kg	0.5	< 0.5	0.6
Miscellaneous					
pH	M	pH units	0.1	8.4	8.1
Total Organic Carbon	N	%	0.01	15	4.0
Phenols					
Total Phenols	N	mg/kg	6	< 6	< 6
Polyaromatic hydrocarbons					
Naphthalene	M	mg/kg	0.1	n/t	n/t
Acenaphthylene	M	mg/kg	0.1	n/t	n/t
Acenaphthene	M	mg/kg	0.1	n/t	n/t
Fluorene	M	mg/kg	0.1	n/t	n/t
Phenanthrene	M	mg/kg	0.1	n/t	n/t
Anthracene	M	mg/kg	0.1	n/t	n/t
Fluoranthene	M	mg/kg	0.1	n/t	n/t
Pyrene	M	mg/kg	0.1	n/t	n/t
Benzo(a)anthracene	M	mg/kg	0.1	n/t	n/t
Chrysene	M	mg/kg	0.1	n/t	n/t
Benzo(b)fluoranthene	M	mg/kg	0.1	n/t	n/t
Benzo(k)fluoranthene	M	mg/kg	0.1	n/t	n/t
Benzo(a)pyrene	M	mg/kg	0.1	n/t	n/t
Indeno(1,2,3-cd)pyrene	M	mg/kg	0.1	n/t	n/t
Dibenzo(a,h)anthracene	M	mg/kg	0.1	n/t	n/t
Benzo[g,h,i]perylene	M	mg/kg	0.1	n/t	n/t
Coronene	N	mg/kg	0.1	n/t	n/t
Total PAH(16)	M	mg/kg	0.4	n/t	n/t
Total PAH (Including Coronene GC-FID)	N	mg/kg	2	n/t	n/t



Results Summary

2683

Report No.: 19-25378, issue number 2

ELAB Reference	187193	187196
Customer Reference		
Sample ID		
Sample Type	SOIL	SOIL
Sample Location	TP10	TP10
Sample Depth (m)	0.20	1.50
Sampling Date	16/10/2019	16/10/2019

Determinand	Codes	Units	LOD		
BTEX					
Total BTEX	M	mg/kg	0.01	n/t	n/t
TPH CWG					
>C5-C6 Aliphatic	N	mg/kg	0.01	< 0.01	< 0.01
>C6-C8 Aliphatic	N	mg/kg	0.01	< 0.01	< 0.01
>C8-C10 Aliphatic	N	mg/kg	1	< 1.0	< 1.0
>C10-C12 Aliphatic	M	mg/kg	1	< 1.0	< 1.0
>C12-C16 Aliphatic	M	mg/kg	1	< 1.0	< 1.0
>C16-C21 Aliphatic	M	mg/kg	1	3.6	< 1.0
>C21-C35 Aliphatic	M	mg/kg	1	7.8	1.7
>C35-C40 Aliphatic	M	mg/kg	1	4.0	< 1.0
Total aliphatic hydrocarbons (>C5 - C40)	N	mg/kg	1	15.9	2.3
>C5-C7 Aromatic	N	mg/kg	0.01	< 0.01	< 0.01
>C7-C8 Aromatic	N	mg/kg	0.01	< 0.01	< 0.01
>C8-C10 Aromatic	N	mg/kg	1	< 1.0	< 1.0
>C10-C12 Aromatic	M	mg/kg	1	< 1.0	< 1.0
>C12-C16 Aromatic	M	mg/kg	1	2.4	< 1.0
>C16-C21 Aromatic	M	mg/kg	1	32.6	2.8
>C21-C35 Aromatic	M	mg/kg	1	239	16.2
>C35-C40 Aromatic	M	mg/kg	1	18.8	< 1.0
Total aromatic hydrocarbons (>C5 - C40)	N	mg/kg	1	293	20.6
Total petroleum hydrocarbons (>C5 - C40)	N	mg/kg	1	309	22.9
Total Petroleum Hydrocarbons					
Mineral Oil	M	mg/kg	5	n/t	n/t
PCB (ICES 7 congeners)					
PCB (Total of 7 Congeners)	M	mg/kg	0.03	n/t	n/t

Results Summary

Report No.: 19-25378, issue number 2

WAC Analysis

Elab Ref:	187191					Landfill Waste Acceptance Criteria Limits*		
Sample Date:	16/10/2019					Inert Waste Landfill	Stable Non-reactive Hazardous waste in non-hazardous Landfill	Hazardous Waste Landfill
Sample ID:	TP07							
Depth (m)	1							
Site:	City Labs, Manchester							
Determinand		Code	Units					
Total Organic Carbon		N	%		2.10	3	5	6
Loss on Ignition		M	%			--	--	10
Total BTEX		M	mg/kg		< 0.01	6	--	--
Total PCBs (7 congeners)		M	mg/kg		< 0.03	1	--	--
TPH Total WAC		M	mg/kg		< 5	500	--	--
Total (of 17) PAHs		N	mg/kg		8.0	100	--	--
pH		M			8.6	--	>6	--
Acid Neutralisation Capacity		N	mol/kg			--	To evaluate	To evaluate

Eluate Analysis

		10:1	10:1	Limit values for compliance leaching test using BS EN 12457-2 at L/S 10 l/kg		
		mg/l	mg/kg			
Arsenic	N	< 0.005	< 0.05	0.5	2	25
Barium	N	0.078	0.78	20	100	300
Cadmium	N	< 0.001	< 0.01	0.04	1	5
Chromium	N	0.026	0.26	0.5	10	70
Copper	N	< 0.005	< 0.05	2	50	100
Mercury	N	< 0.005	< 0.01	0.01	0.2	2
Molybdenum	N	< 0.005	< 0.05	0.5	10	30
Nickel	N	< 0.001	< 0.05	0.4	10	40
Lead	N	0.158	1.58	0.5	10	50
Antimony	N	0.048	0.48	0.06	0.7	5
Selenium	N	< 0.005	< 0.05	0.1	0.5	7
Zinc	N	0.010	0.10	4	50	200
Chloride	N	28	277.00	800	15000	25000
Fluoride	N	< 5	< 10	10	150	500
Sulphate	N	14	136.00	1000	20000	50000
Total Dissolved Solids	N	157	1580.00	4000	60000	100000
Phenol Index	N	< 0.01	< 0.10	1	-	-
Dissolved Organic Carbon	N	7.070	71.00	500	800	1000

Leach Test Information

pH	N	8.1				
Conductivity (uS/cm)	N	235				
Dry mass of test portion (g)		103.000				
Dry Matter (%)		81				
Moisture (%)		23				
Eluent Volume (ml)		984				

Results are expressed on a dry weight basis, after correction for moisture content where applicable

* Stated limits are for guidance only, and not for conformity assessment.

Results Summary

Report No.: 19-25378, issue number 2

Asbestos Results

Analytical result only applies to the sample as submitted by the client. Any comments, opinions or interpretations (marked #) in this report are outside UKAS accreditation (Accreditation No2683). They are subjective comments only which must be verified by the client.

Elab No	Depth (m)	Clients Reference	Description of Sample Matrix #	Asbestos Identification	Gravimetric Analysis Total (%)	Gravimetric Analysis by ACM Type (%)	Free Fibre Analysis (%)	Total Asbestos (%)
187188	0.50	TP04	Brown sandy soil, stones, clinker, brick, glass	No asbestos detected	n/t	n/t	n/t	n/t
187189	0.20	TP07	Brown sandy soil, clinker, brick, stones	No asbestos detected	n/t	n/t	n/t	n/t
187191	1.00	TP07	Brown sandy soil, brick, clinker	No asbestos detected	n/t	n/t	n/t	n/t
187193	0.20	TP10	Brown sandy soil, clinker, stones	No asbestos detected	n/t	n/t	n/t	n/t
187196	1.50	TP10	Brown sandy soil, brick, mortar, clinker,	Chrysotile (weathered Damp Proof	0.193	Weathered DPC (0.193% Chrysotile)	< 0.001	0.193

Method Summary

Report No.: 19-25378, issue number 2

Parameter	Codes	Analysis Undertaken On	Date Tested	Method Number	Technique
Soil					
TOT PAH (GC-FID)	N	As submitted sample	24/10/2019		GC-FID
Hexavalent chromium	N	As submitted sample	22/10/2019	110	Colorimetry
pH	M	Air dried sample	24/10/2019	113	Electromeric
Total Petroleum Hydrocarbons in solids	M	As submitted sample	22/10/2019	117	GC-FID
Aqua regia extractable metals	M	Air dried sample	22/10/2019	118	ICPMS
PCB (ICES 7 congeners)	M	Air dried sample	22/10/2019	120	GC-MS
Phenols in solids	N	As submitted sample	22/10/2019	121	HPLC
PAH (GC-FID)	M	As submitted sample	22/10/2019	133	GC-FID
Low range Aliphatic hydrocarbons soil	N	As submitted sample	23/10/2019	181	GC-MS
Low range Aromatic hydrocarbons soil	N	As submitted sample	23/10/2019	181	GC-MS
BTEX in solids	M	As submitted sample	23/10/2019	181A	GC-MS
Water soluble boron	N	Air dried sample	23/10/2019	202	Colorimetry
Total cyanide	M	As submitted sample	22/10/2019	204	Colorimetry
Total organic carbon/Total sulphur	N	Air dried sample	23/10/2019	210	IR
TPH CWG soil by gc-gc	M	As submitted sample	21/10/2019	214	
Asbestos identification	U	Air dried sample	23/10/2019	260	Microscopy

Leachate

Tests marked N are not UKAS accredited

Report Information

Report No.: 19-25378, issue number 2

Key

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NS	Subcontracted to approved laboratory. UKAS accreditation is not applicable.
I/S	Insufficient Sample
U/S	Unsuitable sample
n/t	Not tested
<	means "less than"
>	means "greater than"

Soil sample results are expressed on an air dried basis (dried at < 30°C), and are uncorrected for inert material removed.

ELAB are unable to provide an interpretation or opinion on the content of this report.

The results relate only to the sample received.

PCB congener results may include any coeluting PCBs

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Deviation Codes

-
- | | |
|---|--|
| a | No date of sampling supplied |
| b | No time of sampling supplied (Waters Only) |
| c | Sample not received in appropriate containers |
| d | Sample not received in cooled condition |
| e | The container has been incorrectly filled |
| f | Sample age exceeds stability time (sampling to receipt) |
| g | Sample age exceeds stability time (sampling to analysis) |

Where a sample has a deviation code, the applicable test result may be invalid.

Sample Retention and Disposal

All soil samples will be retained for a period of one month

All water samples will be retained for 7 days following the date of the test report

Charges may apply to extended sample storage



Unit A2
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Ponswood Industrial Estate
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East Sussex
TN38 9BY
Telephone: (01424) 718618

cs@elab-uk.co.uk
info@elab-uk.co.uk

THE ENVIRONMENTAL LABORATORY LTD

Analytical Report Number: 19-25500

Issue: 1

Date of Issue: 30/10/2019

Contact: Daniel O'Regan

Customer Details: CC Geotechnical Ltd
Unit 1 & 2 Deltic Place
Deltic Way
Liverpool
Merseyside L33 7BA

Quotation No: Q14-00045

Order No: Not Supplied

Customer Reference: CCG-C-19-11195

Date Received: 28/10/2019

Date Approved: 30/10/2019

Details: City Labs, Manchester

Approved by:

John Wilson, Quality Manager

Any comments, opinions or interpretations expressed herein are outside the scope of UKAS accreditation (Accreditation Number 2683)

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Sample Summary

Report No.: 19-25500, issue number 1

Elab No.	Client's Ref.	Date Sampled	Date Scheduled	Description	Deviations
187932	BH01 6.00	11/10/2019	28/10/2019	Clayey loam	
187933	BH01 7.50	11/10/2019	28/10/2019	Clayey loam	
187934	BH01 10.50	11/10/2019	28/10/2019	Loamy sand	
187935	BH02 2.00	15/10/2019	28/10/2019	Clayey loam	
187936	BH02 6.00	15/10/2019	28/10/2019	Clayey loam	
187937	BH02 10.50	15/10/2019	28/10/2019	Loamy sand	
187938	BH03 1.50	07/10/2019	28/10/2019	Sandy clayey loam	
187939	BH03 6.00	07/10/2019	28/10/2019	Silty clayey loam	
187940	BH03 12.00	07/10/2019	28/10/2019	Sand	
187941	TP01 0.50	15/10/2019	28/10/2019	Loamy sand	
187942	TP04 3.60	16/10/2019	28/10/2019	Clayey loam	
187943	TP10 3.50	16/10/2019	28/10/2019	Sandy clayey loam	



Results Summary

2683

Report No.: 19-25500, issue number 1

ELAB Reference				187932	187933	187934	187935	187936
Customer Reference								
Sample ID								
Sample Type				SOIL	SOIL	SOIL	SOIL	SOIL
Sample Location				BH01	BH01	BH01	BH02	BH02
Sample Depth (m)				6.00	7.50	10.50	2.00	6.00
Sampling Date				11/10/2019	11/10/2019	11/10/2019	15/10/2019	15/10/2019
Determinand	Codes	Units	LOD					
Soil sample preparation parameters								
Material removed	N	%	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Description of Inert material removed	N		0	None	None	None	None	None
Metals								
Water soluble magnesium	N	g/l	0.01	< 0.01	0.01	0.01	< 0.01	0.01
Anions								
Water Soluble Chloride	M	mg/l	20	< 20	< 20	< 20	20	< 20
Water Soluble Nitrate	N	mg/l	20	34	33	29	24	37
Water Soluble Sulphate	M	g/l	0.02	0.03	0.03	0.03	< 0.02	0.03
Miscellaneous								
pH	M	pH units	0.1	8.8	8.8	8.9	8.3	8.7



Results Summary

2683

Report No.: 19-25500, issue number 1

ELAB Reference				187937	187938	187939	187940
Customer Reference							
Sample ID							
Sample Type				SOIL	SOIL	SOIL	SOIL
Sample Location				BH02	BH03	BH03	BH03
Sample Depth (m)				10.50	1.50	6.00	12.00
Sampling Date				15/10/2019	07/10/2019	07/10/2019	07/10/2019
Determinand	Codes	Units	LOD				
Soil sample preparation parameters							
Material removed	N	%	0.1	< 0.1	< 0.1	< 0.1	66.5
Description of Inert material removed	N		0	None	None	None	Stones
Metals							
Water soluble magnesium	N	g/l	0.01	< 0.01	< 0.01	0.02	< 0.01
Anions							
Water Soluble Chloride	M	mg/l	20	< 20	152	< 20	< 20
Water Soluble Nitrate	N	mg/l	20	< 20	20	28	< 20
Water Soluble Sulphate	M	g/l	0.02	< 0.02	0.12	0.13	< 0.02
Miscellaneous							
pH	M	pH units	0.1	8.7	7.7	8.6	9.1



Results Summary

2683

Report No.: 19-25500, issue number 1

ELAB Reference	187941	187942	187943
Customer Reference			
Sample ID			
Sample Type	SOIL	SOIL	SOIL
Sample Location	TP01	TP04	TP10
Sample Depth (m)	0.50	3.60	3.50
Sampling Date	15/10/2019	16/10/2019	16/10/2019

Determinand	Codes	Units	LOD			
Soil sample preparation parameters						
Material removed	N	%	0.1	34.4	< 0.1	< 0.1
Description of Inert material removed	N		0	Stones,brick,clinker	None	None
Metals						
Water soluble magnesium	N	g/l	0.01	< 0.01	0.01	0.01
Anions						
Water Soluble Chloride	M	mg/l	20	147	23	51
Water Soluble Nitrate	N	mg/l	20	41	35	< 20
Water Soluble Sulphate	M	g/l	0.02	0.02	< 0.02	0.17
Miscellaneous						
pH	M	pH units	0.1	9.2	8.6	7.7



Method Summary

Report No.: 19-25500, issue number 1

Parameter	Codes	Analysis Undertaken On	Date Tested	Method Number	Technique
Soil					
pH	M	Air dried sample	29/10/2019	113	Electromeric
W. Sol Metals	N	Air dried sample	30/10/2019	118	ICPMS
Water soluble anions	M	Air dried sample	29/10/2019	172	Ion Chromatography

Tests marked N are not UKAS accredited

Report Information

Report No.: 19-25500, issue number 1

Key

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*	UKAS accreditation not applicable for sample matrix
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SM	Subcontracted to approved laboratory MCERTS/UKAS Accredited for the test
NS	Subcontracted to approved laboratory. UKAS accreditation is not applicable.
I/S	Insufficient Sample
U/S	Unsuitable sample
n/t	Not tested
<	means "less than"
>	means "greater than"

Soil sample results are expressed on an air dried basis (dried at < 30°C), and are uncorrected for inert material removed.

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The results relate only to the sample received.

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Deviation Codes

-
- | | |
|---|--|
| a | No date of sampling supplied |
| b | No time of sampling supplied (Waters Only) |
| c | Sample not received in appropriate containers |
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| e | The container has been incorrectly filled |
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| g | Sample age exceeds stability time (sampling to analysis) |

Where a sample has a deviation code, the applicable test result may be invalid.

Sample Retention and Disposal

All soil samples will be retained for a period of one month

All water samples will be retained for 7 days following the date of the test report

Charges may apply to extended sample storage



Unit A2
Windmill Road
Ponswood Industrial Estate
St Leonards on Sea
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TN38 9BY
Telephone: (01424) 718618

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info@elab-uk.co.uk

THE ENVIRONMENTAL LABORATORY LTD

Analytical Report Number: 19-25658

Issue: 1

Date of Issue: 14/11/2019

Contact: Daniel O'Regan

Customer Details: CC Geotechnical Ltd
Unit 1 & 2 Deltic Place
Deltic Way
Liverpool
Merseyside L33 7BA

Quotation No: Q19-01561

Order No: Not Supplied

Customer Reference: 19/11195

Date Received: 07/11/2019

Date Approved: 14/11/2019

Details: City Labs, Manchester

Approved by:

John Wilson, Quality Manager

Any comments, opinions or interpretations expressed herein are outside the scope of UKAS accreditation (Accreditation Number 2683)

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Sample Summary

Report No.: 19-25658, issue number 1

Elab No.	Client's Ref.	Date Sampled	Date Scheduled	Description	Deviations
189014	BH02	06/11/2019	07/11/2019		
189015	BH03	06/11/2019	07/11/2019		

Results Summary

Report No.: 19-25658, issue number 1

ELAB Reference	189014	189015
Customer Reference		
Sample ID		
Sample Type	WATER	WATER
Sample Location	BH02	BH03
Sample Depth (m)		
Sampling Date	06/11/2019	06/11/2019

Determinand	Codes	Units	LOD		
Dissolved Metals					
Arsenic	U	ug/l	5	< 5	< 5
Beryllium	U	ug/l	5	< 5	< 5
Calcium	U	ug/l	100	108000	100000
Cadmium	U	ug/l	1	< 1	< 1
Chromium	U	ug/l	5	< 5	< 5
Copper	U	ug/l	5	< 5	< 5
Mercury	U	ug/l	0.1	< 0.1	< 0.1
Magnesium	U	ug/l	100	63700	63100
Manganese	U	ug/l	5	887	1020
Nickel	U	ug/l	5	< 5	< 5
Lead	U	ug/l	1	< 1	< 1
Antimony	N	ug/l	5	< 5	< 5
Selenium	U	ug/l	5	< 5	< 5
Vanadium	N	ug/l	5	< 5	< 5
Zinc	U	ug/l	5	< 5	< 5
Anions					
Chloride	U	mg/l	0.5	24.6	33.6
Inorganics					
Ammoniacal Nitrogen as N	N	mg/l	0.1	0.6	0.2
Total Cyanide	U	ug/l	5	< 5	< 5
Miscellaneous					
Dissolved organic carbon	U	mg/l	1.5	12	11
Hardness (CaCO ₃)	N	mg/l CaCO ₃	0.1	531	510
pH	U	pH units	0.1	7.4	7.5
Phenols					
Total Phenols	N	ug/l	1	< 1	< 1
TPH CWG					
>C5-C6 Aliphatic	N	ug/l	1	< 1.0	< 1.0
>C6-C8 Aliphatic	N	ug/l	1	< 1.0	< 1.0
>C8-C10 Aliphatic	N	ug/l	5	< 5.0	< 5.0
>C10-C12 Aliphatic	N	ug/l	5	< 5.0	< 5.0
>C12-C16 Aliphatic	N	ug/l	5	7.9	< 5.0
>C16-C21 Aliphatic	N	ug/l	5	15.2	< 5.0
>C21-C35 Aliphatic	N	ug/l	5	86.4	54.7
>C35-C40 Aliphatic	N	ug/l	5	< 5.0	< 5.0
Total (>C5-C40) Aliphatic	N	ug/l	5	110	54.7
>C5-C7 Aromatic	N	ug/l	1	< 1.0	< 1.0
>C7-C8 Aromatic	N	ug/l	1	< 1.0	< 1.0
>C8-C10 Aromatic	N	ug/l	5	< 5.0	< 5.0
>C10-C12 Aromatic	N	ug/l	5	< 5.0	< 5.0
>C12-C16 Aromatic	N	ug/l	5	< 5.0	< 5.0
>C16-C21 Aromatic	N	ug/l	5	11.5	< 5.0
>C21-C35 Aromatic	N	ug/l	5	83.4	50.0
>C35-C40 Aromatic	N	ug/l	5	15.0	< 5.0
Total (>C5-C40) Aromatic	N	ug/l	5	110	50.0
Total (>C5-C40) Ali/Aro	N	ug/l	5	220	105

Method Summary

Report No.: 19-25658, issue number 1

Parameter	Codes	Analysis Undertaken On	Date Tested	Method Number	Technique
Water					
Aliphatic/Aromatic hydrocarbons in water	N		14/11/2019		GC-FID
Aromatic hydrocarbons in water	N		14/11/2019		GC-FID
Phenols in waters	N		08/11/2019		HPLC
Dissolved metals by ICP in waters	U		08/11/2019	101	ICPMS
Dissolved organic carbon	U		12/11/2019	102	IR
pH of waters	U		08/11/2019	113	Electromeric
Ammonia in waters	N		11/11/2019	151	Colorimetry
Low range Aliphatic hydrocarbons water	N		08/11/2019	200	GC-MS
Low range Aromatic hydrocarbons water	N		08/11/2019	200	GC-MS
Cyanide in waters	U		08/11/2019	205	Colorimetry
Aliphatic hydrocarbons in water	N		14/11/2019	215	GC-FID
Aromatic hydrocarbons in water	N		14/11/2019	215	GC-FID
Anions	U		08/11/2019	270	Ion Chromatography
Hardness in waters	N		11/11/2019	APHA	ICPMS

Tests marked N are not UKAS accredited

Report Information

Report No.: 19-25658, issue number 1

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- | | |
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Sample Retention and Disposal

All soil samples will be retained for a period of one month

All water samples will be retained for 7 days following the date of the test report

Charges may apply to extended sample storage



APPENDIX H

GAS / GROUNDWATER MONITORING RESULTS & CALIBRATION CERTIFICATES

GAS AND WATER MONITORING RESULTS

[illegible]

TEST DATE AND CONDITIONS	
Date	8/7/19
Atmospheric Pressure	1013mB
Ambient Temp	24.7°C
EnviroNics Serial No.	2633



GAS DATA LTD
Pegasus House
Seven Stars Estate
Wheler Rd
Coventry
CV3 4LB
Tel 02476303311 Fax 02476307711

GFM436-1 FINAL INSPECTION & CALIBRATION CHECK CERTIFICATE

INSTRUMENT DETAILS	
Serial No	Customer
12220	CC Geotechnical Ltd

INSTRUMENT CHECKS			
Keyboard	✓	Pump Flow	500cc/min
Display Contrast	✓	Pump Flow @ -200mB	325cc/min
Clock Set / Running	✓	S/W Version	G436.0027/0009
Labels Fitted	✓	Recalibration Date	8/7/20

GAS CHECKS							
Calibration Gas		Instrument Gas Channels Read					
Gas Type	Applied Conc.	CH4 (%)	tol. (% vol.)	CO2 (%)	tol. (% vol.)	O2 (%)	tol. (% vol.)
N2	100%	0.0	0.0	0.0	0.0	0.0	+/-0.1
CH4	5%	4.9	+/-0.3	0.0	0.0	0.0	+/-0.1
	60%	59.8	+/-3.0	0.0	0.0	0.0	+/-0.1
CO2	5%	0.0	0.0	5.0	+/-0.3	0.0	+/-0.1
	40%	0.0	0.0	40.6	+/-3.0	0.0	+/-0.1
O2	20.9%	0.0	0.0	0.0	+0.1	20.9	+/-0.5

OPTIONAL GAS CHECKS								
Calibration Gas		Instrument Gas Channels Read						
Gas Type	Applied Conc.	Label	H2S	CO			Hexane	tol. (% vol.)
		Range	5000ppm	2000ppm			2.00%	
N2	100%		0	0			0.0	+/- 5.0
H2S	1500ppm		1520	0				+/- 5.0
CO	1000ppm		60	998				+/- 5.0
Hexane	2.00%						2.1	+/- 10.0

PRESSURE CHECKS							
Calibration Pressure		Instrument Pressure Channels Read					
Pressure @	Applied Pressure	Atmospheric [Ap] (mB)	tol. (mB)				
All Ports	Current Atmospheric	1013	+/-2.0				
Ap Port (Internal)	+800mB(a)	800	+/-5.0				
	+1200mB(a)	1201	+/-5.0				

TEST DATE AND CONDITIONS	
Date	8/7/19
Atmospheric Pressure	1013mB
Ambient Temp	24.7°C
EnviroNics Serial No.	2633



GAS DATA LTD

Pegasus House
Seven Stars Estate
Wheler Rd
Coventry
CV3 4LB
Tel 02476303311 Fax 02476307711

GFM436-1 FINAL INSPECTION & CALIBRATION CHECK CERTIFICATE

FLOW CHECKS					
Calibration Flow		Instrument Flow Channels Read			
Applied Flow (l/hour)	Applied Pressure (Pa)	Flow [Flow] (l/hour)	tol. (l/hour)	Differential Pressure [Dp] (Pa)	tol. (Pa)
-30.0	-410	-29.5	+/-3.0	-415	+/-50
-3.0	-18	-2.7	+/-1.0	-17	+/-6
0.0	0	0.0	0.0	0	0.0
+3.0	15	2.8	+/-0.5	14	+/-3
+30.0	335	29.5	+/-3.0	339	+/-50
+60.0	1017	59.8	+/-6.0	1022	+/-130
+90.0	2020	90.5	+/-9.0	2018	+/-250

TEMPERATURE CHECK		
Calibration Temperature	Instrument Temperature Channel Read	
Applied Equivalent Temperature (°C)	Temperature [Temp] (°C)	tol. (°C)
-10.0	-10.0	+/- 2.0
0.0	0.0	+/- 1.0
30.0	30.0	+/- 1.0
60.0	60.0	+/- 1.0
100.0	100.0	+/- 1.0

Notes:

The instrument identified by the serial number stated above has been tested by Gas Data personnel for calibration accuracy on the date and under the ambient conditions stated. Gas Data Ltd internal BS EN ISO9001:2015 compliant workshop procedures were followed to apply known calibration test gases, gas flow rates, pressures and temperatures of the values stated. The results displayed on the instrument at each stage are recorded above.

Gas Data Ltd is certified to BS EN ISO9001:2015. Certificate NQA 8374. Valid until 22/03/2019



APPENDIX I

NOTES ON LIMITATIONS

Notes on Limitations For Geoenvironmental and Geotechnical Consultancy Services

General

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The findings and opinions are relevant to the dates when the assessment was undertaken, but should not necessarily be relied upon to represent conditions at a substantially later date. In particular, seasonal groundwater levels, with the effects of precipitation, may affect the conditions found during the investigation. The report should be read in conjunction with the further Notes on Limitations included in Appendix A.

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1. the consequences of this document being used for any purpose or project other than for which it was commissioned and/or
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Phase I Environmental Audits / Desk Studies

The work undertaken to provide the basis of a Phase 1 Desk Study report comprises a study of available documented information from a variety of sources (including the client), together with (where appropriate) a brief walk over inspection of the site and meetings and discussions with relevant authorities and other interested parties. The opinions given in a Desk Study report have been dictated by finite data on which they are based and are relevant only to the purpose for which the report was commissioned. The information reviewed should not be considered exhaustive and has been accepted in good faith as providing true and representative data pertaining to site conditions. Should additional information become available which may affect the opinions expressed in the report, CC GEOTECHNICAL LTD reserves the right to review such information and to modify the opinions accordingly.

It should be noted that any risks identified in this report are perceived risks based on the information reviewed; actual risks can only be assessed following a physical investigation of the site.

Phase II Environmental Audits

The investigation of the site has been carried out with the intention of providing sufficient information concerning the type and degree of contamination, and ground and groundwater conditions to allow a reasonable risk assessment to be made. The objectives of the investigation have been limited to establishing the risks associated to potential human targets, building materials, the environment (including adjacent land), and surface and groundwater.

The amount of exploratory work and chemical testing undertaken may have been restricted by the timescale available, and the locations of the exploratory holes may have been restricted to areas unoccupied by the building(s) on the site, and further restricted by the existence of buried services. A more comprehensive investigation may be required if the site is to be redeveloped as, in addition to risk assessment, a number of important engineering and environmental issues may need to be resolved.

For those reasons, if costs have been included in relation to site remediation these must be considered as tentative only and must, in any event, be confirmed by a qualified quantity surveyor.

The exploratory holes undertaken, investigate only a small volume of the ground in relation to the size of the site, and can only provide a general indication of site conditions. The number of sampling points and the methods of sampling and testing do not preclude the existence of localised "hotspots" of contamination where concentrations may be significantly higher than those actually encountered.

Geoenvironmental Ground Investigations

The investigation of the site has been carried out to provide sufficient information within the agreed scope of the investigation, under the general headings of type and degree of contamination, geotechnical characteristics, and ground and groundwater conditions, to provide a reasonable assessment of the environmental risks together with engineering and development implications.

If costs have been included in relation to the site remediation, these must be confirmed by a qualified quantity surveyor.

The exploratory holes undertaken, investigate only a small volume of the ground in relation to the size of the site, and can only provide a general indication of the site conditions. The opinions provided and recommendations given in this report are based on the ground conditions apparent at the site of each of the exploratory holes. There may be ground conditions present on the site which have not been disclosed by this investigation, and which have therefore not been taken into account in this report.

The comments made on groundwater conditions are based on observations made at the time that site work was carried out. It should be noted that groundwater levels will vary owing to seasonal, tidal, weather, or other effects.

The risk assessment and opinions provided, inter alia, take into consideration currently available guidance relating to acceptable contamination concentrations; no liability can be accepted for the retrospective effects of any future changes or amendments to these values.

Appendix D

Detailed Unexploded Ordnance (UXO) Risk Assessment



1ST LINE DEFENCE



Detailed Unexploded Ordnance (UXO) Risk Assessment

Project Name	193 Hathersage Road, Manchester
Client	ARUP Group
Site Address	193 Hathersage Road, Manchester, M13 0JE
Report Reference	DA8680-00
Date	4 th of June 2019
Originator	AH



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Executive Summary

Site Location and Description

The site is located within Longsight, Greater Manchester.

The north of the site is bound by Hathersage Road, while the east, south and west of the site is bound by a variety of large multi-storey structures comprising residential and commercial spaces.

The west of the site is currently comprised of a small temporary-style structure, understood to be a Diabetes Centre, while the remainder of the site is occupied by hardstanding car parking areas.

The site is approximately centred on the OS grid reference: **SJ 8516495817**.

Proposed Works

Planned ground investigation works are understood to comprise of ten trial pits and six boreholes. Intrusive construction works are understood to involve relatively shallow excavation of the near surface Made Ground deposits for utilities and substructure, to around 2-3m maximum depth, as well as bored Contiguous Flight Auger (CFA) piles foundations drilled into the rockhead to around 15-25m depth. Intrusive works are understood to be for the construction of a seven storey steel frame office structure

Geology and Bomb Penetration Depth

The British Geological Survey (BGS) map shows the site to be underlain by the Chester Formation – Sandstone of the Triassic Period. Superficial deposits are described as Till, Devensian – Diamiction of the Quaternary Period.

Site specific geotechnical information was not available to 1st Line Defence at the time of the production of this report. An assessment of maximum bomb penetration depth can be made once such data becomes available, or by a UXO specialist during on-site support.

It should be noted that the maximum depth that a bomb could reach may vary across a site and will be largely dependent on the specific underlying geological strata and its density.

UXO Risk Assessment

1st Line Defence has assessed that there is a **Medium Risk** from items of German aerial delivered UXO and anti-aircraft ordnance within the east of the proposed boundary, with an area of **Low Risk** in the west. (See **Annex N** for a Risk Map). This assessment is based on the following factors:

- During WWII, the site was situated within the County Borough of Manchester. According to Home Office statistics Manchester endured an overall low density of bombing, with an average of 27.1 items recorded per 1,000 acres. In relation to other major cities in Britain, Manchester did not receive the same density of bombing as London, Liverpool, Birmingham, or Coventry. However, Manchester was subject to a number of major bombing raids, including what is known as the Manchester Blitz or 'Christmas Blitz' period. The heaviest raids in this period occurred between the 22nd and 23rd and 23rd and 24th of December 1940.
- A 'Record of the Locations of Aerial Bombs on the City of Manchester' bomb plot map was compiled by the Manchester City Council and obtained from the Manchester University Library. This source records one 'fire bomb', although the exact type of which is unknown, within the east of the site on the centre of a block of six terraced residential properties. The incident is dated to the 22nd – 23rd of December 1940, during one of the heaviest recorded raids in the Manchester Blitz period, and the six properties are recorded to have been demolished as a consequence. This source also documents another 'fire bomb' to have fallen approximately 20m south of the site onto St Gabriel's Hall on the 1st/2nd of June 1941. No resulting damage from this incident is documented.
- Damage cards for Manchester were also obtained from the Manchester Central Library. This source records a number of properties on High Street to have been demolished owing to significant bomb damage. This includes property number 173, which historical OS mapping indicates was located within the very east of the proposed boundary, and number 171 which was located adjacent to the eastern boundary.
- WWII-era aerial imagery corroborates these damage cards, and also indicates that a number of additional houses on High Street were cleared. This 1946 image depicts a large area of clearance with the eastern area of the site, which historical OS mapping indicates was formerly occupied by six terraced properties, and extends beyond the eastern

**UXO Risk Assessment**

site boundary. A structure adjacent to the south of the proposed site also appears damaged, however, the four residential terraced properties with the west of the site appear to have survived the war intact. Notably, the St Gabriel's Hall structure also does not appear to be damaged within this source, and a water tank appears to have been placed with the cleared area within the east of site.

- Following the 'fire bomb' incident within the site in December of 1940, access to the east of the site would have initially ceased, and later been confined to the infrequent access of the water tank, anticipated to have been placed at this location by ARP personnel to be used in the event of a fire, and the ground conditions are considered to have been unfavourable to the detection of UXO. Access to the west of the site is also anticipated to have ceased owing to evacuation protocol, although is likely to have later resumed, and the ground conditions in this far western section are anticipated to have been much more favourable to the detection of UXO given that the properties in this location remained intact. It is conceivable that UXO could have fallen within the small garden areas in this section of the site unnoticed, but this is not considered very likely.
- Overall, given the abovementioned factors there is considered to be an elevated risk of contamination within the eastern and central sections of the site. A buffer zone has been added around this area of clearance/damage to allow for the possibility of 'J-curve', whereby an item of ordnance can come to rest at a lateral offset from its point of entry. The far western section of the site, in which the structures on site appear to have survived the war structurally intact, has been assessed a 'low' risk of contamination. As risk map has been prepared – see **Annex N1 and N2**.
- No evidence could be found to indicate that the site formerly had any military occupation or usage that could have led to contamination with items of Allied ordnance, such as LSA and SAA. The conditions in which HAA or LAA projectiles may have fallen unnoticed within the site boundary are however analogous to those regarding aerial delivered ordnance.
- Redevelopment of the site has included the demolition of all war-era structures on site, as well as the construction of a temporary-style structure and the hardstanding tarmacked areas now used as a car park.

Recommended Risk Mitigation Measures

The following risk mitigation measures are recommended to support the proposed works at the 193 Hathersage Road, Manchester:

All Works

- UXO Risk Management Plan
- Site Specific UXO Awareness Briefings to all personnel conducting intrusive works.

Medium Risk Areas**Open Intrusive Works (trial pits, service pits, open excavations, shallow foundations etc.)**

- UXO Specialist On-site Support

Boreholes and Piled Foundations

- Intrusive Magnetometer Survey of all borehole and pile locations/clusters down to maximum bomb penetration depth.



Risk Map



For indicative purposes – not to scale.

Please note that this assessed risk map may not take into account all post-war redevelopment/excavations on site.



Low Risk



Medium Risk

1st Line Defence Risk Mitigation Services:

All Areas of the Site:

- Site Specific Unexploded Ordnance Awareness Briefings – a service recommended to all personnel conducting intrusive works.

Medium Risk Areas of the site:

- Unexploded Ordnance Specialist - a service to support open intrusive works.
- Intrusive Magnetometer Survey – a service to support any borehole or pile locations/clusters down to an assessed maximum bomb penetration depth.



Glossary

Abbreviation	Definition
AA	Anti-Aircraft
AFS	Auxiliary Fire Service
AP	Anti-Personnel
ARP	Air Raid Precautions
DA	Delay-action
EOC	Explosive Ordnance Clearance
EOD	Explosive Ordnance Disposal
FP	Fire Pot
GM	G Mine (Parachute mine)
HAA	Heavy Anti-Aircraft
HE	High Explosive
IB	Incendiary Bomb
JSEODOC	Joint Services Explosive Ordnance Disposal Operation Centre
LAA	Light Anti-Aircraft
LCC	London County Council
LRRB	Long Range Rocket Bomb (V-2)
LSA	Land Service Ammunition
NFF	National Filling Factory
OB	Oil Bomb
PAC	Pilotless Aircraft (V-1)
PB	Phosphorous Bomb
PM	Parachute Mine
POW	Prisoner Of War
RAF	Royal Air Force
RCAF	Royal Canadian Air Force
RFC	Royal Flying Corps
RNAS	Royal Naval Air Service
ROF	Royal Ordnance Factory
SA	Small Arms
SAA	Small Arms Ammunition
SD2	Anti-personnel "Butterfly Bomb"
SIP	Self-Igniting Phosphorous
U/C	Unclassified bomb
UP	Unrotated Projectile (rocket)
USAAF	United States Army Air Force
UX	Unexploded
UXAA	Unexploded Anti-Aircraft
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
V-1	Flying Bomb (Doodlebug)
V-2	Long Range Rocket
WAAF	Women's Auxiliary Air Force
X	Exploded

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1st Line Defence Limited

Detailed Unexploded Ordnance (UXO) Risk Assessment

Site: 193 Hathersage Road, Manchester
Client: ARUP Group

1. Introduction

1.1. Background

1st Line Defence has been commissioned by ARUP Group to conduct a Detailed Unexploded Ordnance (UXO) Risk Assessment for the proposed works at the proposed 193 Hathersage Road, Manchester site.

Buried UXO can present a significant risk to construction works and development projects. The discovery of a suspect device during works can cause considerable disruption to operations as well as cause unwanted delays and expense.

UXO in the UK can originate from three principal sources:

1. Munitions resulting from wartime activities including German bombing in WWI and WWII, long range shelling, and defensive activities.
2. Munitions deposited as a result of military training and exercises.
3. Munitions lost, burnt, buried or otherwise discarded either deliberately, accidentally, or ineffectively.

This report will assess the potential factors that may contribute to the risk of UXO contamination. If an elevated risk is identified at the site, this report will recommend appropriate mitigation measures, in order to reduce the risk to as low as is reasonably practicable. Detailed analysis and evidence will be provided to ensure an understanding of the basis for the assessed risk level and any recommendations.

This report complies with the guidelines outlined in *CIRIA C681*, 'Unexploded Ordnance (UXO) A Guide for the Construction Industry.'

2. Method Statement

2.1. Report Objectives

The aim of this report is to conduct a comprehensive assessment of the potential risk from UXO at 193 Hathersage Road, Manchester. The report will also recommend appropriate site and work-specific risk mitigation measures to reduce the risk from explosive ordnance during the envisaged works to a level that is as low as reasonably practicable.

2.2. Risk Assessment Process

1st Line Defence has undertaken a five-step process for assessing the risk of UXO contamination:

1. The likelihood that the site was contaminated with UXO.
2. The likelihood that UXO remains on the site.
3. The likelihood that UXO may be encountered during the proposed works.
4. The likelihood that UXO may be initiated.
5. The consequences of initiating or encountering UXO.

In order to address the above, 1st Line Defence has taken into consideration the following factors:

- Evidence of WWI and WWII German aerial delivered bombing as well as the legacy of Allied occupation.
- The nature and conditions of the site during WWII.
- The extent of post-war development and UXO clearance operations on site.
- The scope and nature of the proposed works and the maximum assessed bomb penetration depth.
- The nature of ordnance that may have contaminated the proposed site area.

2.3. Sources of Information

Every reasonable effort has been made to ensure that relevant evidence has been consulted and presented in order to produce a thorough and comprehensible report for the client. To achieve this the following, which includes military records and archive material held in the public domain, have been accessed:

- The National Archives and the Greater Manchester County Record Office.
- Historical mapping datasets.
- Historic England National Monuments Record.
- Relevant information supplied by ARUP Group.
- Available material from 33 Engineer Regiment (EOD) Archive (now 28 Regt).
- 1st Line Defence's extensive historical archives, library and UXO geo-datasets.
- Open sources such as published books and internet resources.

Research involved a visit to The National Archives and the Greater Manchester County Record Office.

3. Background to Bombing Records

3.1. General Considerations of Historical Research

This desktop assessment is based largely upon analysis of historical evidence. Every reasonable effort has been made to locate and present significant and pertinent information. 1st Line Defence cannot be held accountable for any changes to the assessed risk level or risk mitigation measures, based on documentation or other data that may come to light at a later date, or which was not available to 1st Line Defence during the production of this report.

It is often problematic and sometimes impossible to verify the completeness and accuracy of WWII-era records. As a consequence, conclusions as to the exact location and nature of a UXO risk can rarely be quantified and are to a degree subjective. To counter this, a range of sources have been consulted, presented and analysed. The same methodology is applied to each report during the risk assessment process. 1st Line Defence cannot be held responsible for any inaccuracies or the incompleteness in available historical information.

3.2. German Bombing Records

During WWII, bombing records were generally gathered locally by the police, Air Raid Precaution (ARP) wardens and military personnel. These records typically contained information such as the date, the location, the amount of damage caused and the types of bombs that had fallen during an air raid. This information was made either through direct observation or post-raid surveys. The Ministry of Home Security Bomb Census Organisation would then receive this information, which was plotted onto maps, charts, and tracing sheets by regional technical officers. The collective record set (regional bomb census mapping and locally gathered incidents records) would then be processed and summarised into reports by the Ministry of Home Security Research and Experiments Branch. The latter were tasked with providing the government 'a complete picture of air raid patterns, types of weapons used and damage caused- in particular to strategic services and installations such as railways, shipyards, factories and public utilities.'¹

The quality, detail and nature of record keeping could vary considerably between provincial towns, boroughs and cities. No two areas identically collated or recorded data. While some local authorities maintained records with a methodical approach, sources in certain areas can be considerably more vague, dispersed, and narrower in scope. In addition, the immediate priority was mostly focused on assisting casualties and minimising damage at the time. As a result, some records can be incomplete and contradictory. Furthermore, many records were even damaged or destroyed in subsequent air raids. Records of raids that took place on sparsely or uninhabited areas were often based upon third party or hearsay information and are therefore not always reliable. Whereas records of attacks on military or strategic targets were often maintained separately and have not always survived.

3.3. Allied Records

During WWII considerable areas of land were requisitioned by the War Office for the purpose of defence, training, munitions production and the construction of airfields. Records relating to military features vary and some may remain censored. Within urban environments datasets will be consulted detailing the location of munition production as well as wartime air and land defences. In rural locations it may be possible to obtain plans of military establishments, such as airfields, as well as training logs, record books, plans and personal memoirs. As with bombing records, every reasonable effort will be made to access records of, and ascertain any evidence of, military land use. However, there are occasions where such evidence is not available, as records may not be accessible, have been lost/destroyed, or simply were not kept in the first place.

¹ <http://www.nationalarchives.gov.uk/help-with-your-research/research-guides/bomb-census-survey-records-1940-1945/>.

4. UK Regulatory Environment and Guidelines

4.1. General

There is no formal obligation requiring a UXO risk assessment to be undertaken for construction projects in the UK, nor is there any specific legislation stipulating the management or mitigation of UXO risk. However, it is implicit in the legislation outlined below that those responsible for intrusive works (archaeology, site investigation, drilling, piling, excavation etc.) should undertake a comprehensive and robust assessment of the potential risks to employees and that mitigation measures are implemented to address any identified hazards.

4.2. CDM Regulations 2015

The Construction (Design and Management) Regulations 2015 (CDM 2015) define the responsibilities of parties involved in the construction of temporary or permanent structures.

The CDM 2015 establishes a duty of care extending from clients, principle co-ordinators, designers, and contractors to those working on, or affected by, a project. Those responsible for construction projects may therefore be accountable for the personal or proprietary loss of third parties, if correct health and safety procedure has not been applied.

Although the CDM does not specifically reference UXO, the risk presented by such items is both within the scope and purpose of the legislation. It is therefore implied that there is an obligation on parties to:

- Provide an appropriate assessment of potential UXO risks at the site (or ensure such an assessment is completed by others).
- Put in place appropriate risk mitigation measures if necessary.
- Supply all parties with information relevant to the risks presented by the project.
- Ensure the preparation of a suitably robust emergency response plan.

4.3. The 1974 Health and Safety at Work etc. Act

All employers have a responsibility under the Health and Safety at Work etc. Act 1974 and the Management of Health and Safety at Work Regulations 1999, to ensure the health and safety of their employees and third parties, so far as is reasonably practicable and conduct suitable and sufficient risk assessments.

4.4. CIRIA C681

In 2009, the Construction Industry Research and Information Association (CIRIA) produced a guide to UXO for the UK construction industry (CIRIA C681). CIRIA is a neutral, independent and not-for-profit body, linking organisations with common interests and facilitating a range of collaborative activities that help improve the industry.

The publication provides the UK construction industry with a defined process for the management of risks associated with UXO from WWI and WWII aerial bombardment. It is also broadly applicable to the risks from other forms of UXO that might be encountered. It focuses on construction professionals' needs, particularly if there is a suspected item of UXO on site and covers issues such as what to expect from a UXO specialist. The guidance also helps clients to fulfil their legal duty under CDM 2015 to provide designers and contractors with project specific health and safety information needed to identify hazards and risks associated with the design and construction work. This report conforms to this CIRIA guidance and to the various recommendations for good practice referenced therein. It is recommended that this document is acquired and studied where possible to allow a better understanding of the background to both the risk assessment process and the UXO issue in the UK in general.

4.5. Additional Legislation

In the event of a casualty resulting from the failure of an employer/client to address the risks relating to UXO, the organisation may be criminally liable under the Corporate Manslaughter and Corporate Homicide Act 2007.

5. The Role of Commercial UXO Contractors and The Authorities

5.1. Commercial UXO Specialists

The role of a UXO Specialist (often referred to as UXO Consultant or UXO Contractor) such as 1st Line Defence is defined in CIRIA C681 as the provision of expert knowledge and guidance to the client on the most appropriate and cost-effective approach to UXO risk management at a site.

The principal role of UXO Specialists is to provide the client with an appropriate assessment of the risk posed by UXO for a specific project, and identify and carry out suitable methodology for the mitigation of any identified risks to reduce them to an acceptable level.

The requirement for a UXO Specialist should ideally be identified in the initial stages of a project, and it is recommended that this occur prior to the start of any detailed design. This will enable the client to budget for expenditure that may be required to address the risks from UXO, and may enable the project team to identify appropriate techniques to eliminate or reduce potential risks through considered design, without the need for UXO specific mitigation measures. The UXO Specialist should have suitable qualifications, levels of competency and insurances.

Please note 1st Line Defence has the capability to provide a complete range of required UXO risk mitigation services, in order to reduce a risk to as low as reasonably practicable. This can involve the provision of both ground investigation, and where appropriate, UXO clearance services.

5.2. The Authorities

The police have a responsibility to co-ordinate the emergency services in the event of an ordnance-related incident at a construction site. Upon inspection they may impose a safety cordon, order an evacuation, and call the military authorities Joint Services Explosive Ordnance Disposal Operation Centre (JSEODOC) to arrange for investigation and/or disposal. Within the Metropolitan Police Operational Area, SO15 EOD will be tasked to any discovery of suspected UXO. The request for Explosive Officer (Expo) support is well understood and practiced by all Metropolitan Boroughs. The requirement for any additional assets will then be coordinated by the Expo if required.

In the absence of a UXO specialist, police officers will usually employ such precautionary safety measures, thereby causing works to cease, and possibly requiring the evacuation of neighbouring businesses and properties.

The priority given to the police request will depend on the EOD teams judgement of the nature of the UXO risk, the location, people and assets at risk, as well as the availability of resources. The speed of response varies; authorities may respond immediately or in some cases it may take several days for the item of ordnance to be dealt with. Depending on the on-site risk assessment the item of ordnance may be removed from the site and/or destroyed by a controlled explosion.

Following the removal of an item of UXO, the military authorities will only undertake further investigations or clearances in high-risk situations. If there are regular UXO finds on a site the JSEODOC may not treat each occurrence as an emergency and will recommend the construction company puts in place alternative procedures, such as the appointment of a commercial contractor to manage the situation.

6. The Site

6.1. Site Location

The site is located within Longsight, Greater Manchester.

The north of the site is bound by Hathersage Road, while the east, south and west of the site is bound by a variety of large multi-storey structures comprising residential and commercial spaces.

The site is approximately centred on the OS grid reference: **SJ 8516495817**.

Site location maps are presented in **Annex A**.

6.2. Site Description

The west of the site is currently comprised of a small temporary-style structure, understood to be a Diabetes Centre, while the remainder of the site is occupied by hardstanding car parking areas.

A recent aerial photograph and site plan are presented in **Annex B** and **Annex C** respectively.

7. Scope of the Proposed Works

7.1. General

Planned ground investigation works are understood to comprise of ten trial pits and six boreholes. Intrusive construction works are understood to involve relatively shallow excavation of the near surface Made Ground deposits for utilities and substructure, to around 2-3m maximum depth, as well as bored Contiguous Flight Auger (CFA) piles foundations drilled into the rockhead to around 15-25m depth. Intrusive works are understood to be for the construction of a seven storey steel frame office structure.

8. Ground Conditions

8.1. General Geology

The British Geological Survey (BGS) map shows the site to be underlain by the Chester Formation – Sandstone of the Triassic Period. Superficial deposits are described as Till, Devensian – Diamiction of the Quaternary Period.

8.2. Geology

Borehole data of the surrounding area has been provided by ARUP Group. See below for a brief description of the geology encountered.

Geological Unit	
Approximate Depth (m)	Description
GL to 3.0	MADE GROUND. Loose, brown, slightly clayey, gravelly, fine to coarse SAND with occasional pockets of firm, brown, sandy clay. Gravel is angular to subrounded, fine to coarse including sandstone, brick, cinder and ash.
3.0 to 12.0	GLACIAL TILL. Stiff, brown/grey, slightly sandy, slightly gravelly CLAY.
12.0 to 20+	SHERWOOD SAANDSTONE. Very weak to weak, red-brown, fine to coarse SANDSTONE. Contains medium spaced very thin beds of extremely weak sandstone.
UNPROVEN	MANCHESTER MARL. Moderately weathered SILTSTONE.

Site-specific geotechnical data was not available during the production of this report.

9. Site History

9.1. Introduction

The purpose of this section is to identify the composition of the site pre and post-WWII. It is important to establish the historical use of the site, as this may indicate the site's relation to potential sources of UXO as well as help with determining factors such as the land use, groundcover, likely frequency of access and signs of bomb damage.

9.2. Ordnance Survey Historical Maps

Relevant historical maps were obtained for this report and are presented in **Annex D**. See below for a summary of the site history shown on acquired mapping.

WWI Period		
Date	Scale	Description
1908	1:2,500	This map sheet indicates that the site had comprised of ten residential houses and their adjoining gardens in 1908. The north of the site is bound by 'High Street', now known as Hathersage Road, and the east by an access way situated between the most eastern property within the site and its neighbouring structure. Centrally adjacent to the southern boundary is another property of unknown use. To the south-east of the site is lands associated with 'The Lodge' and to the south-west is land associated with 'Rusholme Hall'. The west is bound by more residential housing.

Pre-WWII		
Date	Scale	Description
1933	1:2,500	There are no significant structural changes mapped within this source.

Post-WWII		
Date	Scale	Description
1949-1951	1:1,250	This map sheet no longer records the six easternmost properties formerly located within the site. Additional properties east of the site also appear to have been cleared. This map indicates that the properties formerly located within the site had been numbered from 173 to 191, ascending in order from east to west. South of the site the property at this location has changed, and another smaller structure has been built in very close proximity to the south-west of the site. The 'Boro Const & Ward Bdy' is also recorded adjacent to the south of the site. The Lodge has been extended, and is now recorded as 'St Gabriel's Hall'. Rusholme Hall has also been replaced by a number of adjoining structures recorded as 'Britannia Quilt Works', 'Motor Repair Works' and a 'Condor Works'.

9.3. Historical Photographs of the Site

Historical photographs have been consulted from the Aerofilms collection available from Britain From Above. These photographs provide a view of the site in 1939 (see **Annex E**). See below for a description of each photograph.

Date of Photograph	Comments
1939	In this 1939 image depicting the St Marys Hospital and Manchester Royal Infirmary, the site is visible from its south-west. Residential properties can be seen occupying the north of the site, and their gardens within the site. A similar composition of housing is adjacent to the east and west of the site and more residential housing can be seen south of the site. South-west of the site Rusholme Hall has already been demolished and replaced by large warehouse-style facilities.

10. Introduction to German Aerial Delivered Ordnance

10.1. General

During WWI and WWII, the UK was subjected to bombing which often resulted in extensive damage to city centres, docks, rail infrastructure and industrial areas. The poor accuracy of WWII targeting technology and the nature of bombing techniques often resulted in neighbouring areas to targets sustaining collateral damage.

In addition to raids which concentrated on specific targets, indiscriminate bombing of large areas also took place, this occurred most prominently in the London 'Blitz', though affected many other towns and cities. As discussed in the following sections, a proportion of the bombs dropped on the UK did not detonate as designed. Although extensive efforts were made to locate and deal with these UXBs at the time, many still remain buried and can present a potential risk to construction projects.

The main focus of research for this section of the report will concern German aerial delivered ordnance dropped during WWII, although WWI bombing will also be considered.

10.2. Generic Types of WWII German Aerial Delivered Ordnance

To provide an informed assessment of the hazards posed by any items of unexploded ordnance that may remain in situ on site, the table below provides information on the types of German aerial delivered ordnance most commonly used by the Luftwaffe during WWII. Images and brief summaries of the characteristics of these items of ordnance are listed in **Annex F**.

Generic Types of WWII German Aerial Delivered Ordnance		
Type	Frequency	Likelihood of detection
High Explosive (HE) bombs	In terms of weight of ordnance dropped, HE bombs were the most frequently deployed by the Luftwaffe during WWII.	Although efforts were made to identify the presence of unexploded ordnance following an air raid, often the damage and destruction caused by detonated bombs made observation of UXB entry holes impossible. The entry hole of an unexploded bomb can be as little as 20cm in diameter and was easily overlooked in certain ground conditions (see Annex G). Furthermore, ARP documents describe the danger of assuming that damage, actually caused by a large UXB, was due to an exploded smaller bomb. UXBs therefore present the greatest risk to present-day intrusive works.
1kg Incendiary bombs (IB)	In terms of the number of weapons dropped, small IBs were the most numerous. Millions of these were dropped throughout WWII.	IBs had very limited penetration capability and in urban areas would often have been located in post-raid surveys. If they failed to initiate and fell in water, on soft vegetated ground, or bombed rubble, they could easily go unnoticed.
Large Incendiary bombs (IB)	These were not as common as the 1kg IBs, although they were more frequently deployed than PMs and AP bomblets.	If large IBs did penetrate the ground, complete combustion did not always occur and in such cases they could remain a risk to intrusive works.
Aerial or Parachute mines (PM)	These were deployed less frequently than HE and IBs due to size, cost and the difficulty of deployment.	If functioning correctly, PMs generally would have had a slow rate of descent and were very unlikely to have penetrated the ground. Where the parachute failed, mines would have simply shattered on impact if the main charge failed to explode. There have been extreme cases when these items have been found unexploded. However, in these scenarios, the ground was either extremely soft or the munition fell into water.
Anti-personnel (AP) bomblets	These were not commonly used and are generally considered to pose a low risk to most works in the UK.	SD2 bomblets were packed into containers holding between 6 and 108 submunitions. They had little ground penetration ability and should have been located by the post-raid survey unless they fell into water, dense vegetation or bomb rubble.

10.3. Failure Rate of German Aerial Delivered Ordnance

It has been estimated that 10% of WWII German aerial delivered HE bombs failed to explode as designed. Reasons for why such weapons might have failed to function as designed include:

- Malfunction of the fuze or gain mechanism (manufacturing fault, sabotage by forced labour or faulty installation).
- Many were fitted with a clockwork mechanism that could become immobilised on impact.
- Failure of the bomber aircraft to arm the bombs due to human error or an equipment defect.
- Jettisoning the bomb before it was armed or from a very low altitude. This most likely occurred if the bomber aircraft was under attack or crashing.

From 1940 to 1945 bomb disposal teams reportedly dealt with a total of 50,000 explosive items of 50kg and over, 7,000 anti-aircraft projectiles and 300,000 beach mines. Unexploded ordnance is still regularly encountered across the UK, see press articles in **Annex H**.

10.4. UXB Ground Penetration

An important consideration when assessing the risk from a UXB is the likely maximum depth of burial. There are several factors which determine the depth that an unexploded bomb will penetrate:

- Mass and shape of bomb.
- Height of release.
- Velocity and angle of bomb.
- Nature of the ground cover.
- Underlying geology.

Geology is perhaps the most important variable. If the ground is soft, there is a greater potential of deeper penetration. For example, peat and alluvium are easier to penetrate than gravel and sand, whereas layers of hard strata will significantly retard and may stop the trajectory of a UXB.

10.4.1. The J-Curve Effect

J-curve is the term used to describe the characteristic curve commonly followed by an aerial delivered bomb dropped from height after it penetrates the ground. Typically, as the bomb is slowed by its passage through underlying soils, its trajectory curves towards the surface. Many UXBs are found with their nose cone pointing upwards as a result of this effect. More importantly however is the resulting horizontal offset from the point of entry. This is typically a distance of about one third of the bomb's penetration depth, but can be higher in certain conditions (see **Annex G**).

10.4.2. WWII UXB Ground Penetration Studies

During WWII the Ministry of Home Security undertook a major study on actual bomb penetration depths, carrying out statistical analysis on the measured depths of 1,328 bombs as reported by bomb disposal (BD) teams. Conclusions were made as to the likely average and maximum depths of penetration of different sized bombs in different geological strata.

For example, the largest common German bomb (500kg) had a likely concluded penetration depth of 6m in sand or gravel but 11m in clay. The maximum observed depth for a 500kg bomb was 11.4m and for a 1,000kg bomb 12.8m. Theoretical calculations suggested that significantly greater penetration depths were probable.

10.4.3. Site Specific Bomb Penetration Considerations

When considering an assessment of the bomb penetration at the site of proposed works the following parameters have been used:

- WWII geology – Chester Formation.
- Impact angle and velocity – 10-15° from vertical and 270 metres per second.
- Bomb mass and configuration – The 500kg SC HE bomb, without retarder units or armour piercing nose (this was the largest of the common bombs used against Britain).

It has not been possible to determine maximum bomb penetration capabilities at this stage due to the lack or limitations of site specific geotechnical information. An assessment can be made once such information becomes available or by an UXO Specialist on-site.

10.5. V-Weapons

Hitler's 'V-weapon' campaign began from mid-1944. It used newly developed unmanned cruise missiles and rockets. The V-1 known as the *flying bomb* or *pilotless aircraft* and the V-2, a long range rocket, were launched from bases in Germany and occupied Europe. A total of 9,251 V-1s and 1,115 V-2s were recorded in the United Kingdom.

Although these weapons caused considerable damage, their range was limited by their position of deployment across Europe and as a result the vast majority of V-weapon strikes were directed against targets in the south-east of England, predominantly in the London Boroughs and Home Counties. This limitation of capability meant targets in Manchester and north-western England were generally too far to be considered for V-weapon strikes by the Luftwaffe.

However, V-1 pilotless aircraft were released off the Yorkshire coast from beneath Heinkel He11 bombers on Christmas Eve, 1944. 1 V-1 pilotless aircraft fell within the Civil Defence area for Manchester in Didsbury.

The risk from V-weapons is therefore considered negligible and will not be further addressed in this report.

11. The Likelihood of Contamination from German Aerial Delivered UXBs

11.1. World War I

During WWI Britain was targeted and bombed by Zeppelin Airships as well as Gotha and Giant fixed-wing aircraft. A WWI map of air raids and naval bombardments across England is presented in **Annex I**. This source does not record any WWI bombing incidents to have affected the site.

WWI bombs were generally smaller and dropped from a lower altitude than those used in WWII. This resulted in limited UXB penetration depths. Aerial bombing was often such a novelty at the time that it attracted public interest and even spectators to watch the raids in progress. For these reasons there is a limited risk that UXBs passed undiscovered in the urban environment. When combined with the relative infrequency of attacks and an overall low bombing density the risk from WWI UXBs is considered low and will not be further addressed in this report.

11.2. World War II Bombing of Manchester

The Luftwaffe's main objective for the attacks on Britain was to inhibit the country's economic and military capability. To achieve this they targeted airfields, depots, docks, warehouses, wharves, railway lines, factories, and power stations. As the war progressed the Luftwaffe bombing campaign expanded to include the indiscriminate bombing of civilian areas in an attempt to subvert public morale.

During WWII, the site was located within the County Borough of Manchester, which sustained an overall low density of bombing, as shown in the following section. Manchester was not targeted with the same intensity and frequency as some other major cities in Britain, such as Liverpool, Birmingham, Coventry or London, however, it was still subject to several major raids. This was largely due to the significant number of important targets, such as the docks, located approximately 4km west of the site, Manchester Central Station, and Gaythorn Gas Works. The Manchester Blitz was commonly called the 'Christmas Blitz'. Raids began in August and September 1940. The heaviest raids occurred on the nights of the 22nd/23rd and 23rd/24th December 1940, killing an estimated 684 people and injuring 2,364.

Records of bombing incidents in the civilian areas of Manchester were typically collected by Air Raid Precautions wardens and collated by Civil Defence personnel. Some other organisations, such as port and railway authorities, maintained separate records. Records would be in the form of typed or hand written incident notes, maps and statistics. Bombing data was carefully analysed, not only due to the requirement to identify those parts of the country most needing assistance, but also in an attempt to find patterns in the Germans' bombing strategy in order to predict where future raids might take place.

Records of bombing incidents for Manchester are presented in the following sections.

11.3. WWII Home Office Bombing Statistics

The following table summarises the quantity of German aerial delivered bombs (excluding 1kg incendiaries and anti-personnel bombs) dropped on the County Borough of Manchester between 1940 and 1945.

Record of German Ordnance Dropped on the County Borough of Manchester		
Area Acreage		2,7255
Weapons	High Explosive bombs (all types)	712
	Parachute mines	18
	Oil bombs	7
	Phosphorus bombs	0
	Fire pots	0
	Pilotless aircraft (V-1)	1
	Long range rocket bombs (V-2)	0
Total		738
Number of Items per 1,000 acres		27.1

Source: Home Office Statistics

This table does not include UXO found during or after WWII.

Detailed records of the quantity and locations of the 1kg incendiary and anti-personnel bombs were not routinely maintained by the authorities as they were frequently too numerous to record. Although the risk relating to IBs is lesser than that relating to larger HE bombs, they were similarly designed to inflict damage and injury. Anti-personnel bombs were used in much smaller quantities and are rarely found today but are potentially more dangerous. Although Home Office statistics were not recorded, both types of item should not be overlooked when assessing the general risk to personnel and equipment.

11.4. Blitz Britain: Manchester and Salford by Graham Pythian.

The published source *Blitz Britain: Manchester and Salford* by Graham Pythian presents a transcript of the document 'Manchester Emergency Committee's Log Book of Bombing Incidents 22-24 December 1940' (hence covering the 'Manchester Blitz' period). This is stated to have been obtained from the Emergency Committee Records/Police Museum and Archives, though it was not possible to obtain original documents. No references to bombing incidents within the site or its vicinity could be located. However, the below mentioned passage was found within this source to referencing bombing within the vicinity of the site on Livingstone Street, approximately 150m north-east of the proposed boundary.

'Just south of the MRI an aerial mine destroyed most of Livingstone Street, which use to branch off High Street (now Hathersage Road near Victoria Baths).'

11.5. Record of the Locations of Aerial bombs on the City of Manchester

A local bomb map compiled by Manchester City Council showing HE bomb and incendiary bomb strikes, as well as recorded the damaged and demolished structures, within the borough was obtained from the Manchester University Library. The section showing the area of the site is described in the table below and presented in **Annex J**.

Record of the Locations of Aerial bombs on the City of Manchester– Annex J	
Date Range	Comments
1940-1945	This map records a ‘fire bomb’ within the east of the proposed site, located across six adjoining residential properties which have also been documented as ‘demolished buildings’. The ‘fire bomb’ is recorded to have fallen between the 22nd and 23rd of December 1940. South of the site another fire bomb is recorded to have fallen on ‘St Gabriel’s Hall’, approximately 20m south of the site. This incident is recorded between the 1st and 2nd of January 1941, and the building does not appear to have been damaged. A number of other incidents are also recorded behind properties north of High Street.

11.6. Manchester Damage Cards

Bomb incident records were obtained from Manchester Central Library. This record was compiled by local Air Raid Precaution (ARP) personnel and volunteers during the war. A transcript of the associated written records for damaged properties which fell in and around the site area is presented in the table below. An example of these entries are presented in **Annex K**.

Manchester Bomb Damage Cards – Annex K		
Property numbers	Classification	Notes
Date Inspected: 10 th April 1942		
167	B, D (Demolished)	
169	B	
173 Springfield Hotel	A, D (Demolished)	
		No 173 was Springfield Hotel
		No 171 was a private house occupied by Fraser (Whisky Merchant) This has been demolished and site cleared.

11.7. Air Raid Damage Files

Air Raid Damage files for Manchester were obtained from The National Archives. These reports recorded information such as the date, time, type and damage caused by major bomb incidents in Manchester and are therefore not often comprehensive. No relevant information regarding the site area could be located.

11.8. WWII-Era Aerial Photography

A high-resolution scan of WWII-era aerial photography for the site area was obtained from the National Monuments Record Office (Historic England). This photograph provides a record of the potential composition of the site during the war, as well as its condition immediately following the war (see Annex L).

WWII-Era Aerial Photography – Annex L	
Date	Description
7 th May 1946	This image depicts a large area of clearance within the eastern area of the site, and this extends beyond the site boundary. Four adjoining residential properties are located within the remaining western area of the site, which do not appear to be significantly damaged. A rectangular object resembling a water tank can also be seen within the clearance area in the site. This is likely to have been placed on site by local ARP volunteers to be used in the event of a fire resulting from a bombing raid. To the north of the site High Street can be seen, to the east an area of clearance, and residential housing to the west. South of the site fencing can be seen, adjacent to which several structures appear to have sustained damage. Additionally, approximately 100m north-east of the site a significant area of clearance can be seen either side of Livingstone Street.

11.9. Abandoned Bombs

A post air-raid survey of buildings, facilities, and installations would have included a search for evidence of bomb entry holes. If evidence of an entry hole was encountered, Bomb Disposal Officer Teams would normally have been requested to attempt to locate, render safe, and dispose of the bomb. Occasionally, evidence of UXBs was discovered but due to a relatively benign position, access problems, or a shortage of resources the UXB could not be exposed and rendered safe. Such an incident may have been recorded and noted as an ‘abandoned bomb’.

Given the inaccuracy of WWII records and the fact that these bombs were ‘abandoned’, their locations cannot be considered definitive or the lists exhaustive. The MoD states that ‘action to make the devices safe would be taken only if it was thought they were unstable’. It should be noted that other than the ‘officially’ abandoned bombs, there will inevitably be UXBs that were never recorded.

1st Line Defence holds no records of officially registered abandoned bombs at or near the site of the proposed works.

11.10. Bomb Disposal Tasks

The information service from the Explosive Ordnance Disposal (EOD) Archive Information Office at 33 Engineer Regiment (EOD) (now 29 Regt) is currently facing considerable delay. It has therefore not been possible to include any updated official information regarding bomb disposal/clearance tasks with regards to this site. A database of known disposal/clearance tasks has been referred to which does not make reference to such instances occurring within the site of proposed works. If any relevant information is received at a later date ARUP Group will be advised.



11.11. Evaluation of German Aerial Delivered UXO Records

Factors	Conclusion
Density of Bombing <i>It is important to consider the bombing density when assessing the possibility that UXBs remain in an area. High bombing density could allow for error in record keeping due to extreme damage caused to the area.</i>	During WWII, the site was located within the County Borough of Manchester. According to Home Office statistics Manchester sustained an overall low density of bombing, with an average of 27.1 items of ordnance recorded per 1,000 acres. A record of the locations of aerial bombs on the City of Manchester was obtained from the University of Manchester Library. This bomb plot map documents one 'fire bomb' to have fallen within the boundary of the site, located within the east of the site across six terraced residential houses. This incident is dated to the 22nd/23rd of December 1940. The exact type of 'fire bomb' has not been documented within this source. A number of other bombs are also recorded within proximity to the site, including another 'fire bomb' located approximately 20m south of the site on St Gabriel's Hall. This incident is dated 1st/2nd of June 1941.
Damage <i>If buildings or structures on a site sustained bomb or fire damage any resulting rubble and debris could have obscured the entry holes of unexploded bombs dropped during the same or later raids. Similarly, a high explosive bomb strike in an area of open agricultural land will have caused soil disturbance, increasing the risk that a UXB entry hole would be overlooked.</i>	The record of the locations of aerial bombs in Manchester documents the six most eastern properties within the site to have been demolished due to the 'fire bomb' incident. This source does not record the St Gabriel's Hall structure to have sustained any resulting damage from the 'fire bomb' incident in June of 1941. Cards relating to damage within Manchester also record number of properties on High Street to have been demolished, including property numbers 167, 169, 173 and 171. Historical OS mapping indicates that property number 173 was previously situated on site, and number 171 was adjacent to the eastern boundary. This is supported by WWII-era photography, in which a large area of clearance is visible within the eastern area of the site, which also extends beyond the eastern site boundary. Properties adjacent to the south of the site boundary can also be seen to have sustained bomb damage. North-east of the site large areas of clearance can be seen around Livingstone Street. Although this may partially be attributed to slum clearance, <i>Blitz Britain</i>, by Graham Pythian indicates that 'most' of Livingstone Street was destroyed by a mine. This is not anticipated to elevate the risk of UXO on site.
Access Frequency <i>UXO in locations where access was irregular would have a greater chance of passing unnoticed than at those that were regularly occupied. The importance of a site to the war effort is also an important consideration as such sites are likely to have been both frequently visited and subject to post-raid checks for evidence of UXO.</i>	Historical OS mapping indicates that the structures within the north of the site had been for residential use. The Manchester damage cards also indicate that property number 173 High Street, understood to have been the most eastern structure on site, was used as a hotel. The access to these structures is anticipated to have been frequent at the outbreak of war. However, following the bombing incident between the 22nd and 23rd of December 1940, during one of the heaviest raids of the Manchester Blitz, the access to significantly damaged structures would have ceased. Likewise, the access to surrounding properties, including the residential housing within the remainder of the site which survived the war structurally intact, would also have ceased temporarily owing to evacuation protocol. Although a water tank was later placed within the east of the site, visible with 1946 photography, this is anticipated to have been accessed infrequently.

	Infrequent access may increase the likelihood that signs of UXO, such as entry holes or craters, may go unnoticed.
Ground Cover <i>The nature of the ground cover present during WWII would have a substantial influence on any visual indication that may indicate UXO being present.</i>	Following the bombing incident on the 22nd/23rd of December 1940, a large area of the site and its neighbouring area to the east was occupied by rubble, damage and clearance. Evidence of UXO may easily be overlooked within these conditions. However, WWII-era photography indicates that four adjoining properties within the west of the site survived the war structurally intact. At the locations which were occupied by these structures, the ground conditions are considered to have been favourable to the detection of UXO.
Bomb Failure Rate	There is no evidence to suggest that the bomb failure rate in the locality of the site would have been dissimilar to the 10% normally used.
Abandoned Bombs	1 st Line Defence holds no records of abandoned bombs at or within the site vicinity.
Bombing Decoy sites	1 st Line Defence could find no evidence of bombing decoy sites within the site vicinity.
Bomb Disposal Tasks	1 st Line Defence could find no evidence of bomb disposal tasks within the site boundary and immediate area.

12. Introduction to Allied Explosive Ordnance

12.1. General

Many areas across the UK may be at risk from Allied UXO because of both wartime and peacetime military use. Typical military activities and uses that may have led to a legacy of military UXO at a site include former minefields, home guard positions, anti-aircraft emplacements, training and firing ranges, military camps, as well as weapons manufacture and storage areas.

Although land formerly used by the military were usually subject to clearance before they returned to civilian use, items of UXO are sometimes discovered and can present a potential risk to construction projects.

It should be highlighted that there is no evidence that the site formerly had any military occupation or usage that could have led to contamination with such items of Allied ordnance. Despite this, urban areas such as the location of the site, can however be at risk from buried unexploded anti-aircraft projectiles fired during WWII – as addressed below.

12.2. Defending the UK From Aerial Attack

During WWII the War Office employed a number of defence tactics against the Luftwaffe from bombing major towns, cities, manufacturing areas, ports and airfields. These can be divided into passive and active defences (examples are provided in the table below).

Active Defences	Passive Defences
• Anti-aircraft gun emplacements to engage enemy aircraft. • Fighter aircraft to act as interceptors. • Rockets and missiles were used later during WWII.	• Blackouts and camouflaging to hinder the identification of Luftwaffe targets. • Decoy sites were located away from targets and used dummy buildings and lighting to replicate urban, military, or industrial areas. • Barrage balloons forced enemy aircraft to greater altitudes. • Searchlights were often used to track and divert adversary bomber crews during night raids.

Active defences such as anti-aircraft artillery present a greater risk of UXO contamination than passive defences. Unexploded ordnance resulting from dogfights and fighter interceptors is rarely encountered and difficult to accurately qualify.

12.2.1. Anti-Aircraft Artillery (AAA)

During WWII three main types of gun sites existed: heavy anti-aircraft (HAA), light anti-aircraft (LAA) and 'Z' batteries (ZAA). If the projectiles and rockets fired from these guns failed to explode or strike an aircraft they would descend back to land. The table below provides further information on the operation and ordnance associated with these type of weapons.

Anti-Aircraft Artillery				
Item	Description			
HAA	These large calibre guns such as the 3.7" QF (Quick Firing) were used to engage high flying enemy bombers. They often fired large HE projectiles, which were usually initiated by integral fuzes triggered by impact, area, time delay or a combination of aforementioned mechanisms.			
LAA	These mobile guns were intended to engage fast, low flying aircraft. They were typically rotated between locations on the perimeters of towns and strategically important industrial works. As they could be moved to new positions with relative ease when required, records of their locations are limited. The most numerous of these were the 40mm Bofors gun which could fire up to 120 x 40mm HE projectiles per minute to over 1,800m.			
Variations in HAA and LSA Ammunition	Gun type	Calibre	Shell Weight	Shell Dimensions
	3.0 Inch	76mm	7.3kg	76mm x 356mm
	3.7 Inch	94mm	12.7kg	94mm x 438mm
	4.5 Inch	114mm	24.7kg	114mm x 578mm
	40mm	40mm	0.9kg	40mm x 311mm
Z-AA	The three inch unrotated rocket/projectile known as the UP-3 had initially been developed for the Royal Navy. The UP-3 was also used in ground-based single and 128-round launchers known as "Z" batteries. The rocket, containing a high explosive warhead was often propelled by cordite.			

The closest recorded HAA to the site was located approximately 1.1km south-east of the site, however the range of a projectile can be up to 15km. The site would also have been in range of mobile light anti-aircraft guns.

The conditions in which anti-aircraft projectiles may have fallen unnoticed within a site area are analogous to those regarding aerial delivered ordnance. Unexploded anti-aircraft projectiles could essentially have fallen indiscriminately anywhere within range of the guns. The chance of such items being observed, reported and removed during the war depends on factors such as land use, ground cover, damage and frequency of access – the same factors that govern whether evidence of a UXB is likely to have been noted. More information about these factors with regards to this particular site can be found in the German Aerial Delivered Ordnance section of this report.

Illustrations of Anti-Aircraft artillery, projectiles and rockets are presented at **Annex M**.

13. The Likelihood of Contamination from Allied Ordnance

13.1. Introduction

When undertaking construction work within or immediately adjacent to a site with previous and/or current military use, it is often considered likely to contain an elevated risk of contamination from Allied UXO. This assumption of risk is based on the following reasoning:

- The clearance of ordnance from military camps, depots, storage facilities, ranges and training areas were not always effectively managed, or undertaken to equivalent degrees of certainty. In addition, search and detection equipment used over seventy years ago following WWII has proved ineffective both for certain types of UXO and at depths beyond capability.
- In the vast majority of cases, explosive ordnance would have been stored and available for use at military installations. Ordnance ranged from small arms and land service ammunition to weapons components and larger, aerial delivered items. During periods of heightened activity, ordnance was also frequently lost in transit, particularly between stores and assigned training locations.
- The military generally did not anticipate that their land would be later sold for civilian development, and consequently appropriate ordnance disposal procedure was not always adhered to. It was not uncommon for excess or unwanted ordnance to be buried or burnt within the perimeters of a military establishment as a means of disposal. Records of such practice were rarely kept.

There are several factors that may serve to either affirm, increase, or decrease the level of risk within a site with a history of military usage. Such factors are typically dependent upon the proximity of the proposed area of works to training activities, munition productions and storage, as well as its function across the years.

This section will examine the history of the proposed site and assess to what degree, if any, the site could have become contaminated as a result of the military use of the surrounding area.

13.2. Evaluation of Contamination Risk from Allied UXO

1st Line Defence has considered the following potential sources of Allied ordnance contamination:

Sources of Allied UXO Contamination	Conclusion
Military Camps <i>Military camps present an elevated risk from ordnance simply due to the large military presence and likelihood of associated live ordnance training.</i>	1 st Line Defence could find no evidence of a military camp within the site.
Anti-Aircraft Defences <i>Anti-Aircraft defences were employed across the country. Proximity to anti-aircraft defences increases the chance of encountering AA projectiles.</i>	1 st Line Defence could find no evidence of Anti-Aircraft defences such as a HAA or LAA gun emplacement occupying or bordering the site. The closest HAA was located approximately 1.1km north-east of the site, however the range of a projectile can be up to 15km. The conditions in which HAA or LAA projectiles may have fallen unnoticed within a site footprint are analogous to those regarding German aerial delivered ordnance.
Home Guard Activity <i>The Home Guard regularly undertook training and ordnance practice in open areas, as well as burying ordnance as part of anti-invasion defences.</i>	1 st Line Defence has no evidence of any Home Guard activities on the site.
Defensive Positions <i>Defensive positions suggest the presence of military activity, which is often indicative of ordnance storage, usage or disposal.</i>	There is no evidence of any defensive features formerly located on or bordering the site footprint.
Training or firing ranges <i>Areas of ordnance training saw historical ordnance usage in large numbers, often with inadequate disposal of expended and live items. The presence of these ranges significantly impact on the risk of encountering items of ordnance in their vicinity.</i>	There is no evidence of such features affecting the site.
Defensive Minefields <i>Minefields were placed in strategic areas to defend the country in the event of a German invasion. Minefields were not always cleared with an appropriate level of vigilance.</i>	There is no evidence of defensive minefields affecting the site.
Ordnance Manufacture <i>Ordnance manufacture indicates an increased chance that items of ordnance were stored, or disposed of, within a location.</i>	No information of ordnance being stored, produced, or disposed of within the proposed site could be found.

Military Related Airfields <i>Military airfields present an elevated risk from ordnance simply due to the large military presence and likelihood of associated live ordnance training or bombing practice.</i>	The site was not situated within the perimeters or vicinity of a military airfield.
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14. The Likelihood of UXO Contamination Summary

The following table assesses the likelihood that the site was contaminated by items of German aerial delivered and Allied ordnance. Factors such as the risk of UXO initiation, remaining, and encountering will be discussed later in the report.

UXO Contamination Summary	
Quality of the Historical Record	The research has evaluated pre- and post-WWII Ordnance Survey maps, historical oblique imagery, <i>Blitz Britain: Manchester and Salford</i> by Graham Pythian, a Record of the Locations of Aerial Bombs in Manchester, Manchester damage cards, air raid damage files and WWII-era aerial photography. The record set is of generally good quality, however, some limitations were encountered. Primarily, the Record of the Locations of Aerial Bombs in Manchester source does not document which type of 'fire bomb' fell within the site boundary. Despite this, the resulting damage from this incident is clearly depicted within WWII-era aerial photography. This aids in determining the exact war-time conditions on site following this incident.
German Aerial Delivered Ordnance	- During WWII, the site was situated within the County Borough of Manchester. According to Home Office statistics Manchester endured an overall low density of bombing, with an average of 27.1 items recorded per 1,000 acres. In relation to other major cities in Britain, Manchester did not receive the same density of bombing as London, Liverpool, Birmingham, or Coventry. However, Manchester was subject to a number of major bombing raids, including what is known as the Manchester Blitz or 'Christmas Blitz' period. The heaviest raids in this period occurred between the 22nd and 23rd and 23rd and 24th of December 1940. - A 'Record of the Locations of Aerial Bombs on the City of Manchester' bomb plot map was compiled by the Manchester City Council and obtained from the Manchester University Library. This source records one 'fire bomb', although the exact type of which is unknown, within the east of the site on the centre of a block of six terraced residential properties. The incident is dated to the 22nd – 23rd of December 1940, during one of the heaviest recorded raids in the Manchester Blitz period, and the six properties are recorded to have been demolished as a consequence. This source also documents another 'fire bomb' to have fallen approximately 20m south of the site onto St Gabriel's Hall on the 1st/2nd of June 1941. No resulting damage from this incident is documented. - Damage cards for Manchester were also obtained from the Manchester Central Library. This source records a number of properties on High Street to have been demolished owing to significant bomb damage. This includes property number 173, which historical OS mapping indicates was located within the very east of the proposed boundary, and number 171 which was located adjacent to the eastern boundary. - WWII-era aerial imagery corroborates these damage cards, and also indicates that a number of additional houses on High Street were cleared. This 1946 image depicts a large area of clearance with the eastern area of the site, which historical OS mapping indicates was formerly occupied by six terraced properties, and extends beyond the eastern site boundary. A structure adjacent to the south of the proposed site also appears damaged, however, the four residential terraced properties with the west of the site appear to have survived



	the war intact. Notably, the St Gabriel's Hall structure also does not appear to be damaged within this source, and a water tank appears to have been placed with the cleared area within the east of the site. • Following the 'fire bomb' incident within the site in December of 1940, access to the east of the site would have initially ceased, and later been confined to the infrequent access of the water tank, anticipated to have been placed at this location by ARP personnel to be used in the event of a fire, and the ground conditions are considered to have been unfavourable to the detection of UXO. Access to the west of the site is also anticipated to have ceased owing to evacuation protocol, although is likely to have later resumed, and the ground conditions in this far western section are anticipated to have been much more favourable to the detection of UXO given that the properties in this location remained intact. It is conceivable that UXO could have fallen within the small garden areas in this section of the site unnoticed, but this is not considered very likely. • Overall, given the abovementioned factors there is considered to be an elevated risk of contamination within the eastern and central sections of the site. A buffer zone has been added around this area of clearance/damage to allow for the possibility of 'J-curve', whereby an item of ordnance can come to rest at a lateral offset from its point of entry. The far western section of the site, in which the structures on site appear to have survived the war structurally intact, has been assessed a 'low' risk of contamination. As risk map has been prepared – see Annex N.
Allied Ordnance	• No evidence could be found to indicate that the site formerly had any military occupation or usage that could have led to contamination with items of Allied ordnance, such as LSA and SAA. The conditions in which HAA or LAA projectiles may have fallen unnoticed within the site boundary are however analogous to those regarding aerial delivered ordnance.

15. The Likelihood that UXO Remains

15.1. Introduction

It is important to consider the extent to which any explosive ordnance clearance (EOC) activities or extensive ground works have occurred on site. This may indicate previous ordnance contamination or reduce the risk that ordnance remains undiscovered.

15.2. UXO Clearance

1st Line Defence has found no evidence in the public domain or within internal records that any official ordnance clearance operations have taken place on site. Note however that we have not received confirmation of this fact from the 33 EOD Regiment Archive (now part of 29 Regt). It should also be noted that in addition to 29 Regt archival information, 1st Line Defence also do not currently have access to data that may be relevant including 5131(BD)SQN Archive, SD Training Technical Advisory Section (TAS) and MACA Records (bomb disposal callouts).

If such information is available at a later date, it is recommended that it be reviewed as it will assist with understanding both levels and types of contamination likely to be present, and may indicate risk reduction in certain areas.

15.3. Post-war Redevelopment

Redevelopment of the site has included the demolition of all war-era structures on site, as well as the construction of a temporary-style structure and the hardstanding tarmacked areas now used as a car park.

The risk from deep-buried unexploded bombs is only considered mitigated at locations where post war piling or deep foundations have taken place.

16. The Likelihood of UXO Encounter

16.1. Introduction

For UXO to pose a risk at a site, there should be a means by which any potential UXO might be encountered on that site.

The likelihood of encountering UXO on the site of proposed would depend on various factors, such as the type of UXO that might be present and the intrusive works planned on site. In most cases, UXO is more likely to be present below surface (buried) than on surface.

In general, the greater the extent and depth of intrusive works, the greater the risk of encountering. The most likely scenarios under which items of UXO could be encountered during construction works is during piling, drilling operations or bulk excavations for basement levels. The overall risk will depend on the extent of the works, such as the numbers of boreholes/piles (if required) and the volume of the excavations.

16.2. Encountering Aerial Delivered Ordnance

Since an aerial delivered bomb may come to rest at any depth between just below ground level and its maximum penetration depth, there is a chance that such an item (if present) could be encountered during shallow excavations (for services or site investigations) into the original WWII ground level as well as at depth.

17. The Likelihood of UXO Initiation

17.1. Introduction

UXO does not spontaneously explode. Older UXO devices will require an external event/energy to create the conditions for detonation to occur. The likelihood that a device will function can depend on a number of factors including the type of weaponry, its age and the amount of energy it is struck with.

17.2. Initiating Aerial Delivered Ordnance

Unexploded bombs do not spontaneously explode. All high explosive filling requires significant energy to create the conditions for detonation to occur.

In recent decades, there have been a number of incidents in Europe where Allied UXBs have detonated, and incidents where fatalities have resulted (some examples are presented in **Annex F**). There have been several hypotheses as to the reason why the issue is more prevalent in mainland Europe – reasons could include the significantly greater number of bombs dropped by the Allied forces on occupied Europe, the preferred use by the Allies of mechanical rather than electrical fuzes, and perhaps just good fortune. The risk from UXO in the UK is also being treated very seriously in many sectors of the construction industry, and proactive risk mitigation efforts will also have affected the lack of detonations in the UK.

There are certain construction activities which make initiation more likely, and several potential initiation mechanisms must be considered:

UXB Initiation	
Direct Impact	Unless the fuze or fuze pocket is struck, there needs to be a significant impact e.g. from piling or large and violent mechanical excavation, onto the main body of the weapon to initiate a buried iron bomb. Such violent action can cause the bomb to detonate.
Re- starting the Clock	A small proportion of German WWII bombs employed clockwork fuzes. It is probable that significant corrosion would have taken place within the fuze mechanism over the last 70+ years that would prevent clockwork mechanisms from functioning. Nevertheless, it was reported that the clockwork fuze in a UXB dealt with by 33 EOD Regiment in Surrey in 2002 did re-start.
Friction Impact	The most likely scenario resulting in the detonation of a UXB is friction impact initiating the shock-sensitive fuze explosive. The combined effects of seasonal changes in temperature and general degradation over time can cause explosive compounds to crystallise and extrude out from the main body of the bomb. It may only require a limited amount of energy to initiate the extruded explosive which could detonate the main charge.

18. Consequences of Initiation/Encounter

18.1. Introduction

The repercussions of the inadvertent detonation of UXO during intrusive ground works, or if an item or ordnance is interfered with or disturbed, are potentially profound, both in terms of human and financial cost. A serious risk to life and limb, damage to plant and total site shutdown during follow-up investigations are potential outcomes. However, if appropriate risk mitigation measures are put in place, the chances of initiating an item of UXO during ground works is comparatively low.

The consequences of encountering UXO can be particularly notable in the case of high-profile sites (such as airports and train stations) where it is necessary to evacuate the public from the surrounding area. A site may be closed for anything from a few hours to a week with potentially significant cost in lost time. It should be noted that even the discovery of suspected or possible item of UXO during intrusive works (if handled solely through the authorities), may also involve significant loss of production

18.2. Consequences of Detonation

When considering the potential consequences of a detonation, it is necessary to identify the significant receptors that may be affected. The receptors that may potentially be at risk from a UXO detonation on a construction site will vary depending on the site specific conditions but can be summarised as follows:

- People – site workers, local residents and general public.
- Plant and equipment – construction plant on site.
- Services – subsurface gas, electricity, telecommunications.
- Structures – not only visible damage to above ground buildings, but potentially damage to foundations and the weakening of support structures.
- Environment – introduction of potentially contaminating materials.

19. 1st Line Defence Risk Assessment

19.1. Risk Assessment Stages

Taking into account the quality of the historical evidence, the assessment of the overall risk from unexploded ordnance is based on the following five considerations:

1. That the site was contaminated with unexploded ordnance.
2. That unexploded ordnance remains on site.
3. That such items will be encountered during the proposed works.
4. That ordnance may be initiated by the works operations.
5. The consequences of encountering or initiating ordnance.

19.2. Assessed Risk Level in the Medium Risk Areas

1st Line Defence has assessed that there is a **Medium-Risk** from German and anti-aircraft unexploded ordnance within the east of the proposed site.

Ordnance Type	Risk Level			
	Negligible	Low	Medium	High
German Unexploded HE Bombs			✓	
German 1kg Incendiary Bombs			✓	
Allied Anti-Aircraft Artillery Projectiles			✓	
Allied Land Service and Small Arms Ammunition	✓			

19.3. Assessed Risk Level in Low Risk Areas

1st Line Defence has assessed that there is a smaller area of **Low-Risk** from German and anti-aircraft unexploded ordnance within the west of the proposed site

Ordnance Type	Risk Level			
	Negligible	Low	Medium	High
German Unexploded HE Bombs		✓		
German 1kg Incendiary Bombs		✓		
Allied Anti-Aircraft Artillery Projectiles		✓		
Allied Land Service and Small Arms Ammunition	✓			

Please note – although the risk from unexploded ordnance on this site has been assessed as ‘Low’ in this section of the site, this does not mean there is ‘no’ risk of encountering UXO. This report has been undertaken with due diligence, and all reasonable care has been taken to access and analyse relevant historical information. By necessity, when dealing historical evidence, and when making assessments of UXO risk, various assumptions have to be made which we have discussed and justified throughout this report. Our reports take a common-sense and practical approach to the assessment of risk, and we strive to be reasonable and pragmatic in our conclusions. It should however be stressed that if any suspect items are encountered during the proposed works, 1st Line Defence should be contacted for advice/assistance, and to re-assess the risk where necessary.

The mitigation measures outlined below are recommended as a minimum precaution to alert ground personnel to the history of the site, what to look out for, and what measures to take in the event that a suspect item is encountered. It should also be noted that the conclusions of this report are based on the scope of works outlined in the ‘Proposed Works’ section of this report. Should the scope of works change or additional works be proposed, 1st Line Defence should be contacted to re-evaluate the risk.

20. Proposed Risk Mitigation Methodology

20.1. General

The following risk mitigation measures are recommended to support the proposed works at the 193 Hathersage Road site:

Type of Work	Recommended Mitigation Measure
All Works	UXO Risk Management Plan It is recommended that a site-specific plan for the management of UXO risk be written for this site. This plan should be kept on site and be referred to in the event that a suspect item of UXO is encountered at any stage of the project. It should detail the steps to be taken in the event of such a discovery, considering elements such as communication, raising the alarm, nominated responsible persons etc. Contact 1st Line Defence for help/more information. Site Specific UXO Awareness Briefings to all personnel conducting intrusive works. As a minimum precaution, all personnel working on the site should be briefed on the basic identification of UXO and what to do in the event of encountering a suspect item. This should in the first instance be undertaken by a UXO Specialist. Posters and information on the risk of UXO can be held in the site office for reference.
Shallow Intrusive Works/Open Excavations (Medium Risk Areas only)	Unexploded Ordnance (UXO) Specialist Presence on Site to support shallow intrusive works When on site the role of the UXO Specialist would include: - Monitoring works using visual recognition and instrumentation, including immediate response to reports of suspicious objects or suspected items of ordnance that have been recovered by the ground workers on site. - Providing UXO awareness briefings to any uninformed staff and advise staff of the need to modify working practices to take account of the ordnance risk. - To aid incident management which would involve liaison with the local authorities and police should ordnance be identified and present an explosive hazard.
Borehole/Piles (Medium Risk Areas only)	Intrusive Magnetometer Survey of all borehole and pile locations down to a maximum bomb penetration depth: 1st Line Defence can deploy a range of intrusive magnetometer techniques to clear pile locations. The appropriate technique is influenced by a number of factors, but most importantly the site's ground conditions. The appropriate survey methodology would be confirmed once the enabling works have been completed.

In making this assessment and recommending these risk mitigation measures, if known, the works outlined in the 'Scope of the Proposed Works' section were considered. Should the planned works be modified or additional intrusive engineering works be considered, 1st Line Defence should be consulted to see if a re-assessment of the risk or mitigation recommendations is necessary.

1st Line Defence Limited

4th June 2019

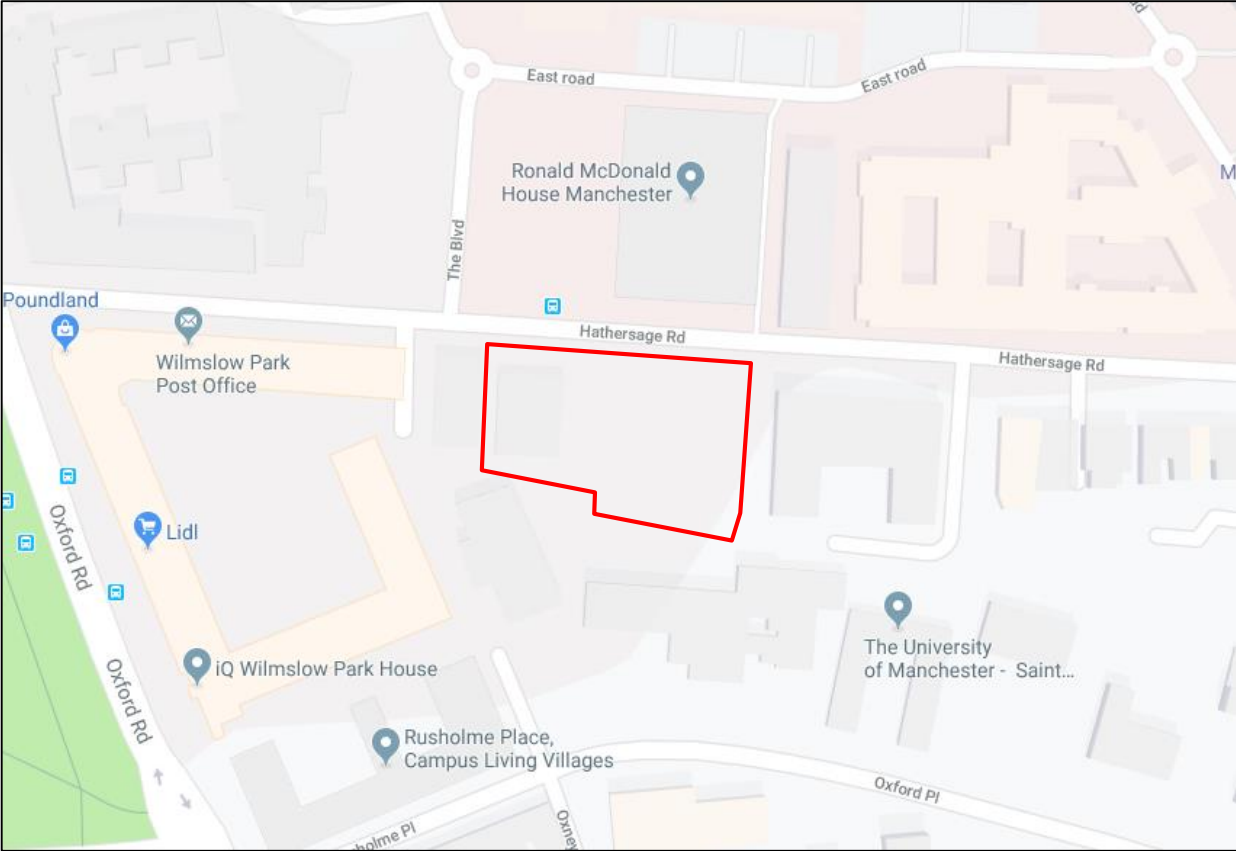
This Report has been produced in compliance with the Construction Industry Research and Information Association (CIRIA) C681 guidelines for the writing of Detailed UXO Risk Assessments.

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Project: **193 Hathersage Road, Manchester**

Ref: **DA8680-00**

Source: Google Maps

 **Approximate site boundary**





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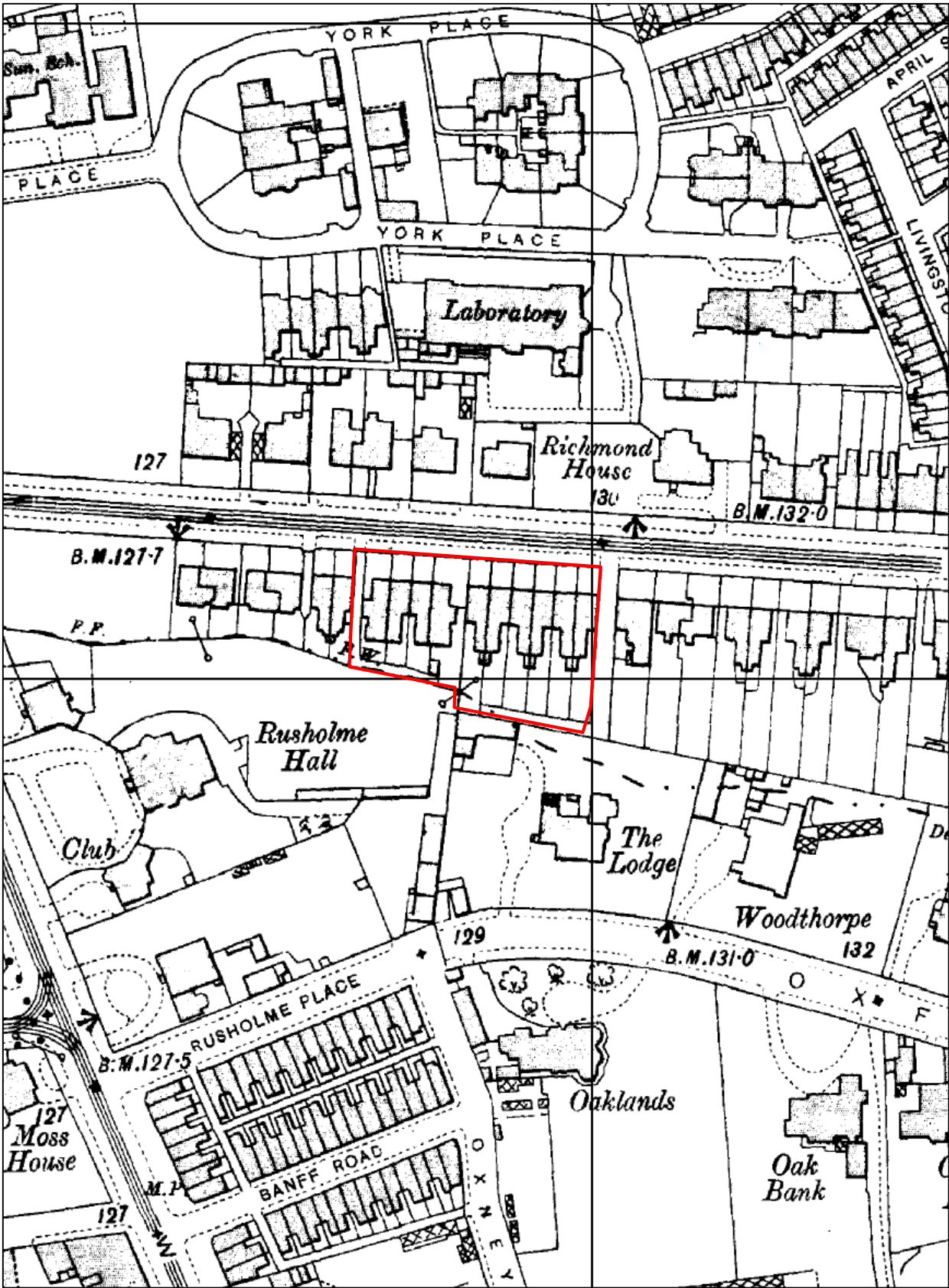
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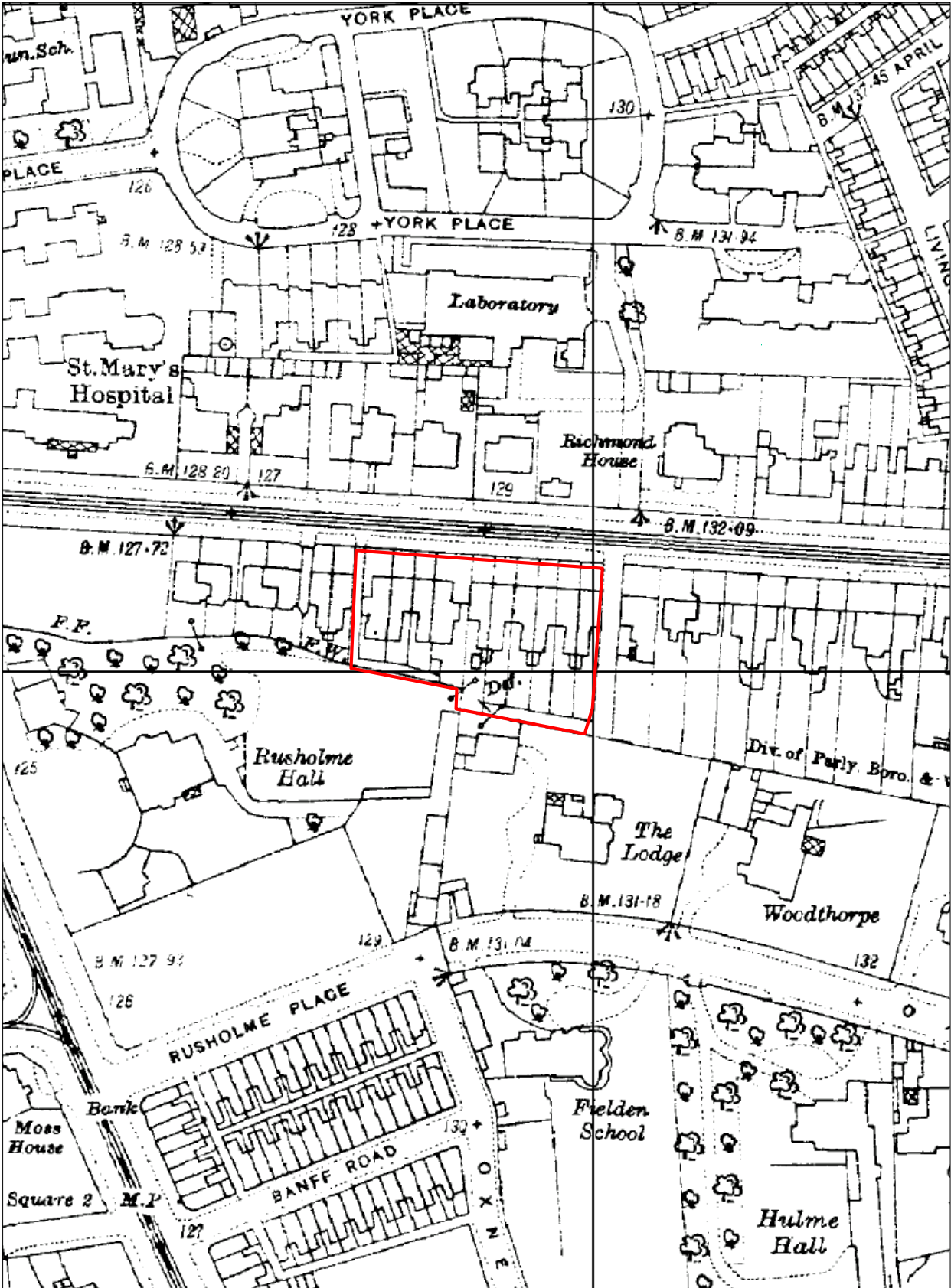
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Source: **Landmark Maps**

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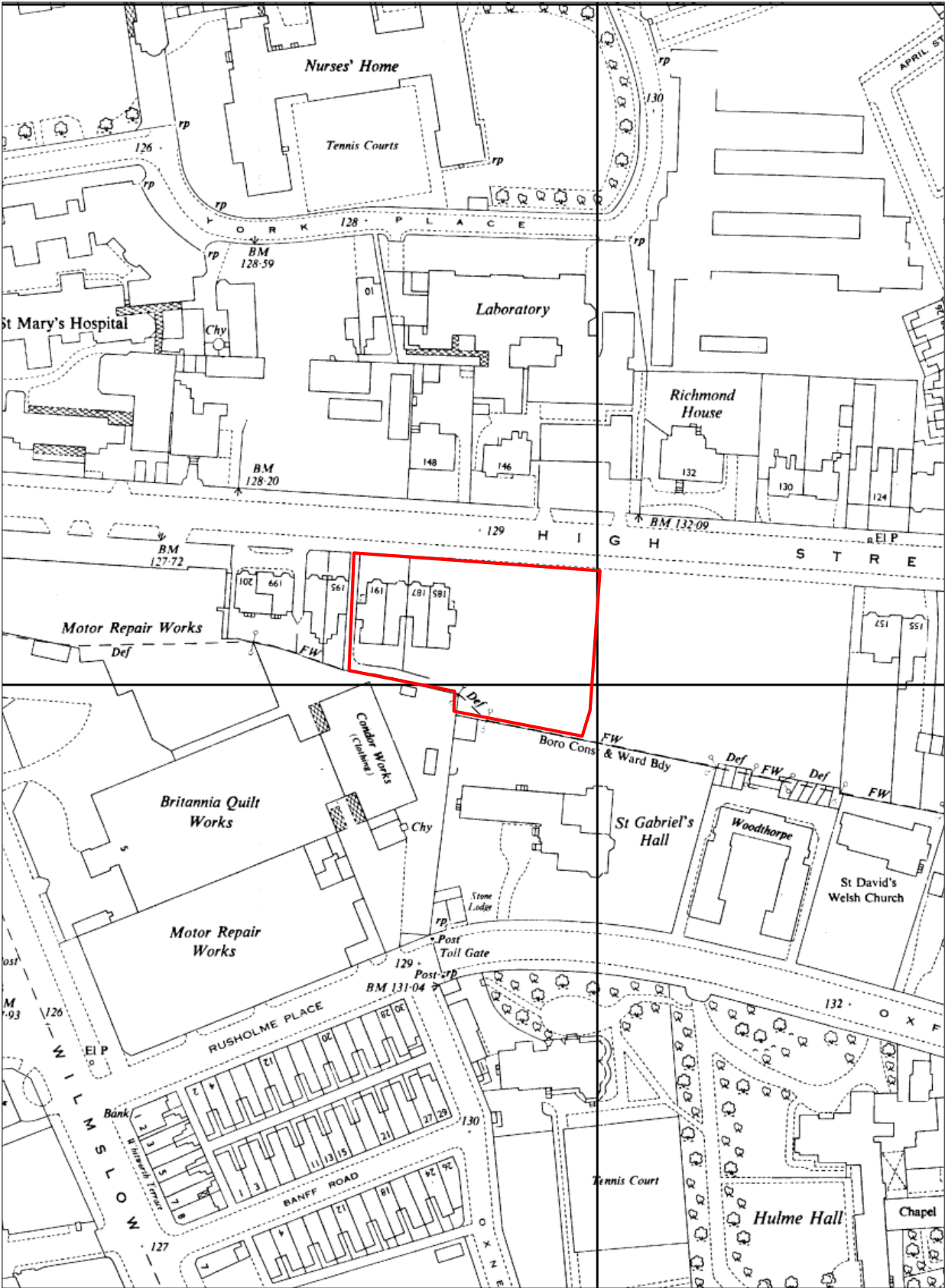
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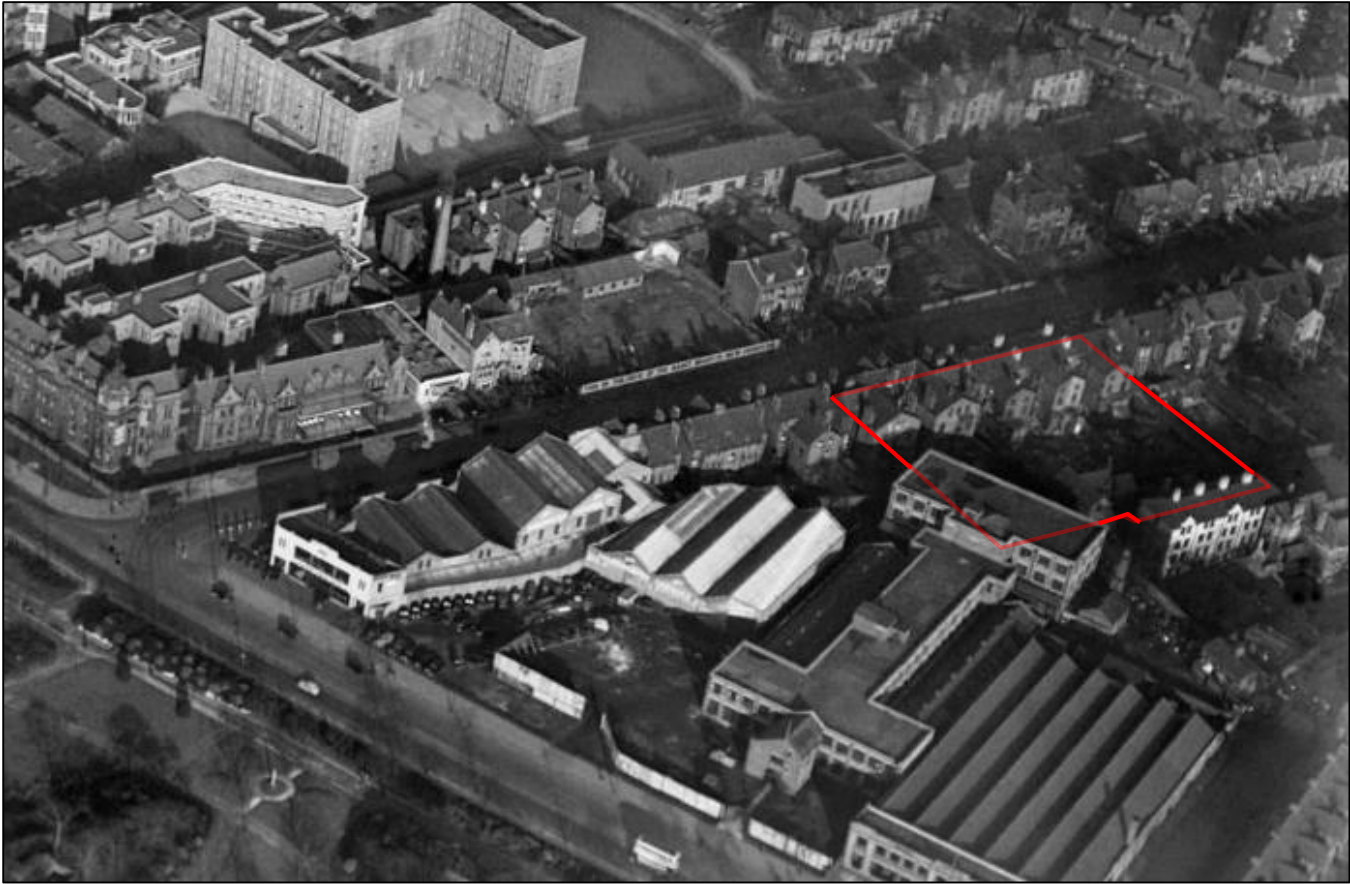
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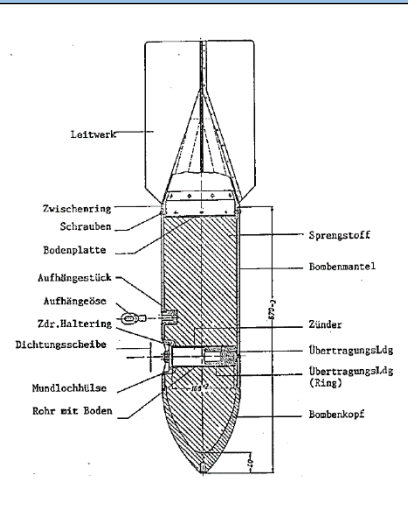


Above: A 1939 image of the St Marys Hospital and Manchester Royal Infirmary, in which the site is visible.

Examples of German Air-Delivered Ordnance

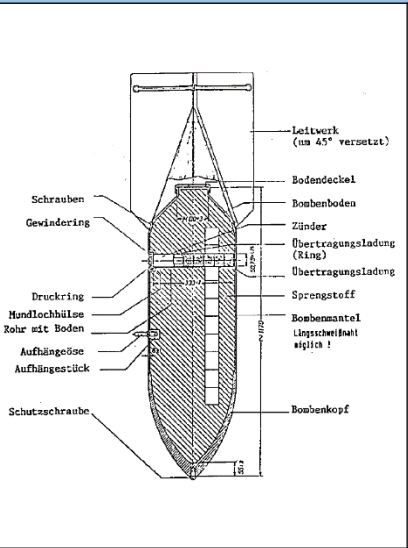
SC 50kg High Explosive Bomb

Bomb Weight	40-54kg (88-119lb)
Explosive Weight	25kg (55lb)
Fuze Type	Impact fuze/electro-mechanical time delay fuze
Bomb Dimensions	1,090 x 280mm (42.9 x 11.0in)
Body Diameter	200mm (7.87in)
Use	Against lightly damageable materials, hangars, railway rolling stock, ammunition depots, light bridges and buildings up to three stories.
Remarks	The smallest and most common conventional German bomb. Nearly 70% of bombs dropped on the UK were 50kg.



SC 250kg High Explosive Bomb

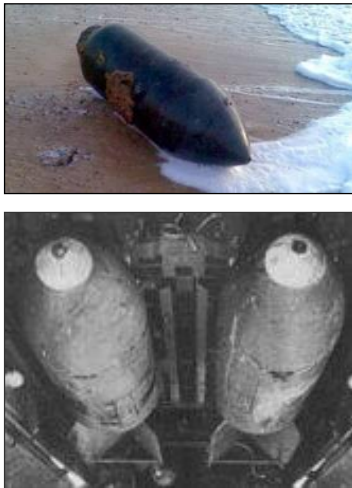
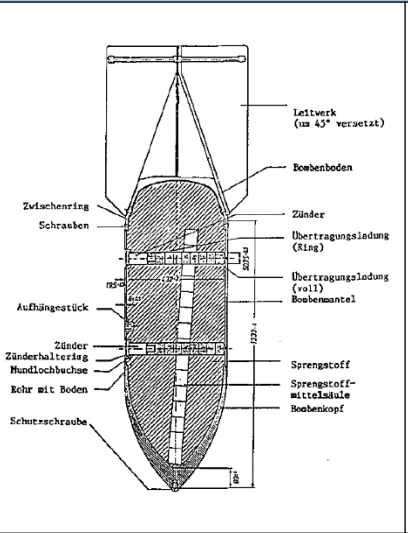
Bomb Weight	245-256kg (540-564lb)
Explosive Weight	125-130kg (276-287lb)
Fuze Type	Electrical impact/mechanical time delay fuze.
Bomb Dimensions	1640 x 512mm (64.57 x 20.16in)
Body Diameter	368mm (14.5in)
Use	Against railway installations, embankments, flyovers, underpasses, large buildings and below-ground installations.
Remarks	It could be carried by almost all German bomber aircraft, and was used to notable effect by the Junkers Ju-87 Stuka (Sturzkampfflugzeug or dive-bomber).



SC250 bomb being loaded onto German bomber

SC 500kg High Explosive Bomb

Bomb Weight	480-520kg (1,058-1,146lb)
Explosive Weight	250-260kg (551-573lb)
Fuze Type	Electrical impact/mechanical time delay fuze.
Bomb Dimensions	1957 x 640mm (77 x 25.2in)
Body Diameter	470mm (18.5in)
Use	Against fixed airfield installations, hangars, assembly halls, flyovers, underpasses, high-rise buildings and below-ground installations.
Remarks	40/60 or 50/50 Amatol TNT, trialene. Bombs recovered with Trialen filling have cylindrical paper wrapped pellets 1-15/16 in. in length and diameter forming



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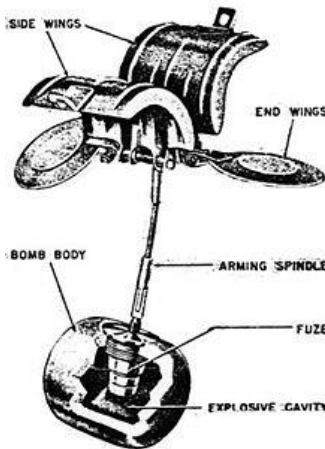
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Source: Various sources

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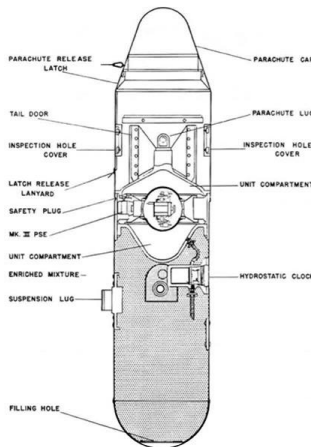
SD2 Anti-Personnel ‘Butterfly Bomb’

Bomb Weight	Approx. 2kg (4.41lb)
Explosive Weight	Approx. 7.5oz (225 grams) of Amatol surrounded by a layer of bituminous composition.
Fuze Type	41 fuze (time) , 67 fuze (clockwork time delay) or 70 fuze (anti-handling device)
Body Diameter	3in (7.62 cm) diameter, 3.1in (7.874) long
Use	Designed as an anti-personnel/ fragmentation weapon. They were delivered by air, being dropped in containers of 23-144 sub-munitions that opened at a predetermined height, thus scattering the bombs.
Remarks	Very rare. First used against Ipswich in 1940, but were also dropped on Kingston upon Hull, Grimsby and Cleethorpes in June 1943, amongst various other targets in UK. As the bombs fell the outer case flicked open by springs which caused four light metal drogues with a protruding 5 inch steel cable to deploy in the form of a parachute & wind vane which armed the device as it span.



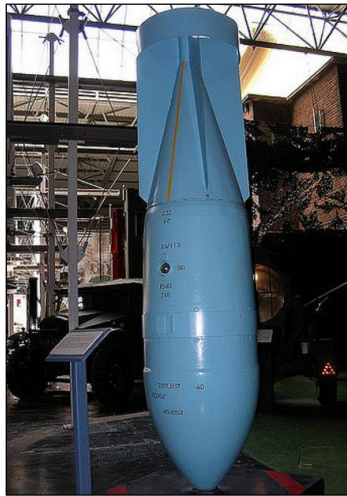
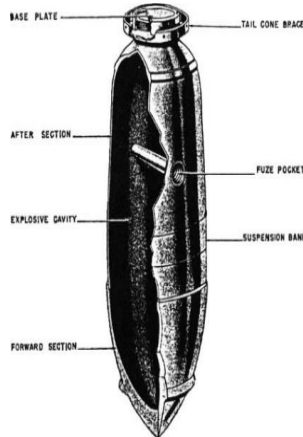
Parachute Mine (Luftmine B / LMB)

Bomb Weight	Approx. 990kg (2176lb)
Explosive Weight	Approx. 705kg (1,554lb)
Fuze Type	Impact/ Time delay / hydrostatic pressure fuze
Dimensions	2.64m x 0.64m (3.04m with parachute housing)
Use	Against civilian, military and industrial targets. Used as blast bombs and designed to detonate above ground level to maximise damage to a wider area.
Remarks	Deployed a parachute when dropped in order to control its descent. Had the potential to cause extensive damage in a 100m radius.



SC 1000kg

Bomb Weight	Approx. 993-1027kg (2,189-2,264lb)
Explosive Weight	Approx. 530-620kg (1168-1367lb)
Fuze Type	Electrical impact/mechanical time delay fuze.
Filling	Mixture of 40% amatol and 60% TNT, but when used as an anti-shipping bomb it was filled with Trialen 105, a mixture of 15% RDX, 70% TNT and 15% aluminium powder.
Bomb Dimensions	2800 x 654mm (110 x 25.8in)
Body Diameter	654mm (18.5in)
Use	SC type bombs are General Purpose Bombs used primarily for general demolition work. Constructed of parallel walls with comparatively heavy noses. They are usually of three piece welded construction



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Ref: DA8680-00

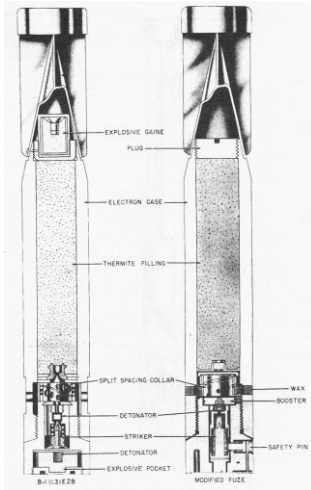
Source: Various sources

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German Incendiary Bombs

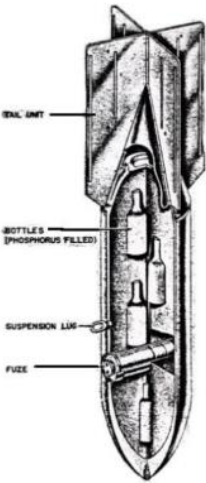
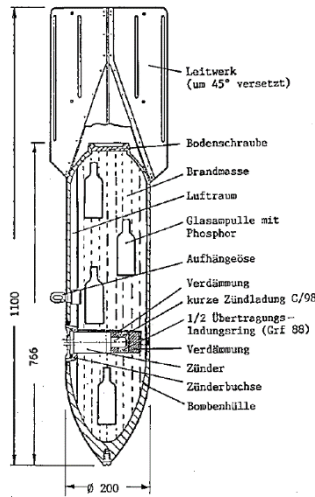
1kg Incendiary Bomb

Bomb Weight	Approx. 1.0 - 1.3kg (2.2 and 2.9lb)
Explosive Weight	Approx. 680g (1.5lb) Thermit 8-15gm Explosive Nitropenta
Fuze Type	Impact fuze
Bomb Dimensions	350 x 50mm (13.8 x 1.97in)
Body Diameter	50mm (1.97in)
Use	As incendiary – dropped in clusters on towns and industrial complexes
Remarks	Magnesium alloy case. Sometimes fitted with high explosive charge. The body is a cylindrical alloy casting threaded internally at the nose to receive the fuze holder and fuze.



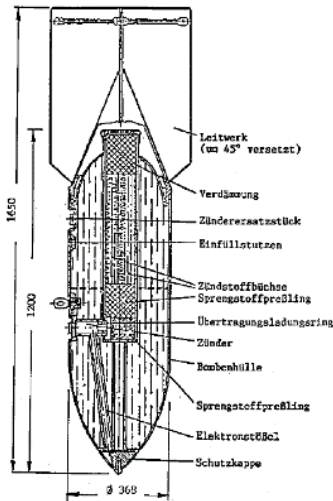
C50 A Incendiary Bomb

Bomb Weight	Approx. 41kg (90.4lb)
Explosive Weight	Approx. 0.03kg (0.066lb)
Incendiary Filling	12kg (25.5lb) liquid filling with phosphor igniters in glass phials. Benzine 85%; Phosphorus 4%; Pure Rubber 10%
Fuze Type	Electrical impact fuze
Bomb Dimensions	1,100 x 280mm (43.2 x 8in)
Use	Against any targets where an incendiary effect is required
Remarks	Early fill was a phosphorous/carbon disulphide incendiary mixture



Flam C-250 Oil Bomb

Bomb Weight	Approx. 125kg (276lb)
Explosive Weight	Approx. 1kg (2.2lb)
Fuze Type	Super-fast electrical impact fuze
Filling	Mixture of 30% petrol and 70% crude oil
Bomb Dimensions	1,650 x 512.2mm (65 x 20.2in)
Body Diameter	368mm (14.5in)
Use	Often used for surprise attacks on ground troops, against troop barracks and industrial installations. Thin casing – not designed for ground penetration



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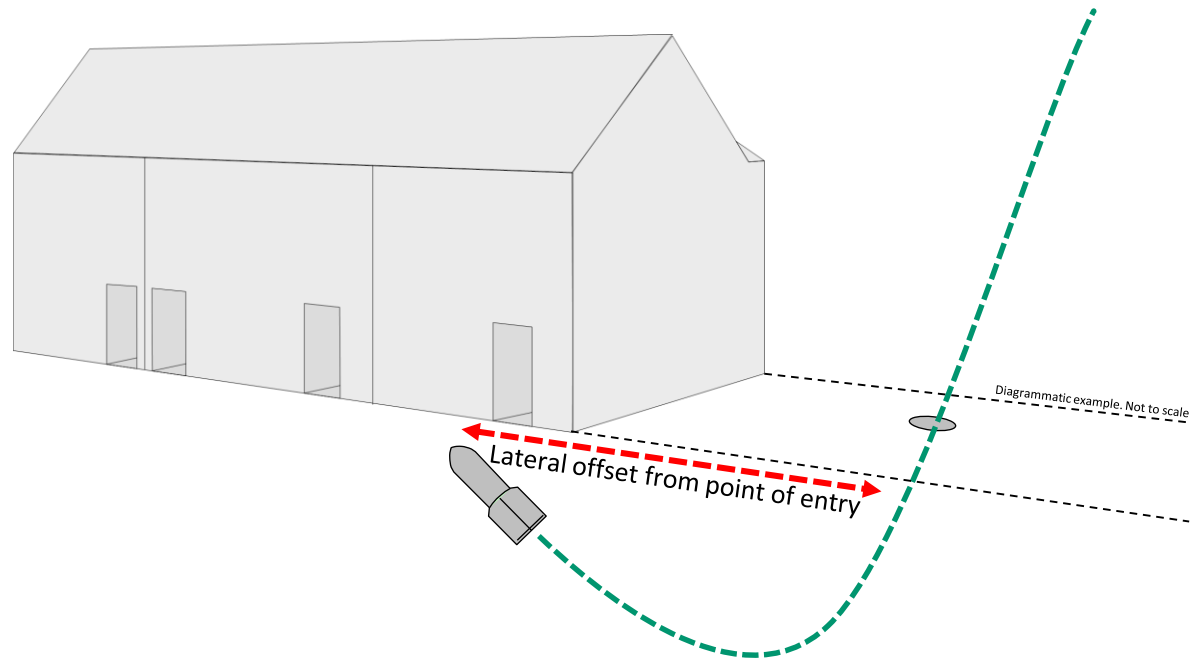
Client: ARUP Group

Project: 193 Hathersage Road, Manchester

Ref: DA8680-00

Source: Various sources

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Top: J-curve Effect - Due to angle of entry, unexploded bombs would often end their trajectory at a lateral offset from point of entry, often ending up beneath adjacent extant structures/sites. The photograph above shows 250kg bomb found in Bermondsey pointing upwards, demonstrating 'J-curve'



One of the most common scenarios for UXO going unnoticed was when a UXB fell into a 'bomb site' (such as the area shown **Top Left**), the entry hole of the bomb obscured by any debris and rubble present. Note that the entry hole of a 50kg UXB could be as little as 20cm in diameter (**Left**).



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Bermondsey bomb: World War Two device safely removed



An unexploded World War Two bomb found in south London has been driven away safely under police and Army escort.

The 500lb (250kg) device was found on a building site in Grange Walk, Bermondsey on Monday.

March 2015



Bethnal Green WW2 bomb: Experts remove unexploded device



An unexploded World War Two bomb that prompted the evacuation of 700 people in east London has been made safe and removed by the military.

Families spent the night in a school hall after the 500lb bomb was found in the basement of a building site on Temple Street, in Bethnal Green, on Monday afternoon.

A 200m (650ft) exclusion zone was set up around the device.

August 2016



Bath WW2 bomb scare: Device defused, police say



A 500lb World War Two bomb found on the site of a former school in Bath has been defused and made safe.

The discovery of the bomb on Thursday led to the evacuation of hundreds of homes and many road closures in the Lansdown area of the city.

A cordon around the site was lifted on Friday evening, more than 24 hours after residents were asked to leave their homes.

May 2016



London City Airport reopens after WW2 bomb moved



London City Airport has reopened after an unexploded 500kg World War Two bomb was safely moved from the area.

The device was discovered at the King George V Dock on Sunday during planned work at the east London airport.

All flights were cancelled on Monday after an exclusion zone was put in place, with the closure affecting up to 16,000 passengers and nearby residents being evacuated from their homes.

May 2015



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Ref: DA8680-00 Source: BBC News

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BASF has confirmed that an explosive device, most likely a World War II-era bomb, caused the blast that left one person injured Tuesday at a plant construction site in Germany.

The explosion was reported at BASF's Ludwigshafen toluene diisocyanate (TDI) plant, which recently broke ground for a 300,000 metric tons per year TDI production plant and other construction to expand its facilities.



BASF Provides Some Details

Responding to a request from *PaintSquare News* for more information on Wednesday (Feb. 27), BASF's manager of media relations and corporate communications Europe, Ursula von Stetten, wrote in an email, "So here [are] the facts: The detonation took place at 10:00 a.m. One person was injured; the injury is not serious. He will be kept in the hospital for some days."

"Cause of the detonation was an explosive device, presumably a bomb deriving from the Second World War. The device detonated when grounding work was done. No details on [a] delay [are] available. At the moment, the exact circumstances of the incident are [being] evaluated."

1st March 2013

SPIEGEL ONLINE

Blast Kills One
World War II Bomb Explodes on German Motorway

A highway construction worker in Germany accidentally struck an unexploded World War II bomb, causing an explosion which killed him and wrecked several passing cars.



A World War II bomb has exploded during construction work on a German highway, killing one worker and injuring several motorists who were driving past, police said.

The worker had been cutting through the road surface near the south-western town of Aschaffenburg when his machine struck the bomb and triggered it. Police said they weren't sure yet what type of bomb it was. "The explosion seems to have been too small for it to have been an aircraft bomb," a police spokesman said.

23rd October 2006

WWII bomb injures 17 at Hattingen construction site



Seventeen people were injured on Friday when a construction crew unwittingly detonated a buried World War II-era bomb in Hattingen.

An excavator apparently drove over a 250-kilogramme (550 pound) American bomb, damaging surrounding buildings. Most of the injured suffered auditory trauma from the blast, and the excavator operator suffered injuries to his hands, police in the German state of North Rhine-Westphalia said.

"The hole was astoundingly small for such a large bomb full of so many explosives," Armin Gebhard, head of the Arnsberg department for military ordnance removal, told *The Local*. "But of course it damaged all the surrounding buildings too. We are really happy it wasn't worse."

19th September 2013



World War II bomb kills three in Germany



A special commission is investigating the causes of the explosion, while prosecutors are considering whether the team leader should face charges of manslaughter through culpable negligence, the BBC's Oana Lungescu reports from Berlin.

The blast happened an hour before the defusing operation was due to start.

Officials said the three men who died were experienced sappers, or combat engineers, who over 20 years had defused up to 700 bombs.

More than 7,000 people were immediately evacuated when the 500kg bomb was found. Several schools, a kindergarten and local companies remain closed.

2nd June 2010



June 2006



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Ref:	DA8680-00	Source:	Various news sources
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Manchester area evacuated as unexploded bomb found near old Coronation Street studio

By **MATT DRAKE**
PUBLISHED: 13:13, Wed, Oct 24, 2018

MANCHESTER city centre was in lock down after an “unexploded cartridge” was found on a building site.

A number of streets between Manchester city centre and Salford were closed because of a police incident.

Irwell Street was closed from Trinity Way to New Quay Street – near the former Old Granada Studios.

A nearby block of flats was evacuated due to the unexploded device.

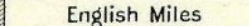


Greater Manchester Police confirmed the incident.

They said on Twitter: “Officers responding to reports that an unexploded tank cartridge has been found on a building site at New Quay Street.

“It appears to have been there some time. Specialist Officers are there & building evacuations are likely. Newquay Street closed at junction Water Street.”

Police confirmed an “unexploded tank cartridge” was found on a building site.





Red circle: fire bomb
Blue circle: high explosive bomb
Green: line mine
Solid red shading: demolished building
Hatched red shading: partially damaged structure



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Client: ARUP Group

Project: 193 Hathersage Road, Manchester

Ref: DA8680-00

Source: The University of Manchester Library

Approximate site boundary



District <i>CW</i>		<i>High Street</i>		Incident Date									
Sector <i>18</i>		<i>6 on M.</i>		Date Inspected <i>10/4/42</i>									
Card No.		Continued on Card No.		Inspector <i>SAT</i>									
No.	H. H.&S. F.	Classifica- tion	TENANT	EXTENT OF DAMAGE								Re- Classification	
				Roofs	Chimneys	Walls	Floors	Ceilings	Doors	Windows	Frames	Class	Date
<i>167</i>		<i>B</i>	<i>D. (S.C.)</i>										
<i>169</i>		<i>B</i>	<i>D.H.</i>										
			<i>SPRINGFIELD HOTEL</i>										
<i>173</i>		<i>A</i>	<i>D. (S.C.)</i>										
<i>NOTE - No. 173 was Springfield Hotel.</i>													
<i>No. 171 was private house occupied by Fraser (Whisky Merchant). This has been demolished & site cleared.</i>													
CODE REFERENCE													
<i>D = Demolished F = Fractured G = Glazing H = Holed</i>													
<i>O = Off or Displaced P = Plastering S = Slight U = Unsafe</i>													
WAR DAMAGE TO HOUSING, HOUSING DEPARTMENT, TOWN HALL, MANCHESTER, 2.													
9531 (4647)													

Left: The damage card which records the extent of damage sustained to properties located on High Street.



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Approximate site boundary



Project: 193 Hathersage Road, Manchester

Ref: DA8680-00

Source: Manchester Central Library



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Project: **193 Hathersage Road, Manchester**

Ref: **DA8680-00**

Source: National Monuments Record Office (Historic England)

 **Approximate site boundary**





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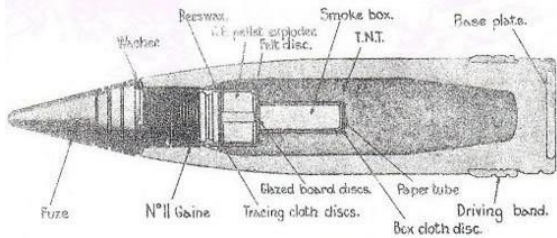
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Examples of Anti-Aircraft Projectiles

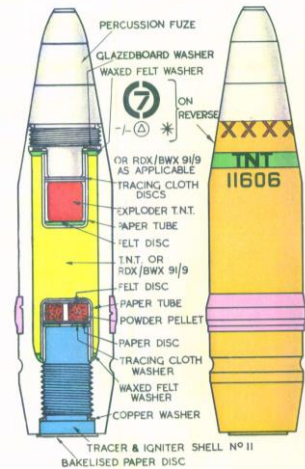
3.7 Inch QF Anti-Aircraft Projectile

Projectile Weight	28lb (12.6 kg)
Explosive Weight	2.52lbs
Fuze Type	Mechanical Time Fuze
Dimensions	3.7in x 14.7in (94mm x 360mm)
Rate of Fire	10 to 20 rounds per minute
Use	The 3.7in AA Mks 1-3 were the standard Heavy Anti-Aircraft guns of the British Army.
Ceiling	30,000ft to 59,000ft



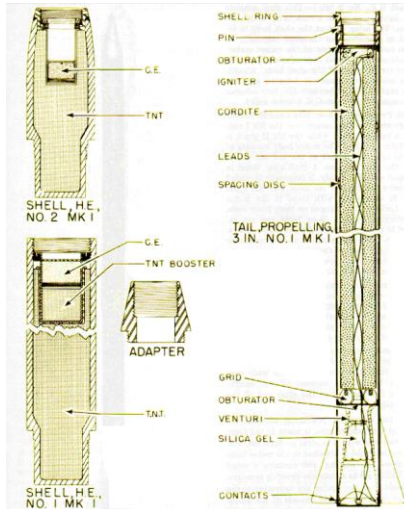
40mm Bofors Projectile

Projectile Weight	1.96lb (0.86kg)
Explosive Weight	300g (0.6lb)
Fuze Type	Impact Fuze
Rate of Fire	120 rounds per minute
Projectile Dimensions	40 x 180mm
Ceiling	23,000ft (7000m)
Remarks	Light quick fire high explosive anti-aircraft projectile. Each projectile fitted with small tracer element. If no target hit, shell would explode when tracer burnt out. Designed to engage aircraft flying below 2,000ft



3in Unrotated Projectile (UP) Anti-Aircraft Rocket ("Z" Battery)

HE Projectile Weight	3.4kg (7.6lb)
Explosive Weight	0.96kg (2.13lb)
Filling	High Explosive – TNT. Fitted with aerial burst fuzing
Dimensions of projectile	236 x 83mm (9.29 x 3.25in)
Remarks	As a short range rocket-firing anti-aircraft weapon developed for the Royal Navy. It was used extensively by British ships during the early days of World War II. The UP was also used in ground-based single and 128-round launchers known as Z Batteries. Shell consists of a steel cylinder reduced in diameter at the base and threaded externally to screw into the shell ring of the rocket motor



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-  Low Risk
-  Medium Risk

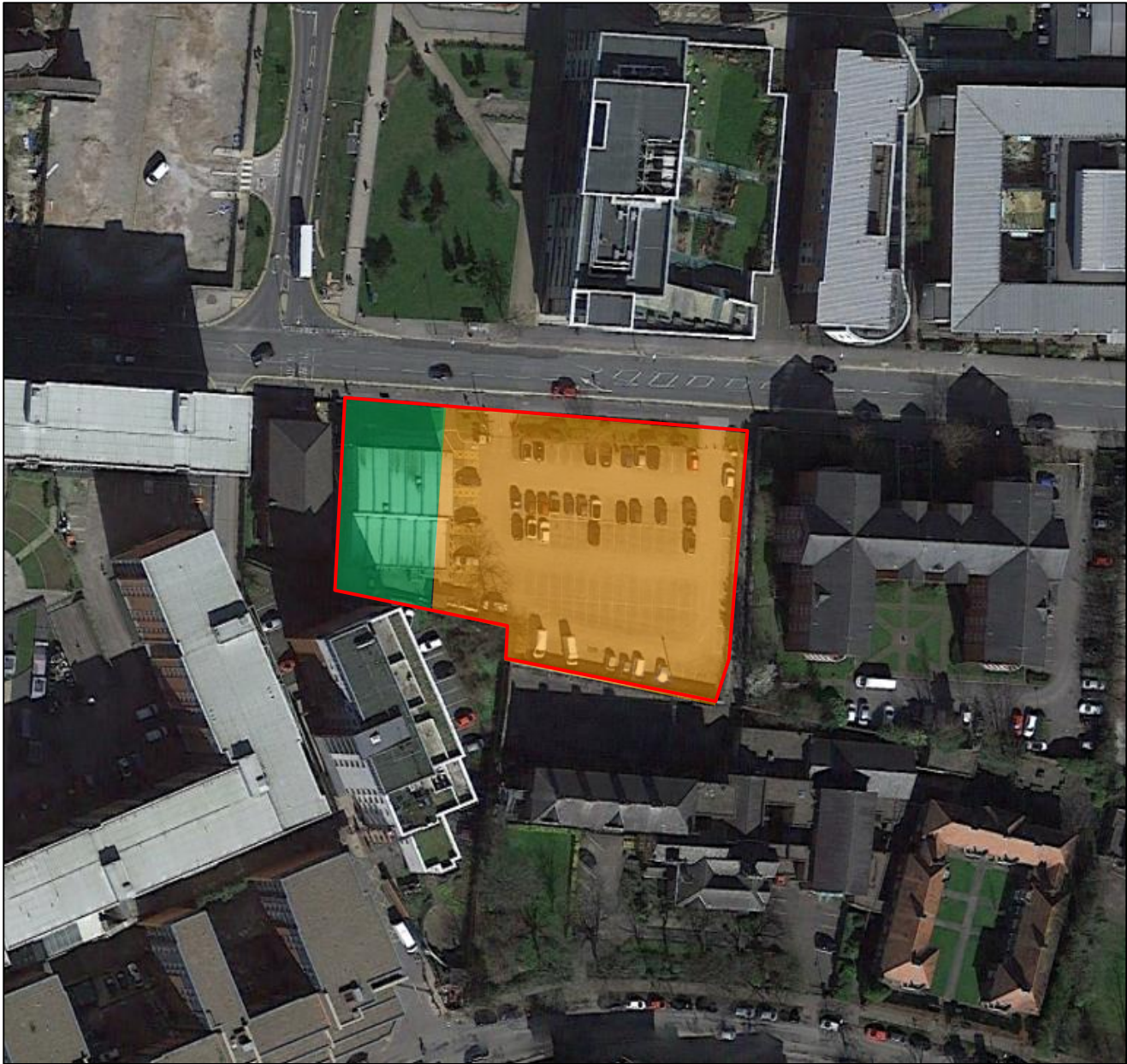
- Low and Medium Risk Areas:**
- Site Specific Unexploded Ordnance Awareness Briefings to all personnel conducting intrusive works
- Medium Risk Area:**
- Unexploded Ordnance (UXO) Specialist Presence on Site to support shallow intrusive works
 - Intrusive Magnetometer Survey of all Borehole and pile locations down to a maximum bomb penetration depth

For indicative purposes – not to scale



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Client: ARUP Group		 Approximate site boundary	
Project: 193 Hathersage Road, Manchester			
Ref: DA8680-00	Source: 1 st Line Defence		



- Low Risk
- Medium Risk

- Low and Medium Risk Areas:**
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