

Chandos Hall/Echo Street, Manchester

Phase 2 Site Investigation

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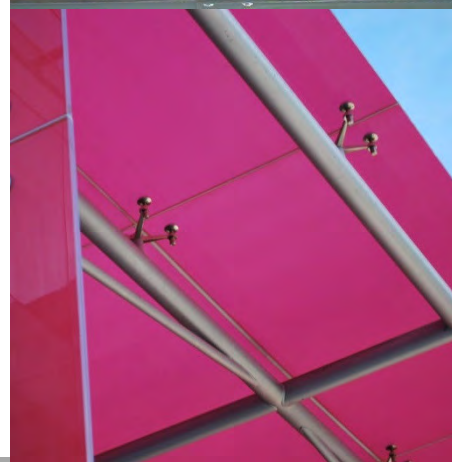
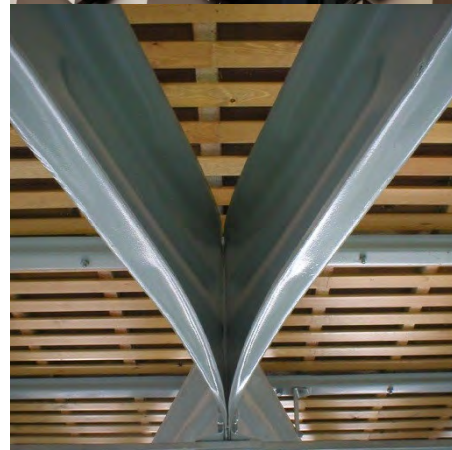
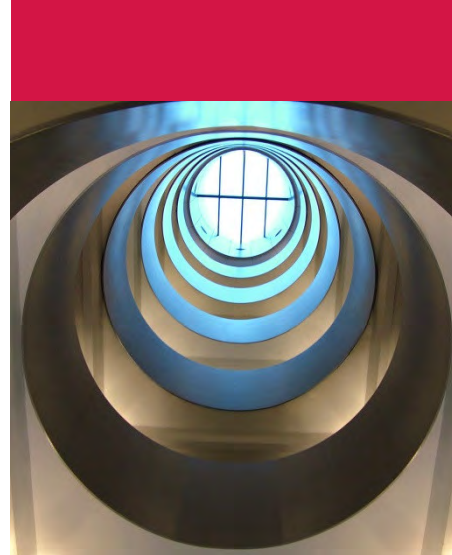
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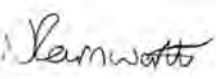


Phase 2 Site Investigation

Rev	Description	Issued by	Checked	Date
V02	Inclusion of Stage 3 investigative works	JB	NF	28 February 2018
V03	Ground gas addendum	MH	SH	13 April 2018
V04	Updated following final stages of investigative works	MH	JJ	18 July 2019

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Executive Summary

Appointment	In June 2017 Curtins were instructed by IQ Student Accommodation to undertake a Phase 2 Site Investigation at the Chandos Hall site in Manchester (approximately centred on NGR 384670, 397700). Development proposals comprise a mixed-use 25-storey student apartment blocks with retail, leisure, amenity, event and children's nursery space on the ground floor, with minor soft landscaping in courtyard areas. Due to current access restrictions, the proposed investigation has been split into stages of work across various portions of the site. This is the final interpretative report for Stages 1 - 5 of the scope of works.
Current Site Status	The site was previously occupied by buildings of various uses including: a 14-storey residential block in the western portion, formerly known as Chandos Hall, with soft landscaping and hardstanding in the centre; Echoes Day Nursery is in the northeast corner of the site; and garages in the southeast, accessed off Echo Street. Demolition of the nursery has been completed and the demolition of Chandos Hall is currently underway. The site slopes from an elevation of approximately 41.00m AOD in the east, to approximately 38.43m AOD in the west, a retaining wall separates the higher eastern (nursery and garages) portion of the site from the lower western (residential) portion. There are also large retaining walls on the north western and western boundaries of the site separating the western (residential) portion of the site from the higher surrounding land. The site is bounded to the north by Granby Row and Lambert House residential apartments, to the east by Echo Street and retail units, a railway line (viaduct) abuts the southern boundary of the site with Altrincham Street beyond, and to the west by a Vimto Park.
Summary of Phase 1	The earliest available historical mapping, in the late 19th Century, shows most of the site is occupied by industrial/commercial buildings (Printing Works, Battery Repairs and Window Cleaner). Surrounding the site is London Road Railway Station (100m northeast) and a Fire Engine Station (90m north). By mid to late 20th Century major demolition has occurred on the site and a depot/garage with an underground petrol tank is constructed in the northeast, Chandos Hall in the west and garages in the southeast. During the 1990s to the present day the depot/garage was converted to a nursery. The site is indicated to be underlain Made Ground, overlying Glacial Till, underlain by sandstone of the Chester Pebble Beds Formation. The superficial deposits are classified as a Secondary Undifferentiated Aquifer whilst the bedrock is classified as a Principal Aquifer. The nearest surface water feature is the River Medlock, located 200m from the southeast of site, flowing in a westerly direction. There are numerous groundwater abstractions located within 1km of the site (the nearest being 255m west), however none of which are noted as potable abstractions. Primary potential risks to be investigated during the Phase 2, as well as establishing ground conditions for geotechnical design, included; potential for land gas and risks to human health and groundwater. Risks to surface waters was Low given the relatively large distance to the nearest receptor, and therefore did not warrant further investigation.
Fieldworks Undertaken	Stage 1 & 5A of the ground investigation was undertaken between 18th and 21st July 2017, Stage 2 undertaken on 27th September 2017, Stage 3 undertaken on 19th to 21st January 2018, Stage 5B undertaken on 13th May 2019, and Stage 4 undertaken between 28th May - 4th June 2019. Investigations were undertaken to characterise ground conditions as well as to identify the dimensions and extent of on-site retaining wall foundations, railway viaduct foundations and an identified concrete cased utility tunnel. These works comprised; six cable percussive boreholes with rotary follow-on, three micro-rotary (open-hole) boreholes, seven machine excavated trial pits, sixteen window samples holes, and five hand dug trial pits with hand-held window sample follow on. Land gas and groundwater monitoring standpipes/piezometers were installed in eight window sample holes and four cable percussive boreholes. Selected soil samples were subjected to laboratory analysis. Six return ground gas monitoring visits have been undertaken, in addition to two groundwater level monitoring visits.
Encountered Ground Conditions	Made ground was encountered at all exploratory hole locations from ground level to depths of 0.30-3.80m bgl. Beneath a surface covering of asphalt, concrete or grass and topsoil overlying Made Ground generally comprised varying thicknesses of Sand & Gravel (sub-base, and ash and brick fill), underlain by Made Ground of very sandy, very gravelly Clay. Anthropogenic constituents included asphalt, coal, aggregate, glass, concrete, ash, tile, clinker, bitumen and brick. The Made Ground was underlain by Glacial Till deposits comprising Clay with interbedded sands and gravels. Clay is firm to very stiff, dark greyish-brown, sandy with frequent fine to coarse sub-angular gravel of mixed lithologies. Underlying this, from depths of between 2.90m – 6.50m bgl, is medium-dense to very dense, reddish-brown, slightly cobbly, gravelly, fine to coarse Sand, considered to be indicative of weathered bedrock deposits. Gravel and cobbles are sub-angular to sub-rounded, fine to coarse of various lithologies including sandstone, mudstone, granite and quartzite. Competent bedrock, associated with the Chester Pebble Beds Formation, was encountered at 7.50-13.50m bgl, recorded as extremely weak to weak, reddish-brown, medium grained, arenaceous Sandstone, identified to a maximum depth of 25.50m bgl through coring. The sandstone is of very poor to poor rock quality. During Stage 5 of the investigation, the railway viaducts foundations/base of the viaduct brick wall were not identified in any of the hand dug or machine excavated trial pit locations undertaken. A thin concrete footing was encountered in TP102 at 1.45m bgl, adjacent to the infilled section of the brick arch. This is not considered indicative of the foundations of the wider viaduct. The inspection of the retaining walls foundation found the concrete foundations for the western boundary wall (top of the foundation was identified at 0.30-0.35m bgl with a projection of 0.55m). However, the retaining wall foundations were not identified along the northern boundary, instead a concrete service tunnel was encountered. No groundwater strikes were recorded during siteworks. Subsequent monitoring has encountered perched water at 0.40m to >3.90m bgl within the window samples holes and within BH03 the groundwater is greater than 10.30m bgl.
Environmental Laboratory Testing	With respect to the adopted Commercial GACs, there have been minor exceedances in six Made Ground samples with respect to PAHs and Lead. An ashy stratum is thought to be responsible for the exceedances and is indicative of the historical uses of the site. No suspected asbestos containing materials (ACMs) were identified during site works or laboratory testing. Marginally elevated concentrations of sulphate, copper and multiple PAHs were recorded in water samples obtained from within the bedrock strata, with respect to UK Drinking Water Standards. During ground gas monitoring, a maximum carbon dioxide (CO₂)

Phase 2 Site Investigation

and Ground Gas Monitoring Results	concentration was identified at 2.4% v/v with a maximum flow of 6.4l/hr recorded. Concentrations of methane (CH₄) has been recorded below the instruments limit of detection in all monitoring wells. The adopted Gas Screening Values (GSV) for the site are 0.011l/hr for carbon dioxide.
Ground Contamination and Ground Gas Assessment	A Moderate/Low risk rating is identified to end-users at this stage from direct contact, inhalation and ingestion of contaminants within Made Ground soils due to concentrations of PAHs and lead recorded above nominated GACs. A Low risk rating is identified to construction workers and adjacent residents at this stage from direct contact, inhalation and ingestion of contaminants associated with Made Ground soils. A Low risk rating is identified to the underlying Secondary Undifferentiated Aquifer associated with Glacial Till soils. Marginally elevated concentrations of sulphate, and multiple PAHs were recorded in groundwater samples, however limited migration is anticipated through cohesive superficial soils. A Moderate/Low risk rating is identified to the underlying Principal Aquifer associated with the Chester Pebble Beds Formation and associated weathered deposits. A Piling Risk Assessment should be undertaken to determine suitable piling methods to mitigate the risk presented to the underlying Principal Aquifer. With reference to CIRIA C665 and BS8485:2015, the maximum carbon dioxide concentrations and respective gas screening values indicate a Gas Characterisation Situation 1 (CS1) gas regime, requiring no gas protection measures for the proposed new development. The risk to site end users from ground gases is therefore considered to be Low. UK Radon Mapping confirms the site is situated in an area where <1% of homes are above the radon action level. Where the new development incorporates a basement the advice of a specialist Radon assessor must be obtained.
Preliminary Material Classification and Soils Reuse	If soil arisings are required to be disposed offsite, an initial assessment of Made Ground was carried out using a preliminary waste characterisation assessment tool. Results of twenty-five of twenty-nine soil samples assessed indicated an initial classification of non-hazardous. Four samples were assessed as hazardous (WS02 at 0.10m, WS04 at 0.15m bgl, BH03 at 0.30m bgl and WS08 at 1.80m bgl). It should also be noted that this information is for guidance only and if soil material is to be disposed offsite, further soil contaminant testing and position specific assessments, in line with WM3, is likely to be required. Further soil contaminant testing, and assessments should be carried out and based on the WAC results. The Contractors should satisfy themselves regarding the classification of any waste arisings. Confirmation of acceptability should be sought from the receiving landfill or treatment facility via the issue of laboratory chemical testing results. Excavated soils should be suitable for re-use at the site following appropriate waste management regulations and/or under a Materials Management Plan (MMP).
Geotechnical Assessment	The Made Ground and the superficial deposits are not considered to be suitable founding strata, and it is likely that the proposed high-rise building will have significant loadings therefore, piled foundations are recommended for the proposed development designed in end bearing in the sandstone. As piled foundations are anticipated, a suspended slab is recommended to bear on the pile caps by a network of beams which will minimise any differential settlement between the floor and the piled structure. Based on the laboratory test results it is considered that a Design Sulphate Class may be taken as DS-3 in Made Ground and DS-1 in natural deposits, and an ACEC class of AC-3 for Made Ground and AC-1 for natural deposits would be appropriate for the site. Excavation through layers of Made Ground and superficial deposits may not be feasible using conventional site plant, due to concrete obstructions. An allowance should be made for breaking out and removing any encountered concrete obstructions. Groundwater is not anticipated to be encountered in shallow excavations, however encountering perched water cannot be discounted.
Additional Considerations	Elevated concentrations of mineral oil contamination with respect to the protection of water supply pipes were identified within the Made Ground. Therefore, it is recommended that appropriate materials for water supply pipes would comprise PVC pipes or Barrier Pipes (PE/AL/PE). The exact requirements should be confirmed with the utility provider. The site is in Manchester City Centre, which during WWII suffered bomb damage. Records obtained to date do not record the site receiving any direct bombing hits during WWII, however it is considered that the risk presented to the site from UXO is Moderate in the northeast and Low across the remainder of the site. Consequently, several recommendations have been made for the implementation of mitigation measures during intrusive works. Historic mapping indicates the presence of tanks beneath the north east corner and centre north of the site. It is unknown at this stage if these tanks are still present on site.
Recommendations	Based on the findings of the ground investigation, the following recommendations are made: 1) It is recommended that in limited areas of soft landscaping, 300mm clean and inert capping is installed to break the source-pathway-receptor (SPR) linkage from elevated PAH and Lead concentrations. For the remainder of the site, the building footprint and areas of hard standing will break the SPR linkage; 2) It is recommended that a Piling Risk Assessment (PRA) is undertaken determine suitable methods of piling to mitigate risk presented to underlying Principal Aquifer; 3) It is unknown at this stage if historic these tanks are still present on site. If, during groundworks or construction works, tanks are discovered the occurrence should be noted, and procedures followed as indicated within a Remediation Strategy; and 4) It is recommended that construction workers are provided with appropriate PPE and sanitary facilities with reference to the environmental testing results..

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1.0 Introduction

1.1 Project Background

In June 2017 Curtins were instructed by IQ Student Accommodation to undertake a Phase 2 Site Investigation at the site known as 'Echo Street' in Manchester. The site is centred on National Grid Reference: 384670, 397700, and covers an area of approximately 0.30Ha. A site location plan is presented as *Figure 2.1*.

1.2 Scope of Services

This investigation addresses recommendations as presented in the Phase 1 report (Ref.1), with the aim of the Phase 2 works to characterise the geo-technical and geo-environmental conditions for the purposes of redevelopment as a mixed-use, (up to 25-storey) student apartment block with retail, leisure, amenity, event and children's nursery space on the ground floor along with minor soft landscaping in the courtyard areas.

This report is also produced in support of an associated planning application, ref 118267/FO/2017. The current development plans for which can be referred to within *Appendix A* of this report.

Due to current access restrictions, the proposed investigation has been split into five stages on four areas of the proposed development site. These stages include:

- Stage 1 Chandos Hall Investigation (western portion);
- Stage 2 Chandos Hall Additional Works (western portion);
- Stage 3 Garages and Nursery Pre-Demolition Investigation (part of the southeast and central portions);
- Stage 4 Nursery Post-Demolition Investigation (remainder of the central and eastern portions); and
- Stage 5 Viaduct Foundation Inspection (southern boundary).

Stage 5a was separated into two phases of investigation. An initial phase of hand excavated trial pits was undertaken, however the foundations of the viaduct were not encountered. A second phase, Stage 5b, was then undertaken, comprising machine excavated trial pits, to attempt to identify the foundations.

A factual geo-environmental letter report summarising the findings of the Stages 1, 2 and 5a (Ref.2) and interim versions of this Phase 2 (Rev V03, April 2018) report have previously been issued.

The final stage of investigation (Stage 4) and the additional viaduct inspections (Stage 5b) are now completed. This report has been updated accordingly and is specifically intended to determine:

- a) If there is a risk of the proposed end-user being adversely impacted upon by potential contamination in shallow site soils that may be present on the site due to its known current, recent and historical use;
- b) If there is a risk of groundwater and/or surface water being adversely impacted upon by potential contamination that may be present on the site due to its known current, recent and historical use;
- c) An assessment of the risk to the end-user from potential ground generating gases.
- d) Recommendations for the design of foundations and building ground floor slabs; and
- e) Recommendations for the specification of sub-structure concrete and water supply pipes.

Consideration of detailed flood risk, ecology and archaeological issues are outside of the scope of this report.

2.0 Phase 1 Preliminary Site Assessment Summary

This section presents a summary of the current site setting, history, geology and hydrogeology/hydrology, as presented in the Curtins Phase 1 report (Ref.1). It is not the intention of this report to duplicate the Phase 1, with the information below providing the background information to support the revised post Phase 2 siteworks Conceptual Site Model (CSM), as presented in *Section 8.0*.

2.1 Current Setting

The site is located off Granby Row in Manchester City Centre as illustrated in *Figure 2.1* below. The site is currently occupied by buildings of various uses including:

- A 14-storey residential block in the western portion, formerly known as Chandos Hall with soft landscaping and hardstanding in the centre. At the time of writing, demolition of this building remains ongoing,
- Echoes Day Nursery is in the northeast corner of the site,
- Garages in the southeast, accessed off Echo Street.

The site slopes from an elevation of approximately 41.00m AOD in the east, to approximately 38.43m AOD in the west, a retaining wall separates the higher eastern (nursery and garages) portion of the site from the lower western (residential) portion.

There are also large retaining walls on the north western and western boundaries of the site separating the western (residential) portion of the site from the higher surrounding land. The site is bounded to the north by Granby Row and Lambert House residential apartments, to the east by Echo Street and retail units, a railway line (viaduct) abuts the southern boundary of the site with Altrincham Street beyond, and to the west by a Vimto Park.

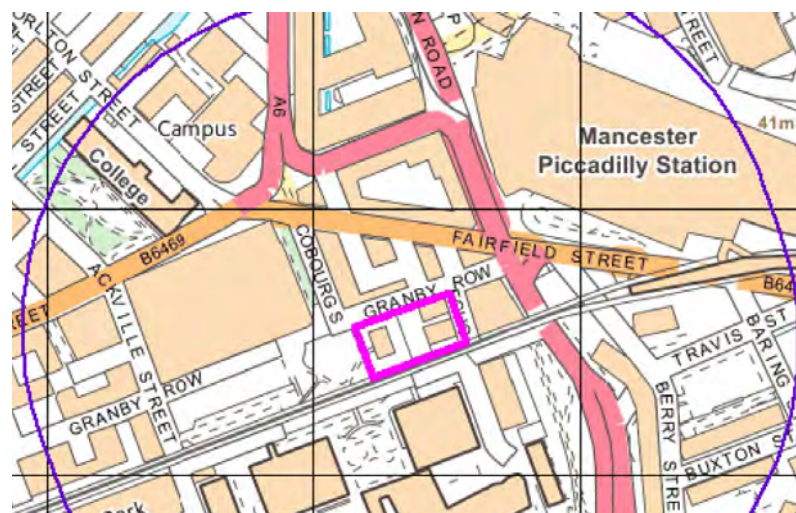


Figure 2.1 – Site Location Plan, site boundary shown in pink and 250m buffer in purple.
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2.2 Previous Site Use

A review of the available historical mapping information for the site, as presented within Curtins Phase 1 report (Ref.1), has been undertaken with specific reference to potential sources of contamination.

The earliest available historical mapping, in the late 19th Century, shows most of the site is occupied by industrial/commercial buildings (Printing Works, Battery Repairs and Window Cleaner). Surrounding the site is London Road Railway Station (100m northeast) and a Fire Engine Station (90m north). By mid to late 20th Century major demolition has occurred on the site and a depot/ garage with a 'sunk' petrol tank noted in the northeast, Chandos Hall in the west and garages in the southeast. During the 1990s to the present day the depot/garage was converted to a children's day nursery.

2.3 Published Geology

A study of the Envirocheck, British Geological Survey (BGS) borehole records and the BGS 1:50,000, (Sheet 85, Solid and Drift, 2011) for Manchester indicates the following likely geological ground conditions across the site:

- Made ground (Undivided) (Holocene)
- Superficial: Glacial Till (Devensian)
- Solid Geology: Chester Pebble Beds Formation (Early Triassic)

2.3.1 Made Ground Deposits

Following a review of the BGS borehole records, Made Ground up to 5.0m thick are anticipated to be present.

2.3.2 Superficial Deposits

Glacial Till, comprising clay and boulders suspended in a matrix of mud or sand, however soft Alluvial Deposits may be expected to be present underlying the site, associated with the adjacent River Medlock. According to local BGS borehole records, the superficial deposits are expected to depths of 5.00-6.50m bgl.

2.3.3 Bedrock Deposits

Bedrock deposits are present as Chester Pebble Beds Formation, predominantly comprising sandstone described as cross-stratified fine to coarse sandstone with conglomerates and sporadic siltstones. The shallow bedrock is expected to be highly weathered.

There are no known faults within a 100m radius outside the site boundary.

2.3.4 Mining and Quarrying

The Coal Authority interactive mapping shows that the site is located within a coal mining reporting area.

No coal outcrops and/or mine entries are recorded within a 1.0 km radius outside the site boundary. The site is not located within an area that has been influenced by past shallow coal mine workings. As such, the risk, to the development, from coal mine workings is low and has not been considered further.

There are no recorded mineral sites within 500m of the site.

2.3.5 Other Pertinent Geological Existing Geological Records

The Envirocheck report confirms that there is low to no hazard from the following ground stability hazards on the site:

- Collapsible and Compressible Ground,
- Dissolution,
- Landslide,
- Running Sand,
- Shrinking or Swelling Clay.

UK Radon Mapping confirms the site is situated in an area where <1% of homes are above the radon action level. Where the new development incorporates a basement the advice of a specialist Radon assessor must be obtained.

2.4 Hydrogeology and Hydrology

Environment Agency data indicates that the site, corresponding with the underlying bedrock geology, overlies a Principal Aquifer. Principal Aquifer is described as:

“Layers of rock or drift deposits that have high intergranular and/or fracture permeability meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, Principal Aquifers are aquifers previously designated as Major Aquifers. “

This is noted as being overlain by a superficial Secondary Undifferentiated Aquifer. Secondary Undifferentiated Aquifer is described as:

“Assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously

been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.”

There are nine groundwater abstraction points located within 1km of the site; the closest is 255m west for industrial/commercial/public service (non-evaporative cooling). The site is not situated within a Groundwater Source Protection Zone (SPZ).

The nearest surface water receptor is the culverted River Medlock, approximately 200m southeast of the site, flowing east to west. The site is not situated within an Environment Agency Designated Flood Risk Zone.

There are six discharge consents within 250m of the site; the closest is 164m northwest comprising public sewage: storm sewage overflow into a freshwater stream/river to Dukes Tunnel.

No pollution incidents have been recorded within 250m within the last 10 years and there are no surface water abstractions recorded within 250m of the site.

2.5 Landfill

No historical landfills, licensed waste management facilities or registered landfill sites recorded within 500m of the site.

2.6 Unexploded Ordnance (UXO) Risk Assessment

UXO risk mapping places Manchester City Centre in a Moderate risk area. Moderate risk regions are those that show a bomb density of 11 to 50 bombs per 1000 acres and that may contain potential WWII targets. Action to mitigate the risk is considered essential, albeit more likely that a reduced scope of work is required compared with that needed for high-risk regions.

Historical mapping shows a wharf 110m and 200m northwest of the site. A review of available Manchester Bomb Damage mapping was also undertaken indicating bombing ruins (red shading), several fire bombs (red circles), high explosives (blue circles) ruins and damaged buildings (dashed shading) in the immediate surroundings of the site.



Figure 2.6a Map of bomb damage in Manchester from WWII. Site boundary identified in red.

Subsequently, a Detailed UXO Report (Ref.3) was obtained, which is enclosed within *Appendix H*, the findings of which are detailed below:

- An area of clearance is noted in the northeast corner of the site. It is thought possible that this was because of a bomb strike/fire damage. If rubble and debris was present in this area, there is a risk that evidence of UXO could easily have been overlooked. UXBs falling into 'bomb sites' was one of the most common scenarios for this going unnoticed and unrecorded.
- The rest of the site appears to have survived the war intact.

Given that most of the site appears to have survived the war, shows no signs of damage and likely accessed frequently, this part of the site has been given a **Low** Risk. The area within the northeast of the site is shown as cleared on post-war aerial photography. Given the poor quality of the record set for Manchester, it has not proved possible to prove that this clearance was not due to bombing. Thus, this area, with a small buffer to account for the 'J-curve' effect, has been given a **Medium** Risk. The zoned risk areas are shown in *Figure 2.6b* below.



Figure 2.6b Zoned UXO Risk Map. Medium risk areas = orange. Low risk areas = green.

As such the following risk mitigation measures are recommended to support the proposed investigation works at the Chandos Hall site:

1. **All Works** – Site Specific Unexploded Ordnance Awareness Briefings to all personnel conducting intrusive works.
2. **Medium Risk Areas:**
 - a. *Open Intrusive Works (trial pits, service pits, open excavations, shallow foundations etc.)* – UXO Specialist On-site Support and Site Specific Unexploded Ordnance Awareness Briefings to all personnel conducting intrusive works.
 - b. *Boreholes and Piled Foundations* - Intrusive Magnetometer Survey of all borehole and pile locations/clusters down to maximum bomb penetration depth.

2.7 Summary of Phase 1 PCSM

A summary of potential pollutant linkages at the development site identified in the Phase 1 report (Ref.1) presented in *Table 2.7*, were identified as requiring further investigation to enable the safe redevelopment of the site.

Table 2.7 – Preliminary Conceptual Site Model

Source	Pathway	Receptor	Risk
Made Ground of unknown composition from uncontrolled deposition of historical construction/ demolition waste onsite. Potential contamination from historical site uses including battery cleaner and printing works. Potential fuel/oil spillages associated with depot/ garage and sunk petrol tanks historically onsite.	Direct contact/ ingestion and inhalation	Future site-users	Moderate/ Low
	Vertical migration through the superficial deposits (soils)	Principal Aquifer	Moderate/ Low
Production of ground generating gases from Made Ground deposits containing organic/ putrescible content from historical site use.	Vertical and horizontal migration through existing service corridors and the underlying superficial deposits	Future site-users	Moderate

Potential contaminants of concern associated with any Made Ground present include, amongst others; broad range aliphatic and aromatic hydrocarbons present within any fuel oils; semi-volatile and volatile organic contamination; polycyclic aromatic hydrocarbons (PAHs); inorganic compounds including heavy metals; and asbestos present in discarded building materials.

The qualitative risk assessment determined the above risks associated with the proposed development of the site warrant further investigation.

It was recommended that a ground investigation is conducted to both confirm this assessment and provide data in support of the structural and civil engineering design. The scope of the investigation undertaken is detailed in *Section 3.0*.

Risks to surface waters is Low considering the relatively large distance to the nearest receptor, and therefore do not warrant further investigation.

3.0 Phase 2 Investigation Scope of Works

The ground investigation was undertaken across numerous stages due to the phasing of demolition works on site.

Stages 1 & 5a were undertaken between 18th and 21st July 2017. Stage 2 was undertaken on 27th September 2017. Stage 3 was undertaken from 19th to 21st January 2018. Stage 4 was undertaken between 28th May and 4th June 2019 and Stage 5b was undertaken on 13th May 2019.

A summary of the scope and rationale is summarised in *Table 3.0*. The scope of the ground investigation was designed in general accordance with current UK guidance including:

- CLR11 (Ref.4);
- British Standard (BS) 10175 (Ref.5);
- BS5930:2015 (Ref.6); and
- BSEN1997: Part 2:2007 Eurocode 7 (Ref.7).

Table 3.0 – Scope and Rationale of Fieldwork Undertaken

Stage	Exploratory Hole Type	Exploratory Hole Ref.	Exploratory Hole Depth (m bgl)	Rationale
1 – Chandos Hall (western portion of site)	Cable Percussive Boreholes with Rotary follow-on	BH01 – BH02	19.00 – 20.00	Confirm ground conditions; Collect soil samples for chemical & geotechnical analysis; Undertake rock coring; Determine geotechnical parameters of the superficial soils and bedrock; and Undertake in-situ testing.
	Machine Excavated Trial Pits	TP01 – TP04	1.40 – 3.30	Confirm shallow ground conditions; and Determine the extent of retaining wall (northern and western boundaries) footings.
2 – Chandos Hall (additional works – western portion of site)	Window Sample Holes	WS01 – WS04 and WS02A	0.60 – 5.00	Confirm shallow ground conditions; Collect soil samples for chemical analysis; Install selected boreholes for gas monitoring; and Undertake in-situ testing.
	Hand Dug Trial Pits with Hand-Held Window Sample follow-on	FP101	1.35	Confirm shallow ground conditions; and Determine the extent of service corridor & retaining wall (northern boundary) footings.

Stage	Exploratory Hole Type	Exploratory Hole Ref.	Exploratory Hole Depth (m bgl)	Rationale
3 – Garages and Nursery Pre-Demolition Investigation (part of the southeast and central portions)	Cable Percussive Boreholes with Rotary follow-on	BH03	25.50	Confirm ground conditions; Collect soil samples for chemical & geotechnical analysis; Undertake rock coring; Determine geotechnical parameters of the superficial soils and bedrock; Undertake in-situ testing; and Install for gas monitoring and groundwater sampling.
	Window Sample Holes	WS08 – WS11	3.00 – 5.00	Confirm shallow ground conditions; Collect soil samples for chemical analysis; Undertake in-situ testing; and Install selected boreholes for gas monitoring.
	Hand-Held Window Sample Holes	WS05 – WS06	2.90 – 3.00	Confirm shallow ground conditions; Collect soil samples for chemical analysis; and Install selected boreholes for gas monitoring.
	Micro-Rotary (open) Boreholes	RH01 – RH03	7.00 – 13.00	Confirm ground conditions; and Determine the depth of the bedrock.
4 – Investigation Post-Demolition of Nursery and Garages (east and north east and north of site)	Cable Percussive Boreholes with Rotary follow-on	BH401- BH403*	21.00 -23.00	Confirm ground conditions; Collect soil samples for chemical & geotechnical analysis; Undertake rock coring; Determine geotechnical parameters of the superficial soils and bedrock; Undertake in-situ testing; and Install for groundwater sampling and monitoring.
	Window Sample Holes	WS401- WS404	4.23 - 5.37	Confirm shallow ground conditions; Collect soil samples for chemical analysis; Undertake in-situ testing;
5A/B – Railway Viaduct Inspection (southern boundary of site)	Hand Dug Trial Pits (A)	HP01 – HP04	0.35 – 2.10	Confirm shallow ground conditions; and Determine the extent of railway viaduct footings.
	Machine Excavated Trial Pits (B)	TP101-TP103	2.60-3.65	Confirm shallow ground conditions; and Determine the extent of railway viaduct footings, undertaken subsequent to hand dug trial pits to gain extra depth.

* BH402 encountered a shallow obstruction, therefore it was relocated to position BH402A where again a shallow obstruction was identified. Therefore, it was moved to BH402B which was advanced to full required depth and extended by rotary coring.

For information about location of the exploratory holes, refer to Curtins drawings ref. 065374-CUR-00-XX-DR-GE-005-V03, *Appendix A*. Exploratory hole logs can be found in *Appendix B*.

Due to restrictions caused by presence of building, only some of the exploratory holes were surveyed. The elevation and coordinates of the remaining exploratory holes have been estimated from a topographic survey where possible.

3.1 Soil Logging and Sampling

Exploratory hole arisings were logged on site by a qualified Engineer. All exploratory holes were logged in accordance with the requirements of BS5930 (Ref.6). The observed visual and olfactory indications of contamination were recorded. Exploratory hole logs are provided in *Appendix B*.

3.2 Monitoring Well Installations

50mm diameter ground gas and groundwater monitoring slotted standpipes were installed within eight of the window sample boreholes and four cable percussive/rotary boreholes. A bentonite seal was placed above and below the screened section of the borehole to minimise potential for downward migration of contaminants and the creation of a preferential migratory pathway. A gravel surround was installed in the annulus between the sides of the borehole and the slotted sections of pipe.

The monitoring wells within window samples boreholes were primarily placed to assess the potential for ground gas and strata likely to have the highest permeability. As such the screened section focussed on Made Ground, where sufficient depth was encountered, or the underlying natural strata.

The monitoring wells within the cable percussive/rotary boreholes were installed for the purposes groundwater monitoring and sampling. Therefore, the strata where groundwater strikes were recorded were targeted.

A summary of the response zones is presented in *Table 3.2* below.

Table 3.2 – Monitoring Well Response Zones

Borehole Ref.	Response Zone(s) (m bgl)	Strata Description(s) (Principal strata in capitals)
WS01	1.00 – 3.00	MADE GROUND
WS02A	1.00 – 3.80	CLAY and Sand
WS03	1.00 – 3.00	CLAY and Sand
WS07	1.50 – 2.50	CLAY and Sand
WS08	1.00 – 2.50	MADE GROUND and Clay

Borehole Ref.	Response Zone(s) (m bgl)	Strata Description(s) (Principal strata in capitals)
WS09	2.50 – 3.50	CLAY and Sand
WS10	1.00 – 1.50	MADE GROUND and Clay
WS11	1.50 – 2.20	CLAY and Gravel
BH03	8.00 – 15.00	SAND and Sandstone
BH401	5.00 – 10.00	SAND and sandstone
BH402B	5.00 – 18.00	SANDSTONE
BH403	12.00 – 21.00	SANDTONE

Copies of borehole logs can be referred to in *Appendix B* of this report.

3.3 Post-Investigation Monitoring

3.3.1 Ground Gas Monitoring

An initial programme of six gas monitoring visits over three months was proposed to assess ground gas conditions as identified in the Preliminary Conceptual Site Model in the Phase 1 Preliminary Site Assessment (Ref.1). The scheduled six visits were undertaken between 26th January and 3rd April 2018.

3.3.2 Groundwater Monitoring & Sampling

Groundwater level monitoring was proposed to assess the groundwater conditions of the site.

Monitoring was undertaken during ground gas monitoring visits, between 26th January and 3rd April 2018 for the window sample boreholes and BH03.

Following the Stage 4 investigation, BH401, BH402B and BH403, were monitored on two occasions on 21st and 26th June 2019. Groundwater samples were obtained from BH401, BH402B and BH403 on 26th June 2019.

4.0 Laboratory Analysis

Representative soil samples were selected for laboratory chemical analysis, based on field observations and to provide a characterisation of the Made Ground and natural strata encountered. Selected soil and groundwater samples were placed in laboratory provided containers and stored in cool boxes prior to being transported to the nominated laboratory under the laboratory's chain of custody documentation.

The laboratories selected by Curtins for chemical analysis was Concept Life Sciences Laboratories and Envirolab (UKAS and MCERTS accredited) and for geotechnical analysis was i2 Analytical (UKAS accredited), Professional Soils Laboratory (UKAS accredited) and Derwentside Environmental Testing Services Ltd (UKAS accredited).

Given the potential site-wide source of contamination (Made Ground) the sampling positions (boreholes) were generally located in a targeted, systematic array to give adequate and representative coverage of the site accounting for the historical site use, proposed end-use and the immediate environmental setting.

4.1 Soil Analysis

The contaminants of concern potentially present on the site was considered to include, amongst others; organic matter, ash and fill, hydrocarbons (e.g. fuel/oils), heavy metals and asbestos the extent of which is captured by the broad environmental testing suite listed in *Table 4.1* below.

Table 4.1 – Environmental Chemistry Analysis Suite: Soils

Suite Ref.	Analyte	LOD
Soils Suite A	Asbestos Screen, pH and Soil Organic Matter (SOM)	-
	Arsenic, Chromium, Chromium VI, Copper, Lead, Selenium, Zinc, Nickel	5 mg/kg
	Boron (water soluble)	1 mg/kg
	Cadmium	0.5 mg/kg
	Mercury	0.1 mg/kg
	Cyanide (total)	10 mg/kg
	Phenols (screen)	1 mg/kg
	PAHs (USEPA 16)	0.1 mg/kg
	TPH (Aro/Alk Split)	0.01 to 0.1 mg/kg

A total of thirty-one soil samples were taken in total from the exploratory hole locations across the site and tested for Suite A. These comprised twenty-nine Made Ground soil samples and two natural soil samples.

Copies of the environmental chemistry testing certificates are presented in *Appendix C*.

4.2 Groundwater Analysis

Groundwater analysis has been undertaken on samples obtained from borehole BH401, BH402B & BH403. These boreholes were selected for sampling to the potential sources of contamination noted within these areas, as identified within the Phase 1 report (Ref.1).

The contaminants of concern potentially present on the site was considered to include, amongst others; organic matter, ash and fill, hydrocarbons (e.g. fuel/oils) and heavy metals the extent of which is captured by the broad environmental testing suite listed in *Table 4.2* below.

Table 4.2 - Environmental Chemistry Analysis Suite: Waters

Suite Ref.	Analyte	LOD
Water Suite A	pH	-
	Total Hardness	2 mg/l
	Arsenic, Lead, Nickel, Selenium, Zinc	1 µg/l
	Boron (water soluble), Chromium, Copper, Mercury, Phenols (screen)	0.01 - 10 µg/l
	Cadmium	0.2 µg/l
	Cyanide, Sulphide	0.005 – 0.1 mg/l
	Sulphate	1 mg/l
	PAHs (USEPA16)	0.01 µg/l
	TPH (Aro/Alk Split)	1 – 5 µg/l

Copies of the environmental chemistry testing certificates are presented in *Appendix C*

4.3 Quality Assurance and Quality Control

Soil chemical analysis was conducted by Concept Life Sciences Laboratories, Derwentside Environmental Testing Services Ltd and Envirolab for various samples. Groundwater samples were tested by Envirolab. All samples were delivered in appropriate containers for the suites tested. Concept Life Sciences and Envirolab did not record any deviating samples.

Derwentside Environmental Testing Services Ltd recorded that holding times were exceeded for tests (sulphate aqueous extract as SO₄). As results appear consistent between laboratories, and no significant sources of sulphate have been identified on site it is considered that these results are acceptable and do not affect the validity of these results.

4.4 Geotechnical Analysis

Soil samples for testing were prepared in accordance with BS1377: Part 1:2016 (Ref.8) and representative sub-samples were taken for testing. The following tests were carried out:

- 12 No. Moisture content;
- 8 No. Atterberg Limits;
- 5 No. Particle Size Distribution by wet sieve;
- 48 No. Water soluble sulphate; and
- 48 No pH value.

Rock samples for geotechnical testing were prepared and tested in accordance with ISRM Suggested Methods (Ref.9). The following tests were carried out:

- 48 No. Point Load Index Test (PLT); and
- 12 No. Uniaxial Compressive Strength (UCS).

Copies of the geotechnical testing certificates are presented in *Appendix D*.

5.0 Encountered Ground Conditions

5.1 General

A summary of the ground conditions encountered during the site investigation works is presented below, with detailed information presented in the exploratory hole logs included in *Appendix B* and a summary of each strata presented in subsequent sections.

Table 5.1 – Summary of Ground Conditions Encountered

Stratum	Depth to top of strata, m bgl (mAOD)	Thickness (m)		Description
		Min	Max	
MADE GROUND	0.00 (38.35 – 41.00)	0.30	3.80	Asphalt, concrete or grass and TOPSOIL, <i>overlying</i> sand and gravel and GRAVEL (ash & brick fill), <i>overlying</i> Very gravelly, very sandy, clay and very gravelly fine to coarse sand. Anthropogenic constituents include asphalt, coal, aggregate, glass, concrete, ash, tile, clinker, bitumen and brick.
SUPERFICIAL DEPOSITS	0.30 – 3.80 (34.55 – 39.70)	0.40	6.30	Slightly sandy slightly gravelly CLAY interbedded with localised sand and gravel.
WEATHERED BEDROCK	2.90 – 6.50 (33.20 – 35.95)	4.20	8.60	Very dense light brown, light reddish brown and orangish brown slightly gravelly fine to coarse SAND. Gravel is fine to coarse subangular to rounded sandstone, mudstone quartzite and granite.
BEDROCK (Chester Pebble Beds Formation)	7.50 – 13.50 (26.60 – 30.96)	3.50*	>20.00*	Extremely weak to weak, reddish-brown, medium grained SANDSTONE.

* Base of deposit not proven

5.2 Made Ground

Made Ground was encountered from ground level to a maximum depth of 3.80m bgl in WS01. It generally comprised asphalt, concrete or grass overlying sand and gravel of brick and ash fill, underlain by clayey made ground. An initial layer of asphalt was encountered across most of the site, with concrete in the east and grass within the centre-north, associated with the former school playground.

Sub-base was encountered between 0.05m and 1.70m bgl underlying the asphalt and concrete, generally described as dark grey to light brown, cobbly, sandy, angular to sub-angular, fine to coarse gravel of aggregate, asphalt and concrete. Cobbles are fine, angular to sub-angular of asphalt and concrete. Directly underlying the grass where encountered, between ground level and 0.20 to 0.30m bgl Made Ground of dark brown, sandy, gravelly clay with frequent rootlets was recorded. Gravel is angular to sub-rounded, fine to medium of tile, brick, concrete, sandstone and coal.

Further granular Made Ground (brick and ash fill) was encountered (within WS01 – WS10, WS02A, TP03, FP101, BH03 and RH02) between 0.05m and 1.40m bgl, comprising yellowish-brown, dark brown and dark grey to black, very gravelly, fine to coarse sand and gravel with low to medium cobble content. Gravel and cobbles are angular to sub-angular of asphalt, coal, aggregate, glass, concrete, ash, tile, clinker, bitumen, brick and other various lithologies including sandstone.

Cohesive Made Ground was encountered (within WS01, WS05, WS07 – WS11, FP101, BH03, RH01 and RH03) between 0.15m and 3.80m bgl, comprising very soft to firm, grey and brown, sandy, gravelly Clay. Gravel is angular to sub-rounded, fine to medium of various lithologies including concrete, tile, metal, asphalt, ash, coal, brick and clinker.

Adjacent to the viaduct, Made Ground soils were recorded to maximum depths of between 1.90m and 3.65m bgl. The base of the Made Ground was not encountered in TP101 at 3.65m bgl. Deposits were consistent with those described previously, where dark brown granular soils are underlain by light and dark brown, with grey mottling, sandy gravelly clay, with exception of TP102 where no cohesive soils were recorded. Boulders of concrete and metal sheeting were also reported in TP102. Timber pieces, exhibiting a hydrocarbon odour, were encountered in TP103 between 0.30m and 1.90m bgl.

A thin vertical layer of Made Ground soils lined the northern edge of the viaduct, separating natural soils from the wall.

The geotechnical test results recorded within the Made Ground are summarised in *Table 5.2*. Full details of the geotechnical results recorded are presented on the exploratory hole logs in *Appendix B*. The test result certificates are included in *Appendix D*.

Table 5.2 – Summary of geotechnical test results – Made Ground

Parameter	No. of tests	Minimum	Maximum	Average
pH	21	7.5	11.4	8.4
Water Soluble Sulphate (mg/l)	21	<10	1000	80
SPT 'N' Value	5	3	13	7

5.3 Superficial Deposits

The superficial stratum comprised Glacial Till from 0.30m to 5.90m bgl (0.40m to 6.50m thick). Deposits comprised firm to very stiff, dark greyish-brown with grey mottling, gravelly, sandy Clay with rare silt lenses containing relic rootlets and rare rounded cobbles of limestone and sandstone. Gravel is fine to coarse, sub-angular to rounded of mixed lithologies including coal, sandstone, mudstone and limestone. Thin sand bands were locally recorded within the generally cohesive soils.

The geotechnical test results recorded within the superficial deposits are summarised in *Table 5.3a* and *Table 5.3b*. Full details of the geotechnical results recorded are presented on the exploratory hole logs in *Appendix B*. The test result certificates are summarised in *Appendix D*.

Table 5.3a – Summary of geotechnical test results – superficial deposits

Parameter	No. of tests	Minimum	Maximum	Average
Moisture Content (%)	12	13	17	14.9
Liquid Limit (%)	8	31	43	37.4
Plastic Limit (%)	8	15	20	17.4
Plasticity Index (%)	8	16	24	20
Modified Plasticity Index (%) ⁽¹⁾	8	15.2	22.08	18.5
pH	12	8	9.5	8.55
Water Soluble Sulphate (mg/l)	12	23	180	88
Uncorrected SPT 'N' Value (full penetration)				
Cohesive	55	2	>50	26
Granular	2	8	16	12
Undrained Shear Strength of Cohesive Soils, Cu (kPa) ⁽²⁾				
Shear Strength at 40kPa confining pressure:	1		104	
Shear Strength at 80kPa confining pressure:			119	
Shear Strength at 160kPa confining pressure:			128	
Linear Regression			85	

(1) Modified plasticity index is the plasticity of components <425µm.

(2) Cu Obtained from laboratory Unconfined Triaxial Compression Test Results

Table 5.3b – Summary of estimated parameters – superficial deposits

Parameter	No. of tests	Minimum	Maximum	Average
Estimated Undrained Shear Strength of Cohesive Soils, Cu (kPa) ⁽¹⁾	55	11	>275	143
Estimated Coefficient of Volume Compressibility of Cohesive Soils, mv (m ² /MN) ⁽²⁾	55	0.037	0.90	0.07
Estimated Effective Angle of Shearing Resistance of Granular Soils, ϕ (°) ⁽³⁾	5	28 - 36		
Unit Weight, γ (kN/m ³) ⁽⁴⁾	-	20		

(1) Cu estimated from SPT N value correlation with average Plasticity Index using a Factor of 5.5 (Stroud and Butler, 1975).

(2) mv estimated from SPT N value correlation with average Plasticity Index using a factor of 0.55 (Stroud and Butler, 1975).

(3) Estimated from the relationship between typical SPT 'N' Value and angle of shearing resistance in granular soils (Peck et al, 1967).

(4) From published sources (BS8002).

Fifty-five, uncorrected, SPT 'N' Values were recorded in the clay, ranging from 2 to >50, which generally increased with depth. The results indicate that cohesive soils are firm to very stiff, with localised pockets of soft and very soft clay. Atterberg test results indicate low to intermediate plasticity with low to medium volume change potential clay.

Undrained shear strength is estimated from SPT 'N' values, where full penetration was achieved. Based on published empirical relationships (Stroud and Butler, 1975), a factor of 5.5 for a clay with a PI of 20% was chosen, resulting in estimated C_u values ranging between 11kPa and >275kPa. The range of C_u values indicate medium to very high strength clay soils (typically high strength). The presence of rare cobbles within the glacial till deposits were noted which could result in higher SPT 'N' values being recorded.

One Multi Stage Undrained Triaxial Compression Test was undertaken on a sample from BH402B at 4m bgl. The test recorded shear strengths ranging between 104kPa – 128kPa, which is consistent with the estimated Undrained Shear Strength derived from SPT 'N' Values which indicated medium to very high strength clay.

Two SPT 'N' Values were recorded in granular soils in BH403, with values of 8 and 16, indicating loose to medium dense soils.

SPT 'N' Values in cohesive superficial soils generally increase with depth, though are generally variable, illustrated in *Figure 5.3*.

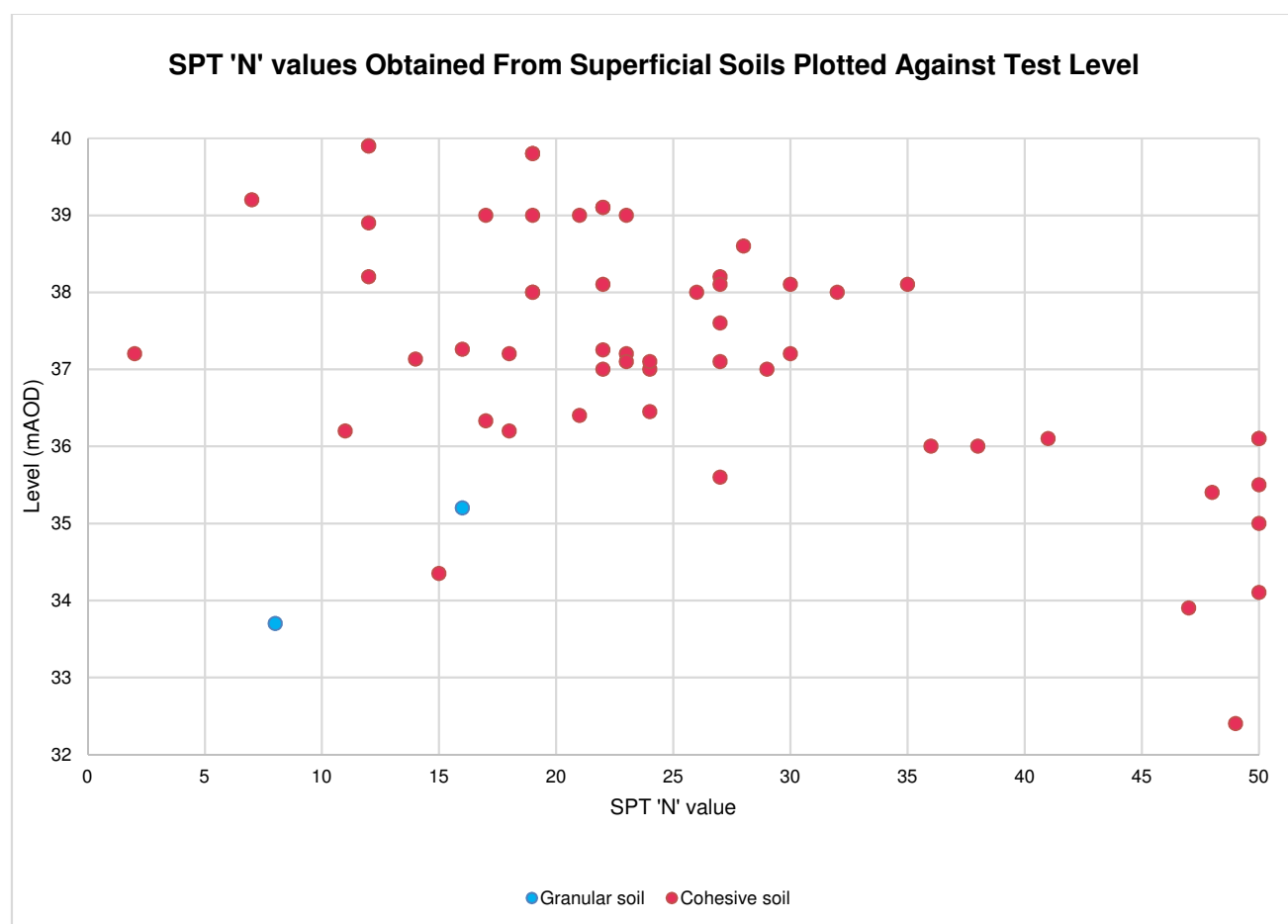


Figure 5.3 – SPT 'N' Values vs Depth (values of >50 were recorded as 50).

It should be noted that, as the SPT data is uncorrected, there may be some variation between the SPTs undertaken in the window sample boreholes compared to those undertaken in the cable percussive boreholes due to the different equipment used. Therefore, the characteristic 'N' values could equate to the lowest values recorded in each stratum; a characteristic SPT 'N' of 11 could be adopted for the cohesive and 26 for the granular superficial deposits, respectively. A review of N_{60} values confirm the lowest N values of 11 and 26 respectively, discounting locally soft deposits.

SPT 'N' values can be used to interpret the effective angle of shearing resistance (ϕ'), using the relationship established by Peck et al (1967) for granular soils. A characteristic N value of 20 correlates to a ϕ' of 32° .

With reference to BS8002:2015 (Ref.10), the characteristic ϕ' of approximately 25° is estimated for a soil with 20% plasticity index and C' should be taken as 0. This is confirmed by Gibson (Ref.11), for a plasticity index of 20%, a peak shear angle ϕ'_p of approximately 27° can be determined for cohesive Glacial Till.

No bulk densities were obtained for the superficial deposits, however, upon assessing the stratum description, along with correlations made within BS8002:2015, the recommended bulk unit weight can be taken as 20kN/m^3 for both the granular and cohesive soils.

5.4 Weathered Bedrock

Weathered bedrock was recorded in the deeper cable percussive boreholes, and WS01, WS02A, WS03, WS402 and WS404, from depths of 2.90m to 6.50m bgl (34.15m to 35.95m AOD). The weathered bedrock was predominantly recovered as dense to very dense light brown, light reddish brown and orangish brown slightly gravelly fine to coarse SAND. Gravels are fine to coarse subangular to rounded sandstone, mudstone, quartzite and granite. BH01 recorded a band (0.90m) of stiff dark brown gravelly clay at 5.80m bgl. A particle size distribution (PSD) test was undertaken on this material which recorded it as a very sandy, slightly silty gravel with cobbles. BH02 recorded very dense gravels of sandstone and mudstone from circa 34m AOD. Four other PSD tests were undertaken within the weathered deposits, indicating deposits comprise generally clayey gravelly sand.

Weathered bedrock directly overlies competent bedrock, to depths of between 7.50m and 13.50m bgl (26.60 and 30.96m bgl). The weathered bedrock thickness ranges between 4.20m and 8.60m.

Twenty-two SPT 'N' Values were recorded in the weathered bedrock. The results ranged between 26 and >50 , indicating the soils are generally dense to very dense, locally medium dense.

SPT 'N' values can be used to interpret the effective angle of shearing resistance (ϕ'), using the relationship established by Peck et al (1967) for granular soils. A characteristic N value of 48 correlates to a ϕ' of 38° .

The geotechnical testing results within the weathered bedrock deposits are summarised in *Table 5.4a* and *Table 5.4b*.

Table 5.4a – Summary of geotechnical test results – Weathered Bedrock deposits

Parameter	No. of tests	Minimum	Maximum	Average
pH	7	7.6	8.8	8.4
Water Soluble Sulphate (mg/l)	7	14	73	36
PSD (%)	5			
Cobbles		0	5	1
Gravel		0	58	17
Sand		34	88	66
Silt/Clay		3	25.6	16
Uncorrected SPT 'N' Value	22	26	>50	48

Table 5.4b – Summary of estimated parameters – Weathered bedrock deposits

Parameter	No. Of Tests	Value
Estimated Effective Angle of Shearing Resistance, ϕ (°) (1)	22	38
Unit Weight, γ (kN/m ³) (2)	-	20

(1) Estimated from the relationship between typical SPT 'N' Value and angle of shearing resistance (Peck et al, 1967)

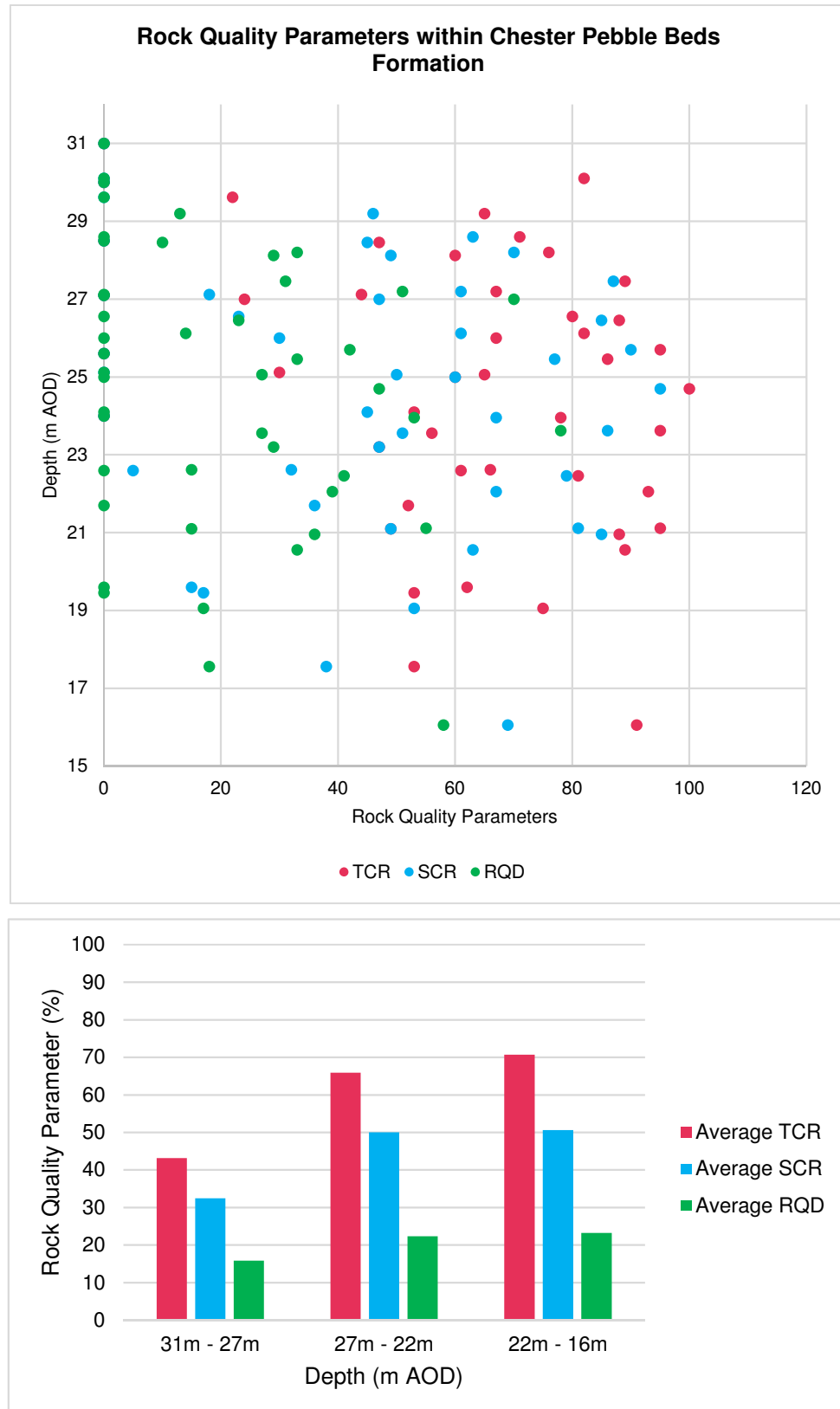
(2) From published sources (BS8002).

5.5 Bedrock Deposits

Competent Sandstone bedrock (Chester Pebble Beds Formation) was encountered within BH01 to BH03 and BH401 to BH403 from depths of 7.50m to 13.50m bgl (26.60m to 30.96m AOD).

The bedrock was recorded as extremely weak to weak, reddish-brown, medium grained, arenaceous Sandstone with occasional inter-bedded medium quartz gravel/clasts. Generally fresh, with extremely closely to closely spaced planar and undulating sub-horizontal to 45° fractures, with clayey and silty sand infill. The rock is highly weathered in places, recovered as non-intact deposits comprising slightly clayey silty medium sand.

Rock Quality Designation (RQD) recorded in the cored samples ranged from 0% to 78%, averaging 19% across all of the rock core samples. This classifies the rock as being of very poor to poor rock mass quality. The RQD varies significantly between core runs. The total core recovery (TCR) ranged between 0% - 100% and the solid core recovery (SCR) ranged between 0% - 95%. The variability in the quality of the rock core samples recovered during this investigation is illustrated in *Figure 5.5a*.

**Figure 5.5a** – Summary of Rock Quality Parameters within Sandstone bedrock

The base of the sandstone was not proven during this investigation. The boreholes were terminated at a maximum depth of 25.50m bgl (BH03).

A summary of the geotechnical test results levels recorded within the bedrock are presented in *Table 5.5a* and *Table 5.5b*. Full details of the geotechnical results recorded are presented on the exploratory hole logs in *Appendix B* and test result certificates in *Appendix D*.

Table 5.5a – Summary of geotechnical test results – bedrock

Parameter		No. of tests	Minimum	Maximum	Average
pH		1	9		
Water Soluble Sulphate (mg/l)		1	10		
Point Load Strength Test, $I_{s(50)}$ (MPa)	Diametral	22	0.01	0.26	0.08
	Axial	26	0.03	0.42	0.13
Unconfined Compressive Strength (MPa)		12	2.6	11.3	5.76
Moisture Content		12	8.4	14.5	11.4
Bulk Density (Mg/m ³)		12	1.90	2.22	2.08

Table 5.5b – Summary of estimated parameters – bedrock

Parameter		No. of tests	Minimum	Maximum	Average
Estimated Unconfined Compressive Strength (MPa) ⁽¹⁾	Diametral	22	0.27	6.94	2.14
	Axial	26	0.80	11.21	3.47

(1) Derived from correlation between PLT $I_{s(50)}$ and UCS testing results using a factor of 26.7.

Overall forty-eight Point Load Tests (PLT) were carried out on samples of sandstone bedrock from rotary cores. PLT $I_{s(50)}$ values in the range 0.01 MPa to 0.42 MPa were obtained. When comparing the rock strength in different orientations the bedrock is weaker diametrically (average 0.08MPa) compared to axially (average 0.13MPa).

An approximation of the unconfined compressive strength (UCS) is derived from the relationship $PLT I_{s(50)} \times 26.7 = UCS$. On this basis UCS values with an overall range from 0.27 MPa to 11.21 MPa have been derived; these values indicate extremely weak to very weak rock.

UCS testing on twelve rock samples recorded values of 2.6 to 11.3MPa indicating a very weak to weak sandstone.

The point load indices indicate that the characteristic compressive strength estimated from point load tests is lower than those derived from direct UCS testing. This is conjectured to be due to preferential selection of samples for the UCS testing which, given their more intact nature, are inherently stronger than those selected for point load tests. It must be noted that a review of the results indicates that the

strength of the rock, derived from PLT Is(50) results, is laterally variable. As such it is advised that a location by location assessment of the rock strength is undertaken for the purposes of design.

The combined dataset is interpreted to provide a reasonable characterisation of the range of rock strength within the boreholes; some variation beyond these limits should be anticipated.

Figure 5.5b, summarises the UCS, estimated axial UCS and estimated diametral UCS test results against depth.

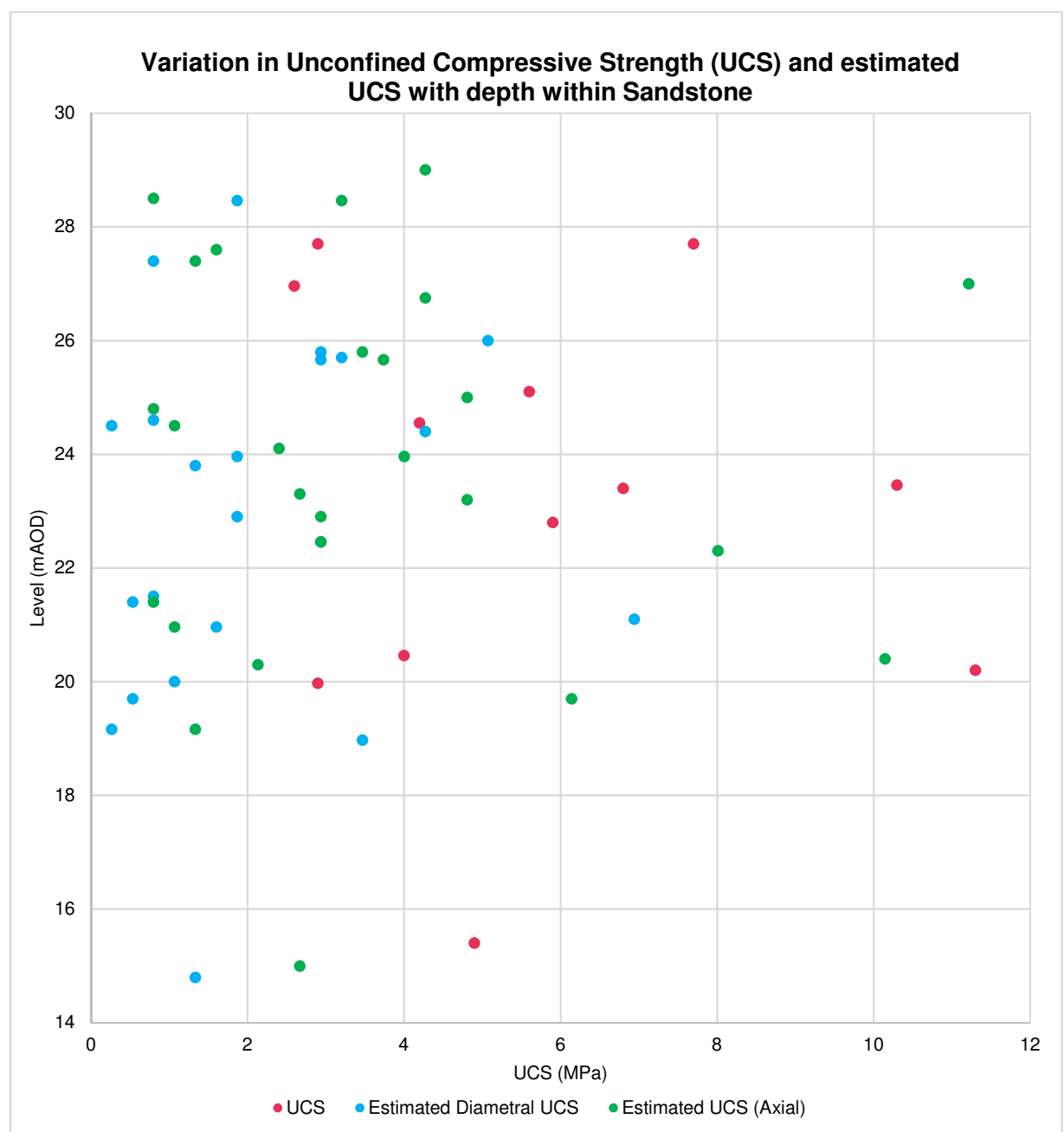


Figure 5.5b – UCS and estimated UCS vs Depth within Sandstone.

5.6 Existing Retaining Walls Foundation Inspection

The concrete retaining wall foundations, along the western boundary of the site, were located in TP01, TP02, & TP03, at similar depths with similar geometries. The top of the foundation was identified at 0.30 to 0.35m bgl with an approximate 0.55m toe length. The depth of the foundation was not identified but it was exposed to 0.40m bgl in TP03. It is anticipated likely that the foundations are founded on stiff clay.

The retaining wall foundations were not identified along the northern boundary of the site in TP04 and FP101. Instead excavations encountered a concrete service tunnel. The top of the service tunnel was identified at 0.25m to 0.30m bgl with a projection from the wall of 1.05m bgl, and a presumed thickness of 1.05m bgl. Further excavations in this area could not be undertaken due to service constraints.

A sketch ref. 064987-CUR-00-XX-DR-GE-004-V01, showing the recorded and estimated potential retaining wall foundation and service tunnel geometries along the northern boundary is provided in *Appendix A*. These cross-section sketches should be read in conjunction with Curtins Trial Pits Logs within *Appendix B*.

5.7 Observed Potential Contamination

Soils which exhibited potential contamination were noted during the siteworks and are detailed in *Table 5.7* as follows:

Table 5.7 – Observed Potential Contamination during Siteworks

Borehole Ref.	Observed Contamination	Depth (m bgl)
WS02	Slight hydrocarbon odour (potentially associated with ashy strata)	0.10 – 0.30
WS03	Slight hydrocarbon odour (potentially associated with ashy strata)	0.15 – 0.40
WS11	Black staining (no odour)	0.50 – 1.20
BH03	Slight odour (potentially associated with ashy strata)	0.05 – 1.20
WS403	Hydrocarbon odour	5.00 – 5.45

5.8 Obstructions Encountered

Obstructions encountered during the siteworks are detailed in *Table 5.8* below.

Table 5.8 – Obstructions Encountered During Siteworks

Borehole Ref.	Obstruction	Outcome	Depth (m bgl)
WS02	Suspected concrete	Borehole moved – WS02A	0.60
WS05	Suspected cobble	Borehole terminated	2.90

Borehole Ref.	Obstruction	Outcome	Depth (m bgl)
WS07	Suspected cobble	Borehole terminated	3.00
WS09	Suspected cobble	Borehole terminated	4.70
FP101	Unknown	Foundation pit terminated	1.35
BH402	Possible live service	Borehole moved – BH402A	0.94
BH402A	Concrete obstruction	Borehole moved – BH402B	0.85

5.9 Groundwater

No groundwater strikes were recorded during siteworks. Water seepages were however encountered within several exploratory holes, likely as perched water within made ground and cohesive soils. Groundwater seepages encountered are recorded in *Table 5.9a*.

Table 5.9a – Summary of groundwater encountered during the investigation works.

Borehole Ref.	Depth (m bgl)	Strata	Description
WS01	1.40 – 1.70	MADE GROUND	Perched water seepage
WS03	0.70	CLAY	Perched water seepage
WS06	1.60	MADE GROUND	Perched water seepage
WS08	1.20	MADE GROUND	Perched water seepage
WS09	1.20	CLAY	Perched water seepage
FP101	1.35	MADE GROUND	Perched water seepage
TP102	1.80	MADE GROUND	Perched water seepage
BH401	3.30	CLAY	Perched water seepage
WS401	0.80	CLAY	Perched water seepage

No significant groundwater strike was noted within the rotary boreholes. It must be noted that water flush added during drilling may have masked the likely strikes.

A summary of the groundwater levels recorded during subsequent monitoring is presented in *Table 5.9b*. Full details of the water strikes recorded during progression of the investigation positions are presented on the exploratory hole logs included in *Appendix B* and full details of the water levels recorded during the monitoring visits are presented in *Appendix E*.

Table 5.9b – Groundwater Noted During Post Investigation Groundwater Level Monitoring

Borehole Ref.	Monitored Water Levels		
	Installation Strata	Depth (m bgl)	Depth (mAOD)
WS01	MADE GROUND	3.00	35.35
WS02A	CLAY and Sand	DRY (>3.90)	DRY (<34.50)
WS03	CLAY and Sand	2.33 – 3.00	35.45 – 36.12
WS07	CLAY and Sand	1.10 – 1.21	38.99 – 39.10
WS08	MADE GROUND and Clay	1.81 – 1.85	38.15 – 38.19
WS09	CLAY and Sand	0.40 – 0.60	36.60 – 39.80
WS10	MADE GROUND and Clay	1.00 – 1.17	39.83 – 40.00
WS11	CLAY and Gravel	DRY (>2.15)	DRY (<38.75)
BH03	SAND and Sandstone	DRY (>10.30)	DRY (<29.80)
BH401	SAND (Weathered bedrock) and Sandstone	7.40 – 7.42	32.68 – 32.70
BH402B	SAND (Weathered bedrock) and Sandstone	12.58 – 15.55	28.42 – 28.45
BH403	SAND (Weathered bedrock) and Sandstone	12.59 – 12.77	28.43 – 28.61

Within the window samples holes, perched water was encountered at 0.40m to >3.90m bgl. Within BH03 the groundwater is greater than 10.30m bgl depth.

5.10 Aggressive Ground Conditions

The classification of the site in terms of concrete in aggressive ground is based on the guidance provided in Table C2 of the Building Research Establishment (BRE) Special Digest 1, 3rd edition of 2005 (Ref.13). A summary of the results obtained during this investigation are summarised in *Table 5.10a* and *Table 5.10b* details the classification for each stratum.

Table 5.10a – Aggressive Chemical Environment for Concrete (ACEC) Site Classification

Stratum	Test Type	Range
Made Ground	pH	7.5 – 11.4
	Water Soluble Sulphate (mg/l)	<10 – 2060
Superficial Deposits	pH	8 – 9.5
	Water Soluble Sulphate (mg/l)	23 – 180
Bedrock	pH	7.6 – 8.8
	Water Soluble Sulphate (mg/l)	14 – 73

Table 5.10b – Aggressive Chemical Environment for Concrete (ACEC) Site Classification

Stratum	Design Sulphate Class	ACEC Class ⁽¹⁾
Made Ground	DS-3	AC-3
Superficial Deposits	DS-1	AC-1
Bedrock	DS-1	AC-1

(1) ACEC assessment was based on a mobile groundwater condition scheme in a *brownfield* scheme area.

6.0 Ground and Groundwater Contamination Assessment

This section of the report includes the assessment of the potential contamination, solid, liquid and gas, identified on the subject site which may present a risk to the proposed end-users, associated utilities and the wider environment.

In guidance published by the Environment Agency, the risk to human health or controlled waters is determined through an assessment of pollutant linkages between a source of contamination (within the ground or groundwater either on or off site) and a sensitive receptor such as end-users of the site, building materials, edible plants grown in gardens or groundwater abstracted for drinking. This is termed a source-pathway-receptor relationship. The same model is applied to the assessment of risk arising from ground gases as detailed within BS8576:2013 (Ref.14).

These models have a common approach, which is one of a tiered assessment. At each stage of the assessment further detail can be applied to the conceptual site model to provide a detailed interpretation on a site by site basis. As part of the planning process this approach is adopted to establish either if the site is 'suitable for use' or whether additional work or else remedial work is required for the site to be deemed so.

The sub-sections hereafter therefore incorporate the first tier (Tier 1) of this approach otherwise referred to as the Generic Quantitative Risk Assessment (GQRA). The GQRA builds on the qualitative risk assessment presented in the Phase 1 Desk Study in conjunction with observations made during the ground investigation and is based solely on the results of the chemical and other testing data obtained as part of Curtins ground investigation. The GQRA is used to build/refine the Conceptual Site Model (CSM) for the site as detailed and presented in *Section 8.0* of this report.

The following sections present more detail on the risk assessment methodology rationale for the main receptors.

6.1 Human Health GQRA

Detailed guidance on human health risk assessment is available within several documents, published by both the Environment Agency and Defra. Guidance includes Contaminated Land Exposure Assessment (CLEA) v1.071 model (Ref.15), Science Report 2 (Ref.16) and Science Report 3 (Ref.17).

A generic quantitative risk assessment (GQRA) has been carried out for the Potential Contaminant Linkages (PCLs) investigated by screening of soil contamination data against relevant Generic Assessment Criteria (GAC) where available, including:

- i) **Soil Guideline Values (SGVs):** These have been published by the Environment Agency and are trigger values for screening out low risk areas of land contamination. SGV's give an indication of representative average concentrations of chemicals in soil, below which long-term health risks are likely to be minimal. SGVs have been published for several contaminants including arsenic, cadmium, mercury, nickel, selenium, BTEX, phenols and dioxins, furans and

dioxin-like PCB substances for land uses including residential, allotments and commercial. The SGVs have been developed for a sandy loam soil with 6% soil organic matter (SOM) content;

- ii) **Supplementary Screening Values (SSVs):** In addition to the SGVs developed by the EA, other third-party organisations have derived SSVs for a wider range of contaminants and land uses using the CLEA Model. Curtins have adopted these numbers where applicable, including those developed by Atkins AtriskSoil™, the LQM/CIEH Suitable for Use Levels (S4UL) and EIC/AGS/CL:AIRE published thresholds;
- iii) **Category 4 Screening Levels (C4SLs):** In March 2014 Defra published C4SLs for arsenic, benzene, benzo(a)pyrene, cadmium, hexavalent chromium and lead. These values were derived to support the revised Part 2A Statutory Guidance issued in 2012 (Ref.18) in which four categories of contaminated land are included, ranging from Category 1 (significant/high risk) to Category 4 (low risk). C4SLs are not representative of significant possibility of significant harm (SPoSH) and are low risk levels which, and therefore where the C4SLs are not exceeded, land can be demonstrated to be in Category 4 and cannot be determined as contaminated land.

6.1.1 Adopted Soil Human Health GACs Screening Methodology

The use of the site, noted as a mixed use 25-storey student apartment blocks with retail, leisure, amenity, event and children's nursery space on the ground floor; is most analogous with a *Commercial* end-use scenario and so assessment has been undertaken against the following GACs, in order of preference:

1. Environment Agency Soil Guideline Values,
2. CL:AIRE, AGS, EIC. Soil Generic Assessment Criteria for Human Health Risk Assessments,
3. LQM/CIEH 2015 S4ULs for Human Health Risk Assessment, and
4. DEFRA Category 4 Screening Levels.

The soil organic matter (SOM) content has an influence on the volatilisation of organic contaminants (i.e. the higher the SOM, the lower the volatilisation rate and therefore inhalation exposure risk). Soil organic matter (SOM) values for the site soils ranged significantly from 0.5% to 40%. The high organic content encountered in several soils is representative of the high ash/clinker content of Made Ground features tested.

With consideration for a calculated geometric average, the soils determine an SOM within Made Ground soils of 5.76%. As such, a comparison against Tier 1 thresholds for a conservative SOM of 6.0% for *Commercial* end-use has been adopted.

For natural soils, SOM contents of 1.5% and 1.6% were reported. As such, a comparison against Tier 1 thresholds for a conservative SOM of 1.0% for *Commercial* end-use has been adopted for natural soils. The adopted GAC's are listed in *Appendix F*.

6.1.2 Generic Assessment Criteria Screening of Soil Laboratory Results

The results of the environmental testing can be referred to in *Appendix C*, with testing undertaken on a total of thirty-one soil samples across the site.

With respect to the proposed 'Commercial' end-use of the site, lead and PAH exceedances are noted within 6no recovered soil samples as detailed below.

Table 6.1.2 – Soil GAC Exceedances for a Commercial End-Use

Borehole Ref.	Depth (m bgl)	Stratum	Determinant	Conc. (mg/kg)	GAC (mg/kg)
WS02	0.10 – 0.20	Made Ground	Dibenzo(a,h)anthracene	11	3.5
WS04	0.15 – 0.25	Made Ground	Benzo(b)fluoranthene	52	45
			Benzo(a)pyrene	54	35
			Dibenzo(a,h)anthracene	13	3.5
WS08	1.80 – 2.00	Made Ground	Lead	6400	2300
BH03	0.30 – 0.40	Made Ground	Lead	3880	2300
WS401	0.40	Made Ground	Benzo(a)pyrene	38	35
			Dibenzo(a,h)anthracene	5.7	3.5
BH402	0.60	Made Ground	Benzo(b)fluoranthene	54	44
			Benzo(a)pyrene	40	35
			Dibenzo(ah)anthracene	7.6	3.5

Selected soil samples were screened for asbestos. No suspected asbestos containing materials (ACMs) were identified in the exploratory hole logs and laboratory screening confirmed that asbestos was absent in the soil samples tested.

There have been minor exceedances within six Made Ground samples with respect to several PAHs and Lead. An ashy stratum, including ash and clinker, encountered in each of these locations is thought to be responsible for the exceedances and is indicative of the historical use of the site.

6.2 Controlled Waters GQRA

A model for assessing the potential for pollution of controlled waters and for deriving a safe concentration in ground and groundwater is the Environment Agency's publication 'Remedial Targets Methodology - Hydrogeological Risk Assessment for Land Contamination' (Ref.19).

In relation to the standards for controlled waters, there are currently no generic groundwater standards or surface water standards that are necessarily applicable to all sites.

However, dependant on the receptor identified as being at risk, see *Section 6.2.1*, the EU Drinking Water Standards (Ref.20), Surface Water (Abstraction for Drinking Water (Ref.31) and/or Water Framework Directive Water Quality Standards (WFD WQS) (Ref.22)) can be utilised as primary screening values in a Level 1 assessment. These can also be supplemented by World Health Organisation (WHO) guidelines (Ref.23), where WFD or DWS water quality standards (WQS) do not exist.

In addition to surface and groundwater samples a soil leaching test can be undertaken to provide a preliminary, conservative, assessment of the potential for contaminants in the soil to pollute ground or surface water. Leachate test results are screened in the same way as for groundwater above.

6.2.1 Adopted Controlled Waters Tier 1 Screening Values and Methodology

The site is underlain by a Principal Aquifer, associated with the Chester Pebble Beds Formation, and so groundwater chemical testing results have been assessed against UK Drinking Water Standards.

The adopted Level 1 Screening Values are listed in *Appendix F*.

6.2.2 Tier 1 Screening of Groundwater Laboratory Results

The results of the environmental testing can be referred to in *Appendix C*.

With respect to the underlying Principal Aquifer; several exceedances are noted within recovered groundwater samples as detailed in *Table 6.2.2*.

Table 6.2.2 – Exceedances Recorded in Groundwater Chemical Testing Results

Determinant	Tier 1 Value (µg/l)	Min Conc. (µg/l)	Max Conc. (µg/l)	Samples > Tier 1 Value
Sulphate	250	57	412	BH401 (412 mg/l)
Benzo(a)pyrene	0.01	0.01	0.03	BH401 (0.03 µg/l) BH402B (0.01 µg/l) BH403 (0.02 µg/l)
Sum of 4 PAHs¹	0.1	<0.01	0.14	BH401 (0.14 µg/l)

1. Benzo(b)fluoranthene, Benzo(ghi)perylene, Benzo(k)fluoranthene and Indeno(1,2,3-c,d)pyrene.

The chemical testing results identified slightly elevated concentrations of sulphate, benzo(a)pyrene and multiple PAHs, with respect to EU Drinking Water Standards (EU DWS).

The site is in Manchester city centre, which historically was heavily industrialised throughout the surrounding area. Although it is considered likely that the exceedances recorded in *Table 6.2.2*, above, are associated with downward migration of contaminants from onsite Made Ground soils, leaching into bedrock, it is likely that the contaminants are also indicative of the wider historic, industrial land use of the city centre.

6.3 Water Supply Pipe Assessment

With reference to the UKWIR Report no. 10/WM/03/21 (Ref.24) advice is given on the appropriate materials for these ground conditions. The exact requirements are to be confirmed with the relevant utility supplier.

PE pipes are not suitable for use for water supply pipes at this site due to concentrations of C5-C10, C11-C20 and C21-40 mineral oils exceeding UKWIR guidelines. Further environmental testing is required to determine the suitability of PVC water supply pipes or whether barrier pipe (PE-Al-PE) is required. The exact requirements are to be confirmed with the relevant utility supplier.

6.4 Materials Management

6.4.1 Re-use of Site Soils

Based on the geochemical testing results presented as part of this investigation it is considered that there is no specific requirement to remove soils from site because of them presenting an unacceptable risk to human health or the environment.

The re-use of site-won soils may therefore be undertaken if the following principles are met:

- i) the geotechnical suitability of the material needs to be confirmed;
- ii) the re-use of the material needs to be covered as part of the planning approval, e.g. site levels maintained within agreed limits;
- iii) the volume of the material being re-used needs to be confirmed and traceable; and
- iv) regulatory approval from the relevant authorities has been sought.

These principles are outlined within the CL:AIRE Definition of Waste Code of Practice (v2) (Ref.25) and if and where the re-use of site-won soils is proposed as part of the development works it is recommended that a Materials Management Plan is produced in line with the Definition of Waste Code of Practice to detail and document the process.

6.4.2 Material Classification

Where any site soils are to be disposed of off-site guidance on the disposal of contaminated soils is provided within the following document published by the Environment Agency, the Guidance on the Classification and Assessment of Waste Technical Guidance WM3: 1st Edition, 2015 (Ref.26).

Guidance states that the principal contractor (or any other sub-contractor undertaking excavations) should, in conjunction with the proposed disposal facility, use where possible the relevant environmental chemistry analyses results to classify any surplus material identified for off-site disposal. However, it should be noted that this information is for guidance only and material identified for disposal should be tested and assessed in accordance with WM3 to enable classification during the works.

An initial assessment for the waste classification of the Made Ground soils encountered onsite has been carried out through a comparison of the soil testing results against the Tier 1 Thresholds and using the Waste Soils Characterisation Assessment Tool, Cat-WasteSoil, developed by McArdle and Atkins. This online tool gives a rapid assessment of contaminated soils and their classification as either hazardous or non-hazardous (stable non-reactive hazardous waste) waste, it should be noted that this tool does not classify inert waste. Persistent Organic Pollutants (POP's) were not tested for as part of the investigation, however based on the Conceptual Site Model the risk of these being present on the site is considered Low.

The initial assessment revealed that of the twenty-nine Made Ground soils tested, twenty-five samples have indicated to be non-hazardous with respect to Environment Agency waste classes, using the guidance given in WM3.

However, four samples have indicated to be hazardous waste for offsite disposal owing to the concentrations of Benzo(a)anthracene and Di-benzo(a,h)anthracene (WS02 at 0.10m and WS04 at 0.15m bgl), Copper, Lead and Zinc (BH03 at 0.30m bgl and WS08 at 1.80m bgl). The elevated concentrations of PAHs and metals may be caused by ash and clinker material as noted in the borehole logs.

For soils classified as hazardous waste and where natural soils are being considered for offsite disposal as inert waste, Waste Acceptance Criteria (WAC) testing should first be undertaken with confirmation of acceptability from the receiving landfill.

As discussed, preliminary waste classification is undertaken to offer indicative advice with respect to disposal requirements. Landfill operators are not obliged to accept waste and, if they were to do so, may have specific requirements beyond those outlined above prior to acceptance. Landfill operators should be contacted to confirm the above classifications or otherwise.

7.0 Ground Gas Assessment

The assessment of risk presented by ground gases is assessed with reference to guidance published by CIRIA (Assessing Risks Posed by Hazardous Ground Gases to Buildings, C665 (Ref.27), BSI Publication (Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings BS8485:2015 (Ref.28) and other broadly accepted references such as the Ground Gas Handbook 2009 (Ref.29).

The gas risk assessment adopts a tiered approach. In the first instance, this involves a re-evaluation of the Conceptual Site Model described within the Phase 1 Preliminary Site Assessment (desk study) and thereafter validating this conceptual model with the ground gas data, the semi-quantitative risk assessment.

7.1 Ground Gas Monitoring Results

To characterise the site's ground gas regime and validate the qualitative assessment of ground gas risk standpipe installations were incorporated within the eight window sample borehole locations and one cable percussion borehole as detailed in *Section 3.2*.

An initial programme of six gas monitoring visits over three months was proposed which has now been completed. Gas monitoring visits have been undertaken between 26th January and 3rd April 2018, with barometric pressure recorded between 980mb and 1016mb and the monitoring period included three monitoring visits during falling barometric pressure. The results log sheets are contained within *Appendix E* and summarised in *Table 7.1* below.

Table 7.1 – Summary of Ground Gas Monitoring Results

Borehole Ref.	Maximum Methane Concentration (%)	Maximum Carbon Dioxide Concentration (%)	Minimum Steady Oxygen Concentration (%)	Maximum gas flow (l/hr)
WS01	<0.1	0.9	18.7	0.1
WS02A	<0.1	2.4	14.4	<0.1
WS03	<0.1	0.7	11.2	-1.0
WS07	<0.1	0.5	19.0	-0.6
WS08	<0.1	0.8	18.4	-0.2
WS09	<0.1	0.2	16.1	<0.1
WS10	<0.1	0.9	19.5	<0.1
WS11	<0.1	0.8	10.6	6.4
BH03	<0.1	1.7	15.6	0.1

Methane (CH₄) was recorded below the instrument's detection limit within all the monitoring wells throughout the monitoring period. Maximum recorded carbon monoxide (CO) and hydrogen sulphide (H₂S) was 750ppm and 40ppm, respectively during visit 1. However, in subsequent visits the maximum recorded carbon monoxide (CO) and hydrogen sulphide (H₂S) readings were 6ppm and 4ppm,

respectively. Carbon Dioxide was recorded in peak concentrations between 0.2% and 2.4%. Maximum gas flow was recorded between -3.0 and 6.4l/hr. Maximum steady state flow rates of between -2.1 and 0.1l/hr were recorded.

7.2 Ground Gas Assessment

The Conceptual Site Model presented within the Phase 1 Preliminary Site Assessment identified possible Made Ground deposits as a potential source of ground gas generation both onsite and offsite resulting from historical development and land use. The report suggests no records of organic rich drift deposits (e.g. peat) being present. Additionally, coal deposits are noted to not underlie the site. Noxious and asphyxiate gases were attributed to include, but not limited to, carbon dioxide, carbon monoxide, methane and hydrogen sulphide. The consequence was evaluated as Moderate risk.

Made Ground soils were encountered to depths of between 0.80m to 3.80m bgl but with limited putrescible content generally. The ground investigation revealed a ground model generally consistent with the preliminary conceptual site model. Natural deposits were generally Clay and Sand with no significant putrescible/organic content.

Consideration of the recorded soil gas flow rates, presented above, enables hazardous gas flow rates to be evaluated. Q_{hg} can be derived for both 'representative' and 'worst case' scenarios and a comparison made in support of an appropriate assessment of ground gas risk. For a 'representative' scenario steady state flow rates are adopted, whilst for a 'worst case' scenario peak flows are adopted.

Evaluation of the 'representative' scenario (highest hazardous gas flow rate that is realistically possible, i.e. in a single borehole) records a maximum Q_{hg} of 0.011 l/hr for carbon dioxide in WS11 on visit 1.

Evaluation of the 'worst case' scenario (highest Q_{hg} across the entire dataset irrespective of location and discrete monitoring events) again records a maximum Q_{hg} of 0.1536 l/hr for carbon dioxide.

The Q_{hg} for a 'representative' scenario has been adopted as the sites Gas Screening Value (GSV) on the basis that the 'worst case' scenario would result in unnecessarily conservative protection measures.

In accordance with an assessment by CIRIA C665 the GSV indicates a Characteristic Situation 1 (CS1) gas regime which does not require any gas protection measures. This is further supported by the concentrations of CO₂ and CH₄ consistently below 5% and 1% respectively with generally low to negligible flow rates recorded across the site.

The potential risks from ground gases to the excavations are to be dealt with by the Contractor, in accordance with the Confined Space Regulations, during construction. Appropriate ground gas monitoring and safety measures should be in place during the works, as the potential presence of ground gases could pose a risk in any confined spaces of deep excavations.

8.0 Revised Conceptual Site Model

The Preliminary Conceptual Site Model (PCSM) presented in the Phase 1 report (Ref.1) and discussed in *Section 3.0* of this report has been revised following the GQRA in *Section 6.0* above. The Revised Conceptual Site Model (CSM) is summarised in the table overleaf.

The CSM details the source-pathway-receptor linkages or potential pollutant linkages (PPL) that have been identified as relevant for the site based on current investigations. The GQRA details the associated level of risk relating to these potential pollutant linkages.

The CSM follows the framework outlined within CIRIA C552 (Ref.30) which is summarised within *Appendix G*.

The 'risk rating' within the CSM refers to the risk that the source, pathway, receptor linkage or PPL is complete. Unless specifically stated it does not necessarily refer to an immediate risk and is intended to be used as a tool to assess the necessity for further assessment/investigation.

Risks presented by Unexploded Ordnance is discussed and assessed in *Section 2.6*.

Under current health and safety legislation, employers are required to carry out their own appropriate risk assessments and mitigation to protect themselves and their employees, other human receptors and the environment from potential contamination. Such risks must be adequately mitigated by law, specifically the Construction Design Management (CDM) Regulations, 2015 (Ref.31) which require that potential risks to human health and the environment from construction activities are appropriately identified and all necessary steps taken to eliminate / manage that risk. It has been assumed that any future construction works on site will be undertaken in compliance with these requirements. Reference should be given to the environmental testing results discussed within *Section 6.0* and presented within *Appendix C*.

The CSM will be updated in a revised version of this report to incorporate the entire site when uncharacterised areas have been investigated.

Phase 2 Site Investigation

Qualitative Risk
AssessmentGeneric
Quantitative Risk
AssessmentDetailed
Quantitative Risk
Assessment or;
Remedial Action

- The table below represents the Second stage in the land quality risk assessment process; the Revised Conceptual Site Model following the Quantitative Risk Assessment.
- For a development site to be deemed 'suitable for use' the level of risk needs to be brought down to acceptable levels, i.e. low to very low risk. The purpose of each stage of risk assessment is ultimately to establish if there is a requirement for additional levels of assessment to be made to have sufficient confidence to support a risk characterisation or management decision, e.g. remedial action.
- In the absence of specific site data, a Generic Quantitative Risk Assessment is invariably recommended.

Conceptual Site Model			Generic Qualitative Risk Assessment			Comments	Action
Identified Source	Pathway(s)	Receptor(s)	Consequence	Likelihood of Occurrence	Risk Rating		
Made Ground – Contamination associated with uncontrolled deposition of construction/demolition waste materials and fill.	Direct contact and dermal uptake, soil and dust ingestion, dust and migration inhalation	Site end-users	Medium	Low Likelihood	Moderate/ Low	Minor PAH and Lead exceedances above <i>Commercial</i> end-use adopted GAC are noted although in distinct source (ash and clinker within Made Ground soils), indicative of historical uses of the site and wider area.	Provision of a suitable thickness of clean and inert cover in all areas of soft landscaping.
	Direct contact and dermal uptake, soil and dust ingestion, dust & migration inhalation	Construction and maintenance workers	Medium	Unlikely (Standard Health & Safety precautions likely to be used by workers)	Low		
	Soil dust ingestion/inhalation produced during construction	Adjacent residents	Medium	Unlikely (Suitable site management and environmental controls likely to be used by principal contractor)	Low		
	Vertical and horizontal migration through the superficial deposits (soils) and bedrock	Secondary Undifferentiated Aquifer (Superficial Soils)	Mild	Low Likelihood (Reflecting limited contamination recorded in environmental testing results)	Low	Slightly elevated concentrations of sulphate and multiple PAHs with respect to EU Drinking Water Standards (EU DWS). No potable groundwater abstractions are located within 1km of the site. Six discharge consents are located within 250m of the site. No surface water abstractions are located within 250m. The site is in Manchester city centre, which historically was heavily industrialised throughout the surrounding area. Although it is considered possible that the exceedances are associated with downward migration of contaminants from onsite Made Ground soils, leaching into superficial soils and bedrock, it is likely that the contaminants are also indicative of the wider historic, industrial, land use of the city centre.	Undertake a Piling Risk Assessment (PRA) to determine suitable methods of piling to mitigate risk presented to underlying Principal Aquifer.
		Principal Aquifer (Bedrock and weathered deposits)	Medium		Moderate/ Low		
Organic matter and/or contamination as source material for the generation of ground gas in remaining parts of the site.	Ground gas & vapour migration and inhalation	Site end-users	Medium	Unlikely (reflecting ground gas monitoring results)	Low	From the monitoring visits undertaken so far, the ground gas assessment records a Q_{hg} of 0.011/hr which has been taken for the GSV, indicating the site to be classified CS1 gas regime	CS1. No gas protection measures are required for this development.
	Direct contact and dermal uptake, soil and dust ingestion, dust & migration inhalation	Construction and maintenance workers	Medium		Low		

8.1 Summary of Significant Pollutant Linkages

A **Moderate/Low** risk rating is identified to end-users from direct contact, inhalation and ingestion of contaminants within Made Ground soils due to minor PAH and Lead exceedances in Made Ground soils.

A **Low** risk rating is identified to construction workers and adjacent residents at this stage from direct contact, inhalation and ingestion of contaminants associated with Made Ground soils.

A **Low** risk rating is identified to the underlying Secondary Undifferentiated Aquifer associated with Glacial Till soils. Marginally elevated concentrations of sulphate, and multiple PAHs were recorded in groundwater samples, however limited migration is anticipated through cohesive superficial soils.

A **Moderate/Low** risk rating is identified to the underlying Principal Aquifer associated with the Chester Pebble Beds Formation and associated weathered deposits. A Piling Risk Assessment should be undertaken to determine suitable piling methods to mitigate the risk presented to the underlying Principal Aquifer.

A **Low** risk rating is identified to construction workers and end-users from ground gas migration and inhalation from soils. This corresponds with a CS1 gas regime, not requiring gas protection measures.

9.0 Engineering Assessment and Recommendations

9.1 Introduction

This section will assess the relevant geotechnical issues for the proposed, up to, 25-storey student accommodation and commercial development. The proposed development plan is contained within *Appendix A*.

The engineering assessment considers foundation design, excavations, and ground floor slabs. Structural details and loadings have not yet been provided. It should be noted that the proposed development detail beyond the issue of this Phase 2 Report may change. Therefore, the Construction Designer should satisfy themselves regarding the adequacy of their design and the proposed approach to construction by reference to the on-going project design proposals, the site investigation information and their own examination of the site.

9.2 Summary of Ground Conditions

The ground conditions at the site generally comprised Made Ground, underlain by Glacial Till (clay locally interbedded with sand and gravel), overlying the Chester Pebble Beds Formation (Sandstone). The rock is highly weathered at the top of the strata, often recovered as very dense sand.

No significant groundwater strikes were recorded during the investigation works. Several exploratory boreholes recorded seepages of perched water within made ground and shallow cohesive soils. It should be noted that water flush methods were used during the progression rotary cored boreholes, which may have masked the groundwater conditions.

The geotechnical parameters recommended for use in the design based on the ground conditions encountered are summarised in *Table 9.2* below.

Table 9.2 – Geotechnical Parameters

Parameter	Firm/Stiff Clay	Sand (Weathered bedrock)	Sandstone
Estimated Undrained Shear Strength, C_u (kPa)	60	-	-
Estimated Effective Angle of Shearing Resistance, ϕ (°) ⁽¹⁾	-	38	41
Effective Cohesion C' (kPa) ⁽¹⁾	0	0	400
Unit Weight, γ (kN/m ³) ⁽²⁾	20	20	20
Unconfined Compressive Strength (UCS) (MPa)	-	-	5.0

(1) Determined from Foundations of Engineering Geology, P54 (Ref. 34)

(2) From published sources (BS8002) and (Hoek & Bray 1974).

9.3 Railway Viaduct Foundation Inspection

9.3.1 Stage 5a Hand Excavated Foundation Trial Pits

Four hand excavated trial pits, HP01 – HP04 were undertaken directly adjacent to the northern side of the viaduct, to a maximum depth of 2.10m bgl. The railway viaducts brick wall foundations/bases were not identified in any of the hand dug trial pit locations undertaken.

Exploratory hole HP01 was advanced to a depth of 2.10m bgl. This exploratory hole identified Made Ground to a depth of 1.15m overlying clayey slightly gravelly sand overlying brown slightly gravelly sandy clay. Exploratory hole HP02 was advanced to a depth of 2.10m bgl and identified Made Ground to 1.55m bgl overlying brown slightly gravelly sandy clay. Exploratory hole HP04 was advanced to a depth of 1.60m bgl and identified Made Ground to the base of the excavation.

Exploratory holes HP01, HP02 & HP04 were terminated at the previously indicated depths due to hand digging limitations. The foundations of the viaduct were not encountered during this phase of the investigation.

HP03 was terminated due to a concrete obstruction encountered underlying the tarmac at 0.10m bgl. The obstruction was broken out to the final depth at 0.35m bgl.

Exploratory hole logs and trial pit cross sections are attached within *Appendix B* and *Appendix A* respectively.

9.3.2 Stage 5b Machine Excavated Foundation Trial Pits

Given the hand excavated foundation pits failed to expose the foundations of the viaduct, three additional machine excavated trial pits were undertaken directly north of the viaduct brick wall. They were progressed to depths of 3.65m, 3.60m and 2.60m bgl respectively. A thin layer of Made Ground, of a similar composition to that recorded in the hand pits, was encountered directly adjacent to the wall. Natural soils, consistent with those recorded elsewhere on site, were recorded in TP102 and TP103 from depths of 2.60m and 1.90m bgl respectively. TP101 was terminated within Made Ground soils at 3.65m bgl.

A 150mm thick layer of concrete was encountered in TP102 at 1.45m bgl, undertaken adjacent to the infilled brick arch. The concrete stepped out 150mm from the edge of the brick wall, in an approximately northerly direction, which may represent foundations associated with the infilled portion of the viaduct arch. This is not indicative of the foundations of the viaduct itself.

The foundations of the viaduct were not encountered in any of the excavations.

Exploratory hole logs and trial pit cross sections are attached within *Appendix B*.

9.4 Foundation Design

It is understood that the proposed development is to consist of a 25-storey high-rise commercial and residential development. Loadings are currently unknown and are likely to pre-determine the suitability of the foundations to be adopted at the site.

The Made Ground and the superficial deposits are not considered to be suitable founding strata due to the likely significant loadings for a high-rise building, therefore piled foundations are recommended for the proposed development, likely to terminate within the competent bedrock.

The carrying capacity of piles depends not only on their size and the ground conditions but also on their method of installation. Pile design and installation are continuously evolving processes and state-of-the-art are often employed before they reach the public domain, perhaps several years down the line. Therefore, it is recommended that specialist Piling Contractors be contacted as to the suitability and carrying capacity of their piles in the ground conditions pertaining to the site.

9.5 Ground Floor Slabs

Based on observations onsite together with the results of laboratory tests it is recommended that consideration is given to a suspended ground floor slab, due to the expected high building loads.

As piled foundations are anticipated, a suspended slab is recommended to bear on the pile caps by a network of beams which will minimise any differential settlement between the floor and the piled structure.

9.6 Chemical Attack on Buried Concrete

The site has been classified in accordance with BRE Special Digest 1 (Ref.13) and laboratory testing undertaken accordingly as detailed in *Section 5.10*. Based on the laboratory test results it is considered that a Design Sulphate Class may be taken as DS-3 in made ground and DS-1 for natural deposits. An ACEC class of AC-3 for made ground and AC-1 in natural deposits would be appropriate for the site.

9.7 Excavation and Support

The stability of the excavations must be confirmed by a suitably qualified temporary works designer. Generally, shallow excavations (<1.2m bgl deep) can be unsupported if battered to a suitable angle, designed by a qualified temporary works designer. Excavations deeper than 1.2m may require side support due to space constraints, otherwise suitable stable slope angles may also be adopted for deeper excavations, to provide stability. Plant and equipment movement across the site must be taken into consideration, when assessing the excavations stability.

Excavation through layers of Made Ground and superficial deposits should be feasible using conventional site plant. However unknown buried obstructions were encountered in the southeast of the western portion, the north east corner, and a service corridor runs adjacent to the northern retaining wall. Historic mapping indicates the presence of tanks beneath the north east corner and centre north of the site. It is unknown at this stage if these tanks are still present on site. Further unknown obstructions cannot be discounted, and significant foundations are expected to be present underlying the current building in the western portion. An allowance should be made for breaking out any concrete which may be encountered.

Groundwater is not likely to be encountered within the superficial deposits, however encountering perched water cannot be discounted. It is considered that groundwater inflows, if encountered, may be controlled by pumping from sumps.

Although no blowing or running sand conditions were recorded during the site investigations, running sand conditions may be prevalent across the site where excavations for buried structures intercept any sand bands. Adequate excavation support together with groundwater control will be necessary to prevent sands from flowing into the excavation leading to settlement of the surrounding ground.

10.0 Conclusions & Recommendations

10.1 Conclusions

A revised tabulated revised Conceptual Site Model has been derived following the findings on the Generic Quantitative Risk Assessment risk assessment and is presented in *Section 8.0*.

10.1.1 Ground and Groundwater Contamination

The environmental chemistry soil results have been compared with the Tier 1 criteria for soils with respect to human health against '*Commercial*' thresholds.

With respect to the proposed end-use of the site Tier 1 thresholds there have been minor exceedances in six Made Ground samples with respect to PAHs and Lead. These concentrations are likely to be associated with ash and clinker within the Made Ground and may pose a risk if future site users become exposed to these soils, primarily in landscaped areas. It is considered that the risk presented to site end-users from Made Ground soils on site is currently **Moderate/Low**. This will be reduced to Low if a suitable thickness of 'clean and inert' capping is installed in areas of soft landscaping. The building footprint and areas of hard standing will break the source-pathway-receptor linkage across the remainder of the site.

A **Low** risk rating is identified to construction workers and adjacent residents at this stage from direct contact, inhalation and ingestion of contaminants associated with Made Ground soils.

A **Low** risk rating is identified to the underlying Secondary Undifferentiated Aquifer associated with Glacial Till soils. Marginally elevated concentrations of sulphate, and multiple PAHs were recorded in groundwater samples, however limited migration is anticipated through cohesive superficial soils.

A **Moderate/Low** risk rating is identified to the underlying Principal Aquifer associated with the Chester Pebble Beds Formation and associated weathered deposits. A Piling Risk Assessment should be undertaken to determine suitable piling methods to mitigate the risk presented to the underlying Principal Aquifer.

10.1.2 Ground Gas Assessment

Gas monitoring results recorded a maximum carbon dioxide concentration of 2.4% v/v and a maximum flow of 6.4l/hr. Concentrations of methane were consistently below 0.1% v/v in all monitoring wells. The risk to the end-user of the development site from soil gases is therefore considered to be **Low**. The gas regime for the site is CS1, not requiring gas protection measures.

The BGS Radon Mapping confirms the site is situated in an area where <1% of homes are above the radon action level. Radon protection measures are therefore not considered necessary within the proposed development. However, where the new development incorporates a basement the advice of a specialist Radon assessor must be obtained.

10.1.3 Geotechnical Assessment

The Made Ground and superficial deposits are not considered to be suitable founding strata, and it is likely that the proposed high-rise building will have significant loadings, therefore piled foundations are recommended for the proposed development designed in end bearing in the sandstone.

As piled foundations are anticipated then the suspended slab is recommended to bear on the pile caps by a network of beams which will minimise any differential settlement between the floor and the piled structure.

Based on the laboratory test results it is considered that a Design Sulphate Class may be taken as DS-3 in made ground and DS-1 in natural deposits, and an ACEC class of AC-3 in made ground and AC-1 in natural deposits would be appropriate for the site.

Excavation through layers of Made Ground and superficial deposits may be feasible using conventional site plant. It should be noted that obstructions noted in the southeast of the western portion, the north east corner may require breaking out. It is anticipated that significant foundations will be present beneath the existing building in the western portion of the site. An allowance should be made for breaking out and removing any encountered concrete obstructions.

Groundwater is not anticipated to be encountered in shallow excavations, however encountering perched water cannot be discounted.

10.1.4 Additional Considerations

Elevated concentrations of mineral oil contamination with respect to the protection of water supply pipes were identified within the made ground. Therefore, it is recommended that appropriate materials for water supply pipes would comprise PVC pipes or Barrier Pipes (PE/AL/PE). The exact requirements should be confirmed with the utility provider.

The site is in Manchester City Centre, which during WWII suffered bomb damage. Records obtained to date do not record the site receiving any direct bombing hits during WWII, however several recommendations have been made for the implementation of mitigation measures during intrusive works which are detailed within *Section 2.6* and *Appendix H*. Consequently, it

is considered that the risk presented to the site from UXO is **Moderate** in the northeast and **Low** across the remainder of the site.

Historic mapping indicates the presence of tanks beneath the north east corner and centre north of the site. No evidence was identified indicating the presence of these tanks during this investigation. It is unknown at this stage if these tanks are still present on site. If, during groundworks or construction works tanks are discovered, the occurrence should be noted, and procedures followed as indicated within a Remediation Strategy.

10.2 Recommendations

Based on the findings of the ground investigation, the following recommendations are made:

- 1) It is recommended that in the limited proposed areas of soft landscaping, 300mm clean and inert capping is installed to break the source-pathway-receptor (SPR) linkage from elevated PAH and Lead concentrations. For the remainder of the site, the building footprint and areas of hard standing will break the SPR linkage;
- 2) It is recommended that a Piling Risk Assessment (PRA) is undertaken determine suitable methods of piling to mitigate risk presented to underlying Principal Aquifer;
- 3) It is unknown at this stage if historic these tanks are still present on site. If, during groundworks or construction works, tanks are discovered the occurrence should be noted, and procedures followed as indicated within a Remediation Strategy; and
- 4) It is recommended that construction workers are provided with appropriate PPE and sanitary facilities with reference to the environmental testing results presented herein and within *Appendix C*.

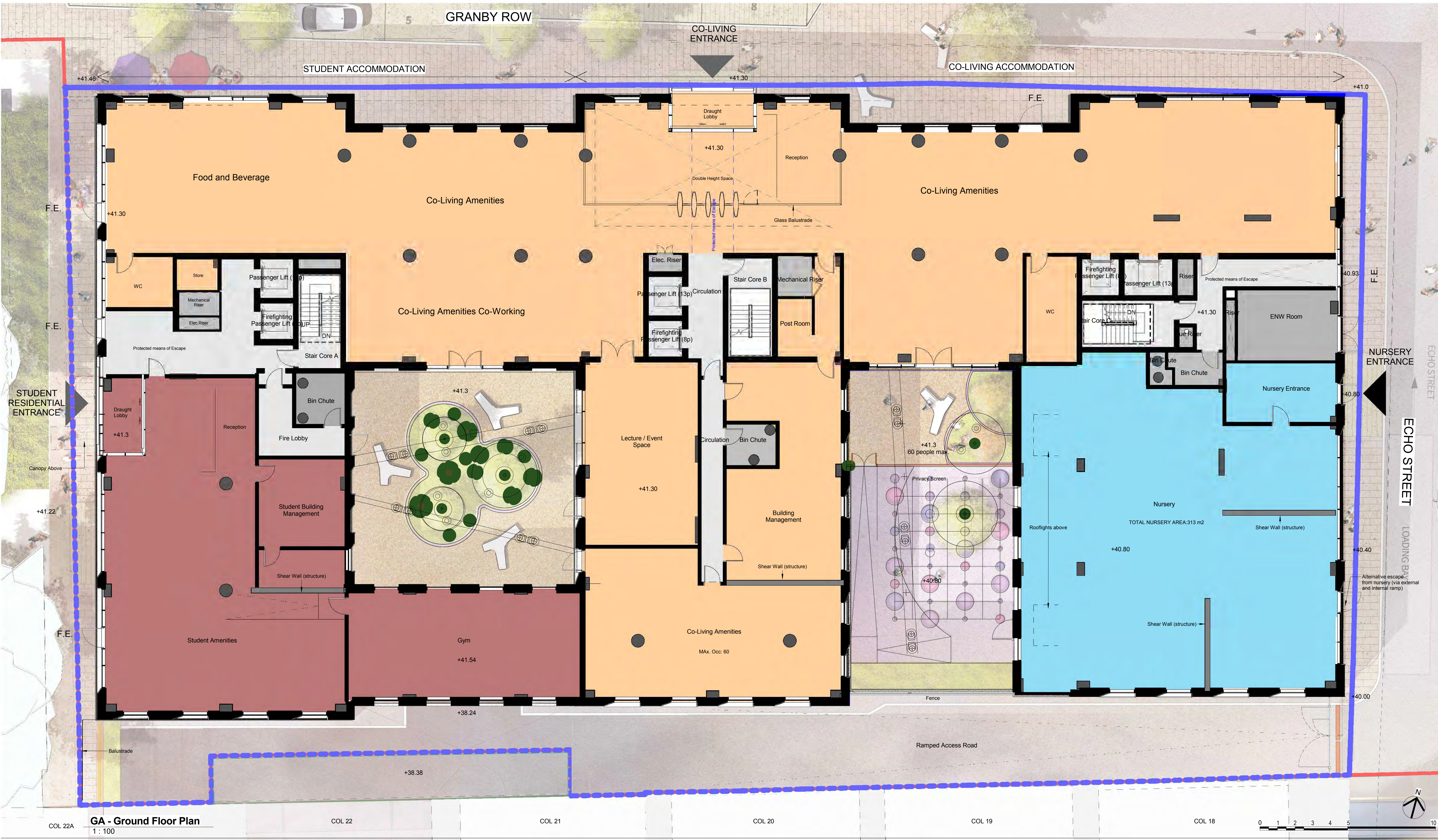
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Appendix A Drawings

- Sheppard Robson, Ground Floor Plan – Stage 3, drawing ref. 5426-SRA-XX-00-DR-A-20-811-P03 (dated Nov 2017).
- Sheppard Robson, Lower Ground Floor Plan – Stage 3, drawing ref. 5426-SRA-XX-B1-DR-A-20-810-P03 (dated Nov 2017).
- Curtins, Stage 1, 2, 3, 4 & 5 Exploratory Hole Location Plan, drawing ref. 065374-CUR-00-XX-DR-GE-005-V03 (dated July 2019)
- Curtins, Foundation Cross Sections TP01 – TP03, drawing ref. 064987-CUR-00-XX-DR-GE-004-V01



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Figures relate to the likely areas of the building at the current stage of the design and are calculated using one of the following (as stated in the accompanying areas schedule) IPMS1, IPMS2, IPMS 3, Gross External Area (GEA), Gross Internal Area (GIA) or Net Internal Area (NIA) methods of measurement from the RICS Property Measurement 1st edition.

- Department Legend
- Circulation
 - Co-Living Amenities
 - Nursery
 - Plant Room
 - Services
 - Store
 - Student Amenities

- PLAN KEY
- Site Boundaries
 - Applicant Ownership
 - Planning Application Boundary
 - Network Rail Ownership

REV.	DATE	AMENDMENT
P01	15/09/17	First Issue - Draft for Planning
P02	10/11/17	Second Issue-Draft for Planning
P03	13/11/17	Planning Submission

KEYPLAN

CLIENT
iQ Student Accommodation

iQ Student Accommodation

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1 : 100 04/09/2017 AC ET RG

PROJECT
Echo Street

General Arrangement - Ground Floor Plan

STATUS PURPOSE FOR ISSUE SR NO. DRAWING NO. REV.
S2 Planning 5426 5426 · SRA · XX · 00 · DR · A · 20-811 P03



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Department Legend

- Circulation
- Functional Amenities
- Plant Room
- Store

PLAN KEY

- Site Boundaries
 - Applicant Ownership
 - Planning Application Boundary
- Network Rail Ownership
- Ground
- Infill Soil

REV.	DATE	AMENDMENT
P01	15/09/17	First Issue - Draft for Planning
P02	10/11/17	Second Issue-Draft for Planning
P03	15/11/17	Planning Submission

KEYPLAN

CLIENT

iQ Student Accommodation



STATUS
S2

PURPOSE FOR ISSUE
Planning

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SCALE@A1
1 : 100

DATE
13/09/17

ORIGINATOR
AC

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AUTHORISED
ET

PROJECT
Echo Street

General Arrangement - Lower Ground Floor Plan

SR NO.
5426

DRAWING NO.
5426 - SRA-XX-B1-DR-A-20-810

REV.
P03



Stage 1, 2, 3 & 5 (completed)

- Window sample borehole location
- Cable percussive with rotary follow-on
- Machine excavated trial pits
- Hand excavated trial pits with hand-held window sample follow-on
- Micro-rotary borehole location
- Denotes the borehole is installed

Rev:	Description:	Date:	By:	Chkd:
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Structures - Civils - Environmental - Infrastructure - Transport Planning - Sustainability - Expert Advisory Services
Birmingham - Bristol - Cardiff - Douglas - Edinburgh - Kendal - Leeds - Liverpool - London - Manchester - Nottingham

Status:

INFORMATION

Project:

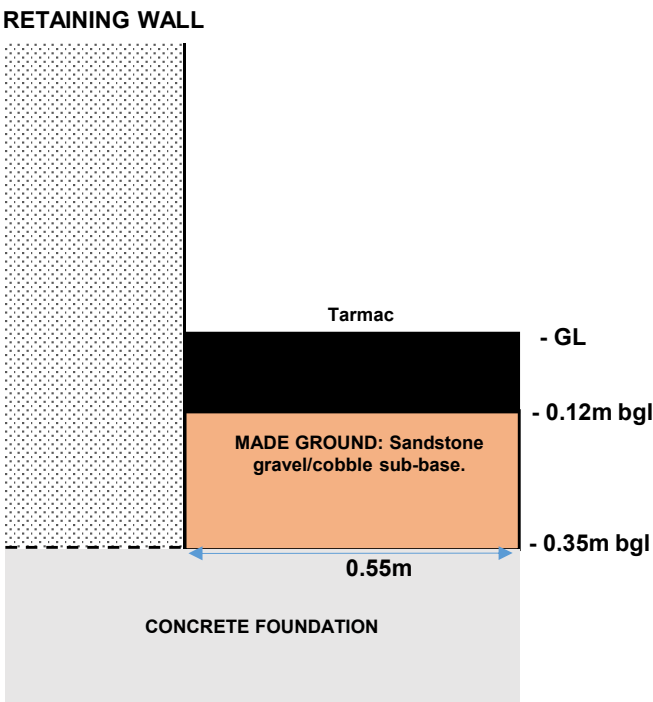
Chandos Hall

Drg Title:
Stage 1, 2, 3, 4 & 5 Exploratory Hole Location Plan

Scale:	Size:	First Issue:	Drawn:	Checked:
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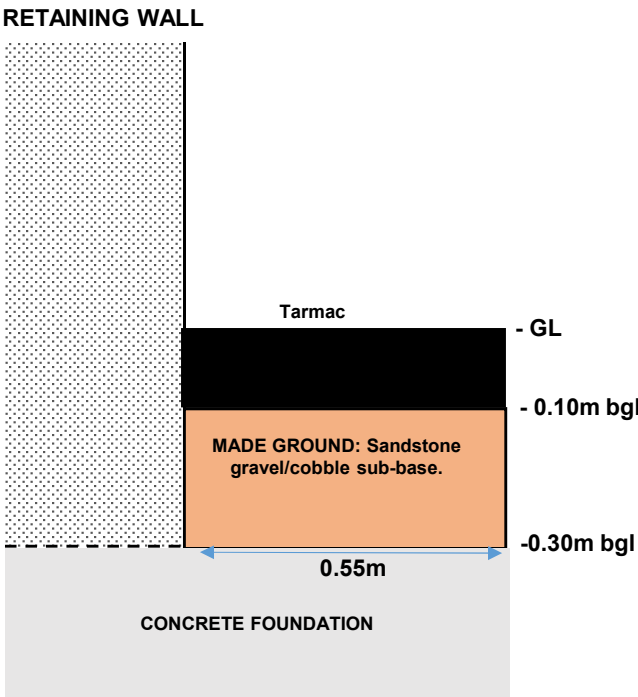
Drg No:	Rev:
065374-CUR-00-XX-DR-GE-005-V03	/

TP01- Identified Dimensions



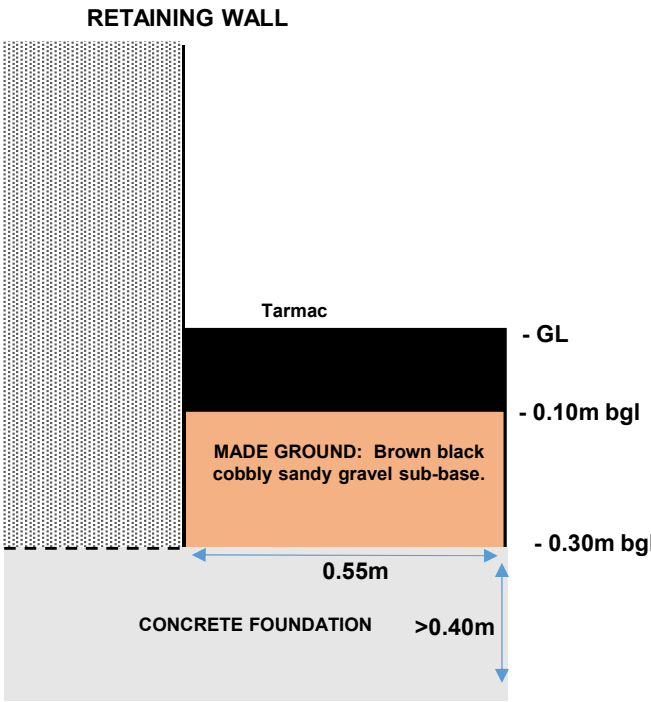
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Concrete foundation encountered but thickness not identified. Reference should be given to corresponding trial pit log for further strata details.

TP02- Identified Dimensions



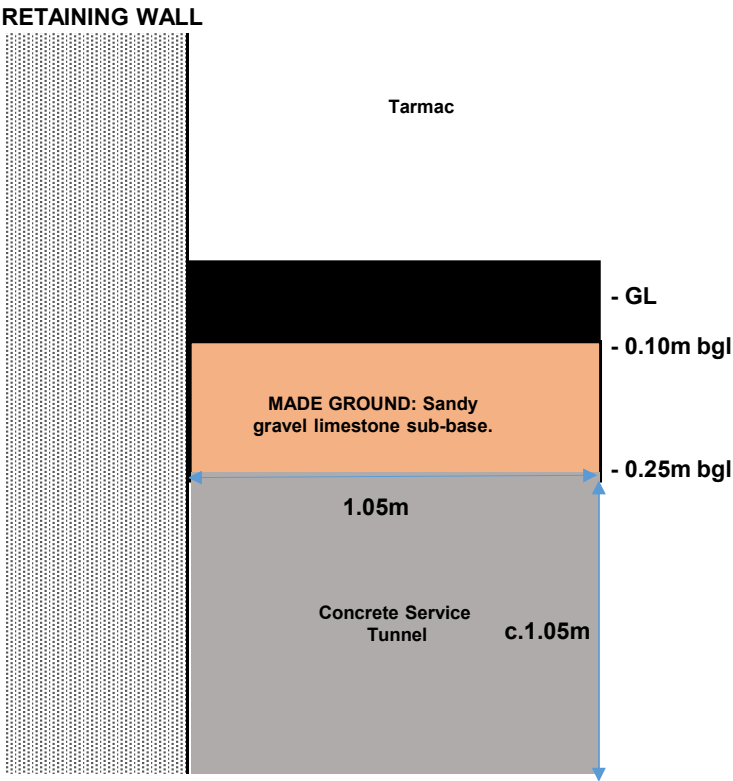
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Concrete foundation encountered but thickness not identified. Reference should be given to corresponding trial pit log for further strata details.

TP03- Identified Dimensions



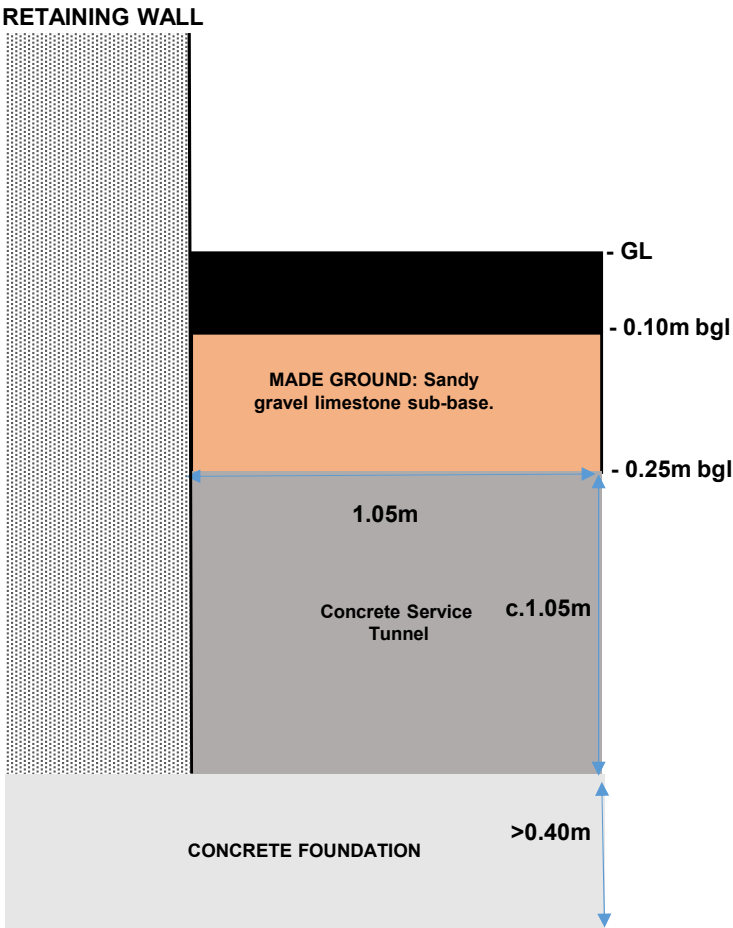
Comments: Not to scale.
Concrete foundation encountered but base not identified. Reference should be given to corresponding trial pit log for further strata details.

TP04- Identified Dimensions



Comments: Not to scale. Concrete service tunnel encountered, wall foundation not identified. Reference should be given to corresponding trial pit log for further strata details.

TP04- Estimated Potential Extent of Foundation



Comments: Not to scale. Drawing shows estimated potential extent of foundation based on available information, indicative only, foundation not proven during investigation.

Appendix B Exploratory Hole Logs

- Stage 1/5A:
 - Cable percussive with rotary follow-on logs, BH01 and BH02
 - Machine excavated trial pit logs and cross-sectional sketches, TP01 – TP04
- Stage 2:
 - Window sample borehole logs, WS01 – WS04 and WS02A
 - Hand excavated pit logs and cross-sectional sketches, FP101
- Stage 3:
 - Window sample borehole logs, WS05 – WS11
 - Cable percussive with rotary follow-on logs, BH03
 - Micro-rotary (open) borehole logs, RH01 – RH03
- Stage 4:
 - Cable Percussive with rotary follow-on logs, BH401 – BH403, including BH402A/B
 - Window Sample borehole logs, WS01 – WS04
- Stage 5A:
 - Hand excavated trial pits with hand-held window sample follow-on logs, HP01 – HP04
- Stage 5B:
 - Machine excavated trial pit logs and cross-sectional sketches, TP101 – TP103



17-19 Whitworth Street West
Manchester
M15WG

Borehole Log

Borehole No.

BH01

Sheet 1 of 2

Project Name: Chandos Hall, Manchester

Project No.
B065374.001

Co-ords: 384641.35 - 397710.88

Hole Type
CP+RC

Location: Manchester

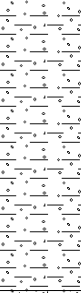
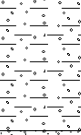
Level: 38.62

Scale
1:50

Client: IQ Student Accomodation

Dates: 18/07/2017 -

Logged By
NF/Geocore

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20 0.25	ES ES		0.13 0.23 0.30	38.49 38.39 38.32	 	MADE GROUND. Tarmac. MADE GROUND. Yellow brown very sandy fine to coarse sub-angular to subrounded gravel of sandstone and limestone including occasional sandstone and limestone cobbles.	
		1.00 1.20	D	N=18 (2,3/4,4,5,5)				MADE GROUND: Dark brown fine to coarse sandy gravel of fine to coarse angular to sub-rounded ash, clinker, bitumen and sandstone.	1
								Stiff dark brown CLAY with frequent fine to coarse sub-angular to rounded gravel of mixed lithologies including coal, sandstone, mudstone, limestone with occasional cobbles of rounded limestone and sandstone. Becoming sandy at 2.0m with frequent limestone cobbles.	2
		3.00 - 3.45	U		3.30	35.32		Dense brown slightly clayey gravelly fine to medium SAND. Gravel of mixed lithologies including fine to coarse rounded to sub-angular limestone, sandstone and igneous intrusions.	3
		4.50		N=47 (4,7/10,12,12,13)	4.90	33.72		Dense light brown fine to medium SAND with silty lenses.	4
		6.00 6.00 - 6.45	B	N=49 (5,10/11,12,13,13)	5.80	32.82		Stiff dark brown CLAY with frequent fine to coarse sub-angular to rounded gravel of mixed lithologies including coal, sandstone, mudstone, limestone with occasional cobbles of rounded limestone and sandstone.	5
		7.00	D		6.70	31.92		Dense brown slightly clayey gravelly fine to medium SAND. Gravel of mixed lithologies including fine to coarse rounded to sub-angular limestone, sandstone and igneous intrusions.	6
		7.50		N=26 (2,4/5,6,7,8)				Dense brown slightly clayey gravelly fine to medium SAND. Gravel of mixed lithologies including fine to coarse rounded to sub-angular limestone, sandstone and igneous intrusions.	7
		8.20	D		8.20	30.42		Dense dark brown clayey gravelly SAND.	8
		8.50	D		8.50	30.12		Reddish light brown weathered SANDSTONE, recovered as a gravelly sand.	9
		9.00		50 (25 for 145mm/50 for 135mm)	9.00	29.62		Medium strong reddish brown medium grained arenaceous SANDSTONE. Generally fresh. Completely weathered in non intact areas where recovered as silty medium sand.	9
								Continued on next sheet	10

Remarks

0.0 to 9.0m cable percussion drilling. 9.0 to 20.0m rotary core drilling. Refer to alternate logs attached for rock core details.





17-19 Whitworth Street West
Manchester
M15WG

Rotary Core Log

Borehole No.

BH01

Sheet 1 of 2

Project Name: Chandos Hall, Manchester

Project No.
B065374.001

Co-ords: 384641.35 - 397710.88

Hole Type
CP+RC

Location: Manchester

Level: 38.62

Scale
1:50

Client: IQ Student Accommodation

Dates: 18/07/2017 -

Logged By
NF/Geocore

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD					
		0.20 0.25	ES ES				0.13 0.23 0.30	38.49 38.39 38.32		MADE GROUND. Tarmac.	
		1.00	D							MADE GROUND. Yellow brown very sandy fine to coarse sub-angular to subrounded gravel of sandstone and limestone including occasional sandstone and limestone cobbles.	1
		3.00 - 3.45	U							MADE GROUND. Dark brown fine to coarse sandy gravel of fine to coarse angular to sub-rounded ash, clinker, bitumen and sandstone.	
										Stiff dark brown CLAY with frequent fine to coarse sub-angular to rounded gravel of mixed lithologies including coal, sandstone, mudstone, limestone with occasional cobbles of rounded limestone and sandstone. Becoming sandy at 2.0m with frequent limestone cobbles.	2
							3.30	35.32		Dense brown slightly clayey gravelly fine to medium SAND. Gravel of mixed lithologies including fine to coarse rounded to sub-angular limestone, sandstone and igneous intrusions.	3
							4.90	33.72		Dense light brown fine to medium SAND with silty lenses.	4
		6.00 - 6.45	B				5.80	32.82		Stiff dark brown CLAY with frequent fine to coarse sub-angular to rounded gravel of mixed lithologies including coal, sandstone, mudstone, limestone with occasional cobbles of rounded limestone and sandstone.	5
		7.00	D				6.70	31.92		Dense brown slightly clayey gravelly fine to medium SAND. Gravel of mixed lithologies including fine to coarse rounded to sub-angular limestone, sandstone and igneous intrusions.	6
		8.20	D				8.20	30.42		Dense dark brown clayey gravelly SAND.	7
		8.50	D				8.50	30.12		Reddish light brown weathered SANDSTONE, recovered as a gravelly sand.	8
		9.00 - 10.50	NI NR	22	0	0	9.00	29.62		Medium strong reddish brown medium grained arenaceous SANDSTONE. Generally fresh. Completely weathered in non intact areas where recovered as silty medium sand.	9
										Continued on next sheet	10

Remarks

0.0 to 9.0m cable percussion drilling. 9.0 to 20.0m rotary core drilling. Refer to alternate logs attached for in situ test results.





17-19 Whitworth Street West
Manchester
M15WG

Rotary Core Log

Borehole No.

BH01

Sheet 2 of 2

Project Name: Chandos Hall, Manchester

Project No.
B065374.001

Co-ords: 384641.35 - 397710.88

Hole Type
CP+RC

Location: Manchester

Level: 38.62

Scale
1:50

Client: IQ Student Accomodation

Dates: 18/07/2017 -

Logged By
NF/Geocore

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD					
		10.50 - 11.50	0	60	49	29					11
			NR								
		11.50 - 12.50	NI	44	18	0				Unfractured in situ.	12
			0								
			NR								
		12.50 - 13.50	NI								
			0	82	61	14					13
			NR								
		13.50 - 15.00	NI								14
			NR	30	0	0					
		15.00 - 16.00	3.15	95	86	78				Fractures sub horizontal, medium spaced, planar, smooth and moderately wide with up to 5mm of medium sand infill.	15
			NR								16
		16.00 - 17.50	0	66	32	15					17
			NR								
		17.50 - 19.00	0	95	81	55				Unfractured in situ.	18
			NI								
			0								
			NR				19.00	19.62		End of borehole at 19.00 m	19
											20

Remarks

0.0 to 9.0m cable percussion drilling. 9.0 to 20.0m rotary core drilling. Refer to alternate logs attached for in situ test results.





17-19 Whitworth Street West
Manchester
M15WG

Borehole Log

Borehole No.

BH02*

Sheet 1 of 2

Project Name: Chandos Hall, Manchester

Project No.
B065374.001

Co-ords: -

Hole Type
CP

Location: Manchester

Level: 38.46

Scale
1:50

Client: IQ Student Accomodation

Dates: 19/07/2018 -

Logged By
NF/Geocore

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	ES		0.10	38.36		MADE GROUND: Yellow brown very sandy fine to coarse sub-angular to subrounded gravel of sandstone and limestone cobbles. including frequent sandstone and limestone cobbles.	
		0.40	ES		0.30	38.16			
					0.50	37.96			
		1.00	D	N=16 (2,3/3,4,4,5)				MADE GROUND. Tarmac.	1
		1.20						MADE GROUND: Dark brown fine to coarse sandy gravel of fine to coarse angular to sub-rounded ash, clinker, quartz, bitumen and sandstone.	
		3.00 - 3.45	U					Stiff dark brown with grey mottling CLAY with frequent fine to coarse sub-angular to rounded gravel of mixed lithologies including coal, sandstone, mudstone, limestone with occasional cobbles of rounded limestone and sandstone.	2
		3.50	D		3.30	35.16		Dense brown slightly clayey gravelly fine to medium SAND. Gravel of mixed lithologies including fine to coarse rounded to sub-angular coal, sandstone, mudstone.	4
		4.50		N=50 (7,10/50 for 295mm)	4.50	33.96		Very dense brown sandy rounded to sub-angular GRAVEL. Gravel of mixed lithologies including fine to coarse rounded to sub-angular sandstone & mudstone.	5
		6.00		50 (5,8/50 for 145mm)					6
		6.70	D		6.70	31.76		Very dense red brown fine to medium clayey SAND.	7
		7.50		50 (5,10/50 for 60mm)	7.50	30.96		Reddish light brown weathered SANDSTONE.	8
		8.00		50 (25 for 105mm/50 for 70mm)	8.20	30.26		Red weathered SANDSTONE. (drillers's description).	9
					10.00	28.46		Continued on next sheet	10

Remarks

0.0 to 8.2m cable percussion drilling. 8.2 to 10.0m rotary openhole. 10 to 20.0m rotary core drilling. Ground level recorded estimated based on topographical survey. Refer to alternate logs attached for rock core details.





17-19 Whitworth Street West
Manchester
M15WG

Rotary Core Log

Borehole No.

BH02

Sheet 1 of 2

Project Name: Chandos Hall, Manchester

Project No.
B065374.001

Co-ords: -

Hole Type
CP+RC

Location: Manchester

Level: 38.46

Scale
1:50

Client: IQ Student Accommodation

Dates: 19/07/2018 -

Logged By
NF/Geocore

Well	Water Strikes	Depth (m)	Type / Fl	Coring			Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD					
		0.20	ES				0.10	38.36		MADE GROUND: Yellow brown very sandy fine to coarse sub-angular to subrounded gravel of sandstone and limestone cobbles. including frequent sandstone and limestone cobbles. MADE GROUND. Tarmac. MADE GROUND: Dark brown fine to coarse sandy gravel of fine to coarse angular to sub-rounded ash, clinker, quartz, bitumen and sandstone. Stiff dark brown with grey mottling CLAY with frequent fine to coarse sub-angular to rounded gravel of mixed lithologies including coal, sandstone, mudstone, limestone with occasional cobbles of rounded limestone and sandstone.	
		0.40	ES				0.30	38.16			
							0.50	37.96			
		1.00	D								1
		3.00 - 3.45	U								3
		3.50	D				3.30	35.16		Dense brown slightly clayey gravelly fine to medium SAND. Gravel of mixed lithologies including fine to coarse rounded to sub-angular coal, sandstone, mudstone.	4
							4.50	33.96		Very dense brown sandy rounded to sub-angular GRAVEL. Gravel of mixed lithologies including fine to coarse rounded to sub-angular sandstone & mudstone.	5
		6.70	D				6.70	31.76		Very dense red brown fine to medium clayey SAND.	7
							7.50	30.96		Reddish light brown weathered SANDSTONE.	8
							8.20	30.26		Red weathered SANDSTONE. (drillers's description).	9
							10.00	28.46		Continued on next sheet	10

Remarks

0.0 to 8.2m cable percussion drilling. 8.2 to 10.0m rotary openhole. 10 to 20.0m rotary core drilling. Ground level recorded estimated based on topographical survey. Refer to alternate logs attached for in situ test results.





17-19 Whitworth Street West
Manchester
M15WG

Rotary Core Log

Borehole No.

BH02

Sheet 2 of 2

Project Name: Chandos Hall, Manchester

Project No.
B065374.001

Co-ords: -

Hole Type
CP+RC

Location: Manchester

Level: 38.46

Scale
1:50

Client: IQ Student Accomodation

Dates: 19/07/2018 -

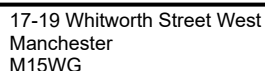
Logged By
NF/Geocore

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD					
		10.00 - 11.00	0	47	45	10				Medium strong reddish brown medium grained arenaceous SANDSTONE. Occasional inter-bedded medium quartz gravels/clasts. Generally fresh. Completely weathered in non intact areas where recovered as silty medium sand.	11
			NR								
		11.00 - 12.00	0	89	87	31					12
			NR								
		12.00 - 13.00	0	88	85	23				Unfractured insitu	13
			NR								
		13.00 - 14.50	0	86	77	33					14
			NR								
		14.50 - 16.00	0	78	67	53				Fractures sub horizontal, closely spaced, planar, smooth and wide with up to 80mm sand infill.	15
			5.8								
			NR								
		16.00 - 17.50	0	81	79	41					16
			NR								
		17.50 - 19.00	0	88	85	36				Unfractured insitu	17
			NR								
		19.00 - 20.00	NI	53	17	0				Notable dark reddish brown 100mm siltstone lens.	18
			0								
			NR								
							20.00	18.46		End of borehole at 20.00 m	19

Remarks

0.0 to 8.2m cable percussion drilling. 8.2 to 10.0m rotary openhole. 10 to 20.0m rotary core drilling. Ground level recorded estimated based on topographical survey. Refer to alternate logs attached for in situ test results.





Trialpit No

TP01

Sheet 1 of 1

Project Name:	Chandos Hall, Manchester
---------------	--------------------------

Project No.
B065374.001

Co-ords:	-
Level:	38.39

Date
21/07/2017

Location: Manchester

Dimensions
(m):

Scale
1:25

Client: IQ Student Accommodation

Depth
0.35

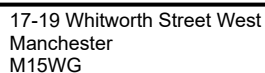
Logged
NF

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.12	38.27		MADE GROUND: Tarmac.
				0.35	38.04		MADE GROUND: Yellow brown sandy gravelly cobbles of sub-angular to subrounded sandstone. Gravel is fine to coarse sandstone. Concrete foundation at 0.35m bgl. End of pit at 0.35 m

Remarks:	No Groundwater Encountered. Reference should be given to associated foundation cross section sketch.
----------	--

Stability: Stable.





Trialpit No

TP02

Sheet 1 of 1

Project Name:	Chandos Hall, Manchester
---------------	--------------------------

Project No.
B065374.001

Co-ords:	-
Level:	38.44

Date
21/07/2017

Location: Manchester

Dimensions
(m):

Scale
1:25

Client: IQ Student Accommodation

Depth
0.30

Logged
NF

[illegible]

Remarks:	No Groundwater Encountered. Reference should be given to associated foundation cross section sketch.
----------	--

Stability: Stable.





17-19 Whitworth Street West
Manchester
M15WG

Trial Pit Log

Trialpit No

TP03

Sheet 1 of 1

Project Name: Chandos Hall, Manchester

Project No.
B065374.001

Co-ords: -
Level: 38.44

Date
21/07/2017

Location: Manchester

Dimensions
(m):

Depth
0.80

Scale
1:25

Logged
NF

Client: IQ Student Accomodation

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.10	38.34		MADE GROUND: Tarmac.
				0.40	38.04		MADE GROUND: Dark brown fine to coarse sandy gravel of fine to coarse angular to sub-rounded ash, clinker, bitumen and sandstone with occasional cobbles of sandstone.
				0.80	37.64		Stiff dark brown with grey mottling CLAY with frequent fine to coarse sub-angular to rounded gravel of mixed lithologies including coal, sandstone, mudstone, limestone. Concrete foundation identified at 0.40m, wooden shuttering surrounding, base not confirmed.
							End of pit at 0.80 m

1

2

3

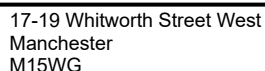
4

5

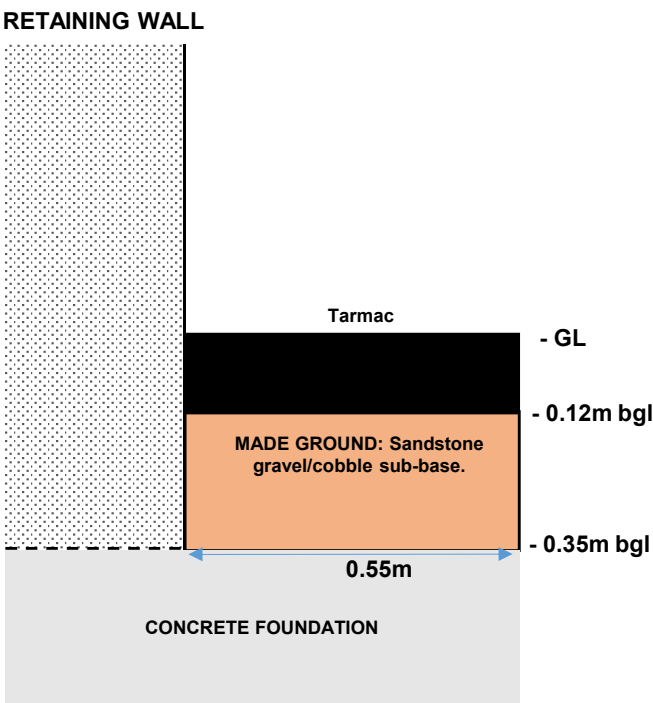
Remarks: No Groundwater Encountered. Reference should be given to associated foundation cross section sketch.

Stability: Stable.



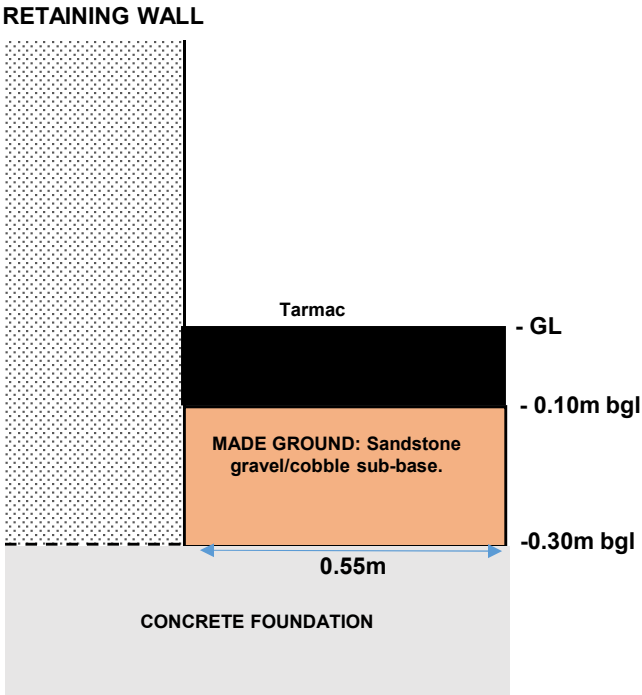


TP01- Identified Dimensions



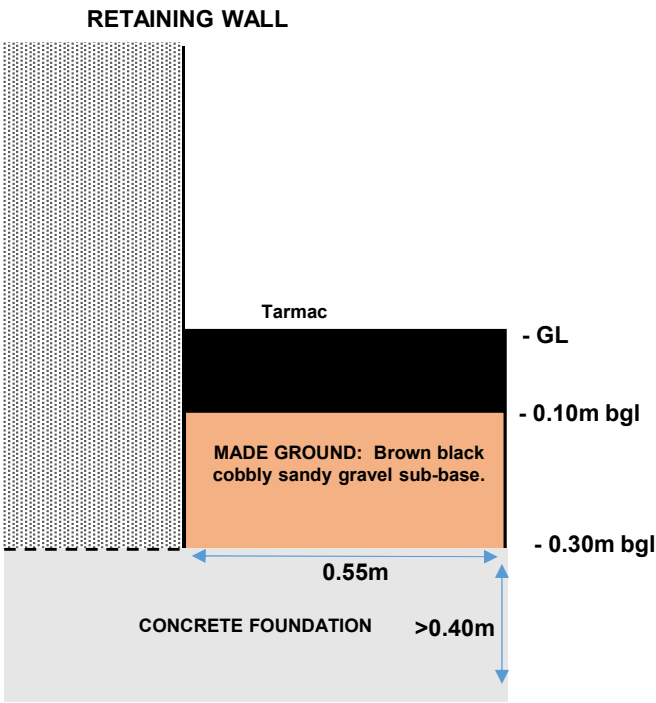
Comments: Not to scale.
Concrete foundation encountered but thickness not identified. Reference should be given to corresponding trial pit log for further strata details.

TP02- Identified Dimensions



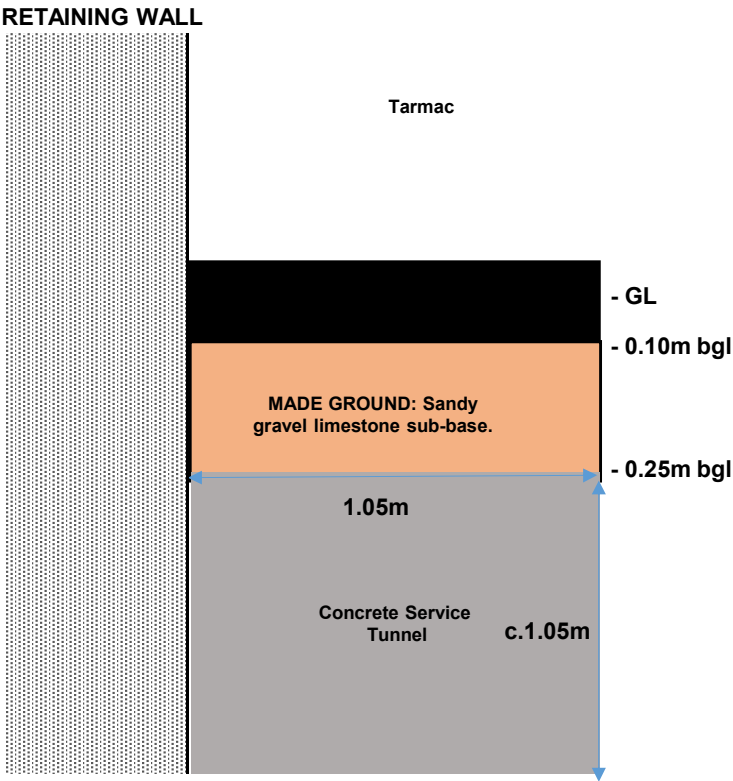
Comments: Not to scale.
Concrete foundation encountered but thickness not identified. Reference should be given to corresponding trial pit log for further strata details.

TP03- Identified Dimensions



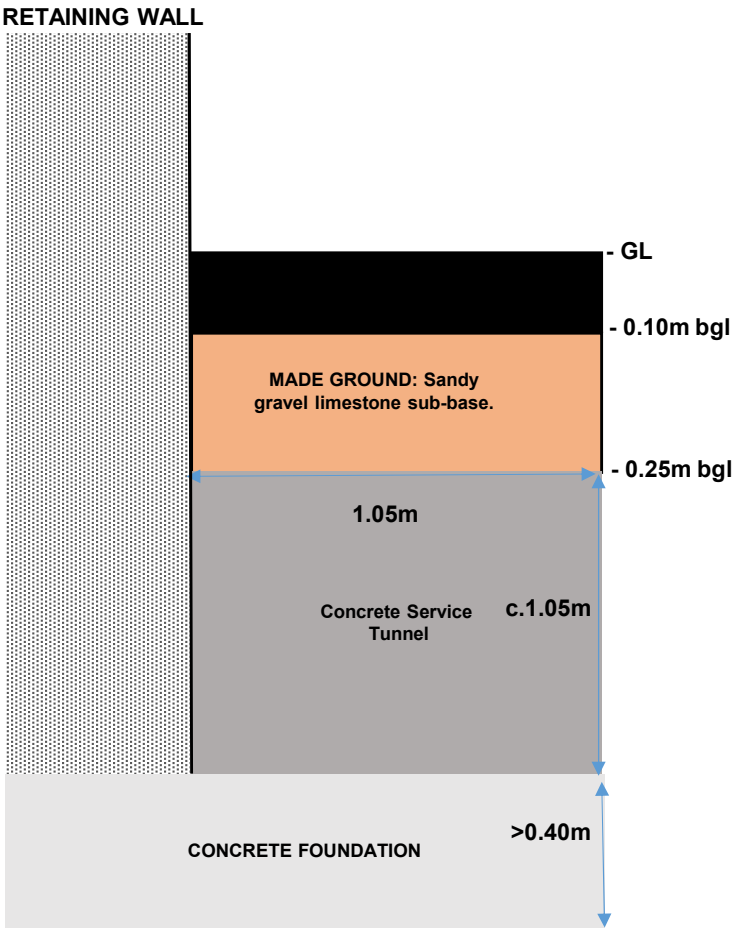
Comments: Not to scale.
Concrete foundation encountered but base not identified. Reference should be given to corresponding trial pit log for further strata details.

TP04- Identified Dimensions



Comments: Not to scale. Concrete service tunnel encountered, wall foundation not identified. Reference should be given to corresponding trial pit log for further strata details.

TP04- Estimated Potential Extent of Foundation



Comments: Not to scale. Drawing shows estimated potential extent of foundation based on available information, indicative only, foundation not proven during investigation.



Curtins
Merchant Exchange
17-19 Whitworth Street West
Manchester
M1 5WG

Borehole Log

Borehole No.

WS01

Sheet 1 of 2

Project Name: Chandos Hall (Stage 2)

Project No.
B065374.001 (2)

Co-ords: -

Hole Type
WS

Location: Granby Row, Manchester

Level: 38.35

Scale
1:16

Client: IQ Student Accommodation

Dates: 27/09/2017 - 27/09/2017

Logged By
JB

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.05	38.30		ASPHALT.	
					0.15	38.20		MADE GROUND: dark grey, cobbly, sandy, angular to sub-angular, fine to coarse GRAVEL of asphalt and concrete. Cobbles are fine, angular to sub-angular of asphalt and concrete. (SUB-BASE)	
		0.40 - 0.50	ES		0.40	37.95		MADE GROUND: yellowish-brown, very gravelly, cobbly, fine to coarse SAND. Gravel and cobbles are angular to sub-angular of concrete, asphalt, various lithologies including sandstone, clinker and ash.	
					0.50	37.85		MADE GROUND: dark grey, fine to coarse SAND and angular to sub-rounded, fine to medium GRAVEL of sandstone, concrete, ash, tile and brick.	
		0.70 - 1.00	ES					MADE GROUND: brown, slightly cobbly, very gravelly, fine to coarse SAND. Gravel is angular to sub-angular, fine to coarse. Cobbles are angular to sub-angular, fine to medium. Gravel and cobbles comprise brick, various lithologies, coal, clinker, asphalt.	1
					1.00	37.35		MADE GROUND: reddish-grey, very gravelly, fine to coarse SAND. Gravel is angular to sub-angular, fine to medium of brick and concrete.	
		1.20		N=7 (1,2/2,2,2,1)	1.20	37.15		MADE GROUND: brown, sandy, slightly gravelly CLAY. Gravel is angular to sub-rounded of various lithologies, brick, coal and clinker.	
					1.40	36.95		MADE GROUND: reddish-grey, cobbly, very gravelly, fine to coarse SAND. Gravel is angular to sub-angular, fine to coarse of brick and concrete. Cobbles are angular to sub-angular, fine to medium of brick. (water seepages throughout stratum)	
					1.70	36.65		MADE GROUND: soft, brown, sandy, slightly gravelly CLAY. Gravel is angular to sub-rounded of various lithologies, brick, coal and clinker.	2
		2.00		N=3 (1,1/0,1,1,1)					
					2.70	35.65		MADE GROUND: firm, brown, very sandy, slightly gravelly CLAY. Gravel is sub-angular to sub-rounded of concrete, brick and various lithologies including coal and mudstone. (REWORKED GROUND)	
		3.00		N=13 (2,2/2,3,4,4)					3

Continued on next sheet

Remarks

Service inspection pit hand excavated from GL to 1.20m. Water seepages at 1.40m bgl. SPT rod lost in hole.





Borehole Log

Borehole No.

WS02

Sheet 1 of 1

Project Name: Chandos Hall (Stage 2)

Project No.	B065374.001 (2)
-------------	-----------------

Co-ords: -

Hole Type	WS
1	1
2	2
3	3
4	4
5	5
6	6
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89	89
90	90
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95	95
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98	98
99	99
100	100

Location: Granby Row, Manchester

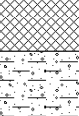
Level: 38.40

Scale
1:16

Client: IQ Student Accommodation

Dates: 27/09/2017 - 27/09/2017

Logged By
JB

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.10 - 0.20	ES		0.05	38.35		ASPHALT.
					0.10	38.30		MADE GROUND: grey, very sandy, angular, fine to medium GRAVEL of various lithologies and concrete. (SUB-BASE)
					0.30	38.10		MADE GROUND: yellowish-grey, very gravelly, fine to coarse SAND. Gravel is angular to sub-angular of concrete, asphalt, various lithologies including sandstone, clinker and ash. (slight hydrocarbon odour noted)
					0.60	37.80		Firm to stiff, dark brown, sandy, slightly gravelly CLAY with silt lenses containing relic rootlets. Gravel is rounded to sub-angular, fine to medium of various lithologies including coal.
								End of borehole at 0.60 m

Remarks

Service inspection pit hand excavated from GL to 0.60m. Borehole terminated at 0.60m bgl due to unknown obstruction. No groundwater encountered.





Curtins
Merchant Exchange
17-19 Whitworth Street West
Manchester
M1 5WG

Borehole Log

Borehole No.

WS02A

Sheet 1 of 2

Project Name: Chandos Hall (Stage 2)

Project No.
B065374.001 (2)

Co-ords: -

Hole Type
WS

Location: Granby Row, Manchester

Level: 38.40

Scale
1:16

Client: IQ Student Accommodation

Dates: 27/09/2017 - 27/09/2017

Logged By
JB

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.05			0.05	38.35		ASPHALT.	
		0.10			0.10	38.30		MADE GROUND: grey, very sandy, angular, fine to medium GRAVEL of various lithologies and concrete. (SUB-BASE)	
		0.30 - 0.40	ES		0.30	38.10		MADE GROUND: yellowish-brown, very gravelly, fine to coarse SAND. Gravel is angular to sub-angular of concrete, asphalt, various lithologies including sandstone, clinker and ash.	
					0.40	38.00		MADE GROUND: dark grey, fine to coarse SAND and angular to sub-rounded, fine to medium GRAVEL of sandstone, concrete, ash, tile and brick.	
								Firm to stiff, dark brown, sandy, slightly gravelly CLAY with silt lenses containing relic rootlets. Gravel is rounded to sub-angular, fine to medium of various lithologies including coal.	
		1.20		N=23 (3,4/5,5,6,7)				Yellowish-brown, medium SAND horizon (0.02m thick).	1
		2.00		N=21 (3,4/4,5,6,6)					2
		3.00		N=48 (7,10/10,14,13,11)				Becomes very stiff.	3
					3.20	35.20		Continued on next sheet	

Remarks

Service inspection pit hand excavated from GL to 1.20m. No groundwater encountered. Borehole terminated at 3.80m bgl due to SPT refusal.





Curtins
Merchant Exchange
17-19 Whitworth Street West
Manchester
M1 5WG

Borehole Log

Borehole No.

WS02A

Sheet 2 of 2

Project Name: Chandos Hall (Stage 2)

Project No.
B065374.001 (2)

Co-ords: -

Hole Type
WS

Location: Granby Row, Manchester

Level: 38.40

Scale
1:16

Client: IQ Student Accommodation

Dates: 27/09/2017 - 27/09/2017

Logged By
JB

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		3.80		N=58 (8,8/10,12,16,20)	3.50	34.90		Very dense, brown, silty, clayey, fine to medium SAND with rare coal fragments.	
								Very dense, reddish-brown, medium SAND.	
					3.80	34.60		End of borehole at 3.80 m	

Remarks

Service inspection pit hand excavated from GL to 1.20m. No groundwater encountered. Borehole terminated at 3.80m bgl due to SPT refusal.





Curtins
Merchant Exchange
17-19 Whitworth Street West
Manchester
M1 5WG

Borehole Log

Borehole No.

WS03

Sheet 1 of 1

Project Name: Chandos Hall (Stage 2)

Project No.
B065374.001 (2)

Co-ords: 384657.81 - 397714.44

Hole Type
WS

Location: Granby Row, Manchester

Level: 38.84

Scale
1:16

Client: IQ Student Accommodation

Dates: 27/09/2017 - 27/09/2017

Logged By
JB

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.50 - 0.60	ES		0.05	38.79		ASPHALT.	1
					0.15	38.69		MADE GROUND: grey, very sandy, angular, fine to medium GRAVEL of various lithologies and concrete. (SUB-BASE)	
					0.40	38.44		MADE GROUND: yellowish-brown, very gravelly, fine to coarse SAND. Gravel is angular to sub-angular of concrete, asphalt, various lithologies including sandstone, clinker and ash. (slight hydrocarbon odour noted)	
					0.60	38.24		MADE GROUND: dark grey, fine to coarse SAND and angular to sub-rounded, fine to medium GRAVEL of sandstone, concrete, ash, tile and brick.	
								Firm, dark brown, sandy, slightly gravelly CLAY with silt lenses containing relic rootlets. Gravel is rounded to sub-angular, fine to medium of various lithologies including coal. <i>Water seepage.</i>	
		1.20		N=22 (3,3/4,4,6,8)				<i>Becomes stiff.</i>	
		2.00		N=24 (5,7/6,6,6,6)					
		3.00		N=56 (13,14/14,14,14,14)	2.90	35.94		Yellowish-brown, medium SAND horizon (0.02m thick).	2
								Yellowish-brown, medium SAND horizon (0.02m thick).	
								Yellowish-brown, medium SAND horizon (0.02m thick).	
					3.00	35.84		Very dense, reddish-brown, medium SAND.	
								End of borehole at 3.00 m	

Remarks

Service inspection pit hand excavated from GL to 1.20m. Water seepages at 0.70m bgl. Borehole terminated at 3.00m bgl due to SPT refusal.





Curtins
Merchant Exchange
17-19 Whitworth Street West
Manchester
M1 5WG

Borehole Log

Borehole No.

WS04

Sheet 1 of 2

Project Name: Chandos Hall (Stage 2)

Project No.
B065374.001 (2)

Co-ords: 384640.04 - 397710.26

Hole Type
WS

Location: Granby Row, Manchester

Level: 38.45

Scale
1:16

Client: IQ Student Accommodation

Dates: 27/09/2017 - 27/09/2017

Logged By
JB

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.15 - 0.25	ES		0.05	38.40		ASPHALT.
					0.15	38.30		MADE GROUND: dark grey, cobbly, sandy, angular to sub-angular, fine to coarse GRAVEL of asphalt and concrete. Cobbles are fine, angular to sub-angular of asphalt and concrete. (SUB-BASE)
					0.35	38.10		MADE GROUND: yellowish-brown, very gravelly, fine to coarse SAND. Gravel is angular to sub-angular of concrete, asphalt, various lithologies including sandstone, clinker and ash.
					0.40	38.05		MADE GROUND: dark grey, fine to coarse SAND and angular to sub-rounded, fine to medium GRAVEL of sandstone, concrete, ash, tile and brick.
		1.20		N=14 (2,3/3,3,4,4)				Firm, dark brown, sandy, slightly gravelly CLAY with low cobble content. Gravel is rounded to sub-angular, fine to medium of various lithologies including coal.
		2.00		N=17 (3,3/3,4,5,5)				
		3.00		N=58 (4,6/9,13,17,19)				
					3.20	35.25		Continued on next sheet

Remarks

Service inspection pit hand excavated from GL to 1.20m. No groundwater encountered. Borehole terminated at 3.40m bgl due to refusal.





Curtins
Merchant Exchange
17-19 Whitworth Street West
Manchester
M1 5WG

Borehole Log

Borehole No.

WS04

Sheet 2 of 2

Project Name: Chandos Hall (Stage 2)

Project No.
B065374.001 (2)

Co-ords: 384640.04 - 397710.26

Hole Type
WS

Location: Granby Row, Manchester

Level: 38.45

Scale
1:16

Client: IQ Student Accommodation

Dates: 27/09/2017 - 27/09/2017

Logged By
JB

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					3.40	35.05		Very dense, reddish-brown, medium SAND.	
								End of borehole at 3.40 m	
									4
									5
									6

Remarks

Service inspection pit hand excavated from GL to 1.20m. No groundwater encountered. Borehole terminated at 3.40m bgl due to refusal.





Curtins
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17-19 Whitworth Street West
Manchester
M1 5WG

Trial Pit Log

Trialpit No

FP101

Sheet 1 of 1

Project Name: Chandos Hall (Stage 2)

Project No.
B065374.001 (2)

Co-ords: -
Level: 38.44

Date
27/09/2017

Location: Granby Row, Manchester

Dimensions
(m):

Depth
1.35

Scale
1:15

Logged
JB

Client: IQ Student Accommodation

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.05	38.39		ASPHALT.
				0.15	38.29		MADE GROUND: dark grey, cobbly, sandy, angular to sub-angular, fine to coarse GRAVEL of asphalt and concrete. Cobbles are fine, angular to sub-angular of asphalt and concrete. (SUB-BASE)
				0.30	38.14		MADE GROUND: light brown, cobbly, sandy, angular to sub-angular, fine to coarse GRAVEL of limestone and concrete. Cobbles are fine, angular to sub-angular of limestone and concrete. (SUB-BASE)
				0.60	37.84		MADE GROUND: yellowish-brown, very gravelly, cobbly, fine to coarse SAND. Gravel and cobbles are angular to sub-angular of concrete, asphalt, various lithologies including sandstone, clinker and ash.
				1.35	37.09		MADE GROUND: firm, dark brown, sandy, slightly gravelly CLAY with tile and metal fragments and cobbles of brick. Gravel is sub-angular, fine to medium of various lithologies including coal.
							End of pit at 1.35 m

1

2

3

Remarks: Please refer to foundation pit cross-section for dimensions of service corridor and other encountered concrete.
Foundation pit terminated at 1.35m bgl due to obstruction.

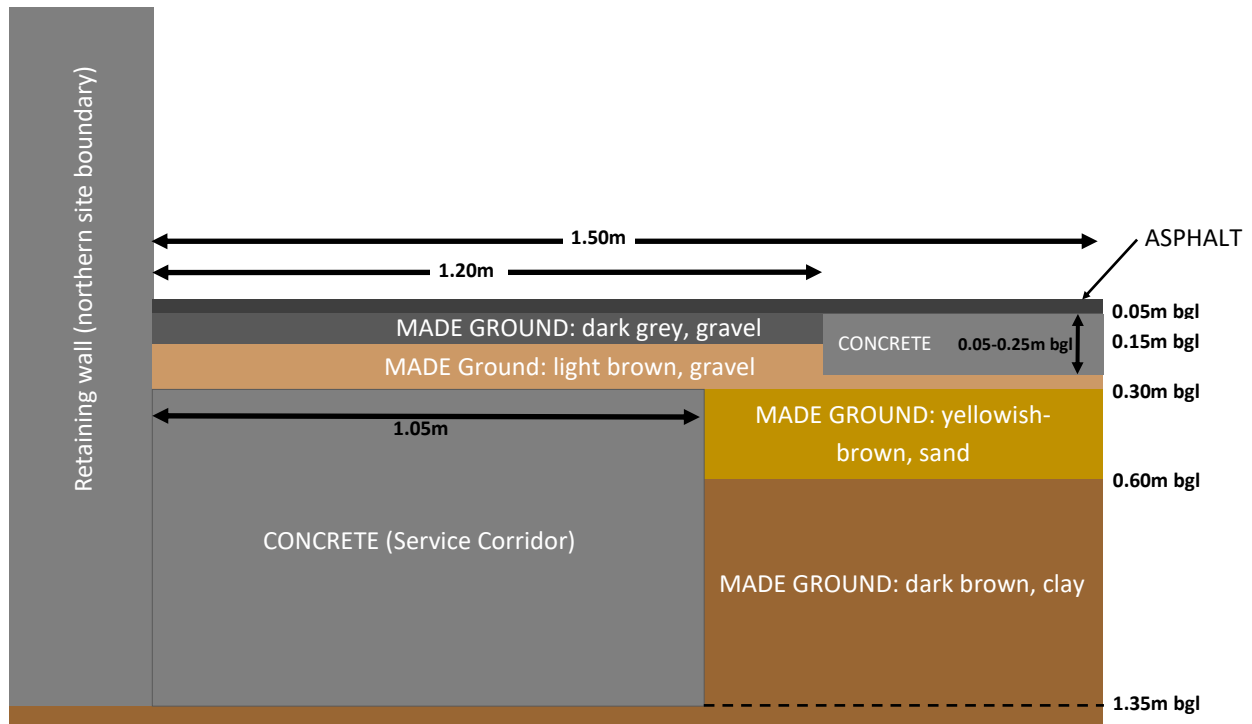
Stability:



Chandos Hall (Stage 2)

Foundation Pit Cross Sectional Sketches

FP101



Comments: Not to scale. Reference should be given to corresponding trial pit log for further strata details. Trial pit edge stable.



Merchant Exchange
17-19 Whitworth Street West
Manchester
M1 5WG

Borehole Log

Borehole No.

WS05

Sheet 1 of 1

Project Name: Chandos Hall (Stage 3)

Project No.
B065374.001 (3)

Co-ords: -

Hole Type
WS

Location: Manchester

Level: 40.10

Scale
1:26

Client: IQ Student Accommodation

Dates: 19/01/2018 - 19/01/2018

Logged By
JB

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20 - 0.30	ES		0.10	40.00		CONCRETE.	1
					0.30	39.80		MADE GROUND: dark brown, slightly clayey, fine to coarse SAND and angular to sub-angular, fine to coarse GRAVEL of brick, concrete, clinker and coal with cobbles of concrete.	
					0.80	39.30		MADE GROUND: dark greyish-brown, very gravelly, very sandy CLAY with cobbles of concrete. Gravel is angular to sub-rounded, fine to coarse of brick, coal, sandstone and concrete.	
								Firm to stiff, greyish-brown with grey mottling, very sandy, slightly gravelly CLAY. Gravel is sub-angular to sub-rounded, fine to coarse of various lithologies including sandstone, coal and mudstone.	
								<i>Becomes stiff to very stiff.</i>	2
					2.90	37.20		End of borehole at 2.90 m	3
									4
									5

Remarks

Service inspection pit hand excavated from GL to 1.20m. Borehole terminated at 2.90m bgl due to possible cobble obstruction. Hand held window sampler used.





Merchant Exchange
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Borehole Log

Borehole No.

WS06

Sheet 1 of 1

Project Name: Chandos Hall (Stage 3)

Project No.
B065374.001 (3)

Co-ords: -

Hole Type
WS

Location: Manchester

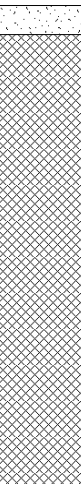
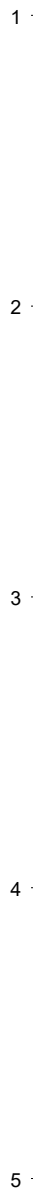
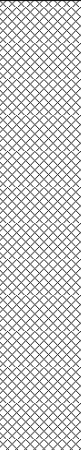
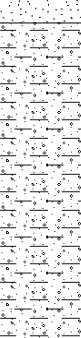
Level: 40.20

Scale
1:26

Client: IQ Student Accommodation

Dates: 19/01/2018 - 19/01/2018

Logged By
JB

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.70 - 0.80	ES		0.10	40.10		Reinforced CONCRETE.	
								MADE GROUND: light brown, fine to coarse SAND and angular to sub-angular, fine to medium GRAVEL of aggregate and rare glass and clinker.	
					1.70 1.80	38.50 38.40		<u>Perched water.</u> Loose to medium-dense, dark brown, fine to medium SAND with rare coal fragments. Stiff, greyish-brown, slightly sandy, slightly gravelly CLAY with rare vertical grey fine sand lenses. Gravel is sub-angular to sub-rounded, fine of various lithologies including sandstone, mudstone and coal. <u>Limited recovery.</u>	
					2.90	37.30		End of borehole at 2.90 m	

Remarks

Service inspection pit hand excavated from GL to 1.20m. Perched water encountered at 1.60m bgl. Borehole terminated at 2.90m bgl due to collapse. Hand held window sampler used.





Merchant Exchange
17-19 Whitworth Street West
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M1 5WG

Borehole Log

Borehole No.

WS07

Sheet 1 of 1

Project Name: Chandos Hall (Stage 3)

Project No.
B065374.001 (3)

Co-ords: -

Hole Type
WS

Location: Manchester

Level: 40.20

Scale
1:26

Client: IQ Student Accommodation

Dates: 19/01/2018 - 19/01/2018

Logged By
JB

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.60	ES		0.10	40.10		CONCRETE.	
					0.70	39.50		MADE GROUND: dark greyish-brown, slightly clayey, fine to coarse SAND and angular to sub-angular, fine to coarse GAVEL of brick, sandstone, coal, concrete and glass with occasional rare whole and part brick.	
					1.10	39.10		MADE GROUND: greyish-brown, very gravelly, very sandy CLAY. Gravel is angular to sub-rounded, fine to medium of coal, brick, sandstone and concrete.	
								Firm to stiff, greyish-brown with grey mottling, very sandy, slightly gravelly CLAY. Gravel is sub-angular to sub-rounded, fine to coarse of various lithologies including sandstone, coal and mudstone.	
								Becomes stiff to very stiff.	
								Bed of fine SAND.	
					3.00	37.20	End of borehole at 3.00 m		

Remarks

Service inspection pit hand excavated from GL to 1.20m. Borehole terminated at 3.00m bgl due to possible cobble obstruction. Hand held window sampler used.





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Borehole Log

Borehole No.

WS08

Sheet 1 of 1

Project Name: Chandos Hall (Stage 3)

Project No.
B065374.001 (3)

Co-ords: 384673.09 - 397697.98

Hole Type
WS

Location: Manchester

Level: 40.02

Scale
1:26

Client: IQ Student Accommodation

Dates: 20/01/2018 - 20/01/2018

Logged By
JB

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.10 - 0.20	ES		0.05	39.97		ASPHALT. MADE GROUND: dark grey, clayey, very gravelly, fine to coarse SAND. Gravel is angular to sub-rounded, fine to coarse of concrete, ash, clinker, brick, tile and sandstone. (ASH FILL)	
					0.80	39.22		MADE GROUND: greyish-brown, gravelly, sandy CLAY. Gravel is angular to sub-rounded, fine to medium of mudstone, brick, sandstone and concrete.	1
		1.20		N=6 (0,0/1,2,1,2)					
		1.80 - 2.00	ES		1.80	38.22		MADE GROUND: very soft, black, gravelly, sandy CLAY. Gravel is angular to sub-angular, fine to coarse of brick, coal, clinker and concrete.	
		2.00		N=19 (2,2/4,4,5,6)	2.00	38.02		Stiff to very stiff, greyish-brown, gravelly, sandy CLAY with grey silt lenses. Gravel is sub-angular to sub-rounded, fine to coarse of mudstone, sandstone and coal. <u>Perched water.</u>	2
		3.00		N=24 (4,4/5,5,7,7)	3.00	37.02		End of borehole at 3.00 m	3
									4
									5

Remarks

Service inspection pit hand excavated from GL to 1.20m. Perched water encountered at 2.00m bgl.





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Borehole Log

Borehole No.

WS09

Sheet 1 of 1

Project Name: Chandos Hall (Stage 3)

Project No.
B065374.001 (3)

Co-ords: 384681.72 - 397708.34

Hole Type
WS

Location: Manchester

Level: 40.30

Scale
1:26

Client: IQ Student Accommodation

Dates: 20/01/2018 - 20/01/2018

Logged By
JB

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.30 - 0.40	ES		0.20	40.10		Grass over MADE GROUND of dark brown, sandy, gravelly CLAY with frequent rootlets. Gravel is angular to sub-rounded, fine to medium of tile, brick, concrete, sandstone and coal.	
					0.40	39.90		MADE GROUND: very dark grey, fine to coarse SAND and angular to sub-angular, fine to coarse GRAVEL of brick, concrete, ash, clinker and tile with frequent cobbles of whole and part brick (BRICK FILL).	
					0.70	39.60		MADE GROUND: dark grey, clayey, very gravelly, fine to coarse SAND. Gravel is angular to sub-rounded, fine to coarse of concrete, ash, clinker, brick, tile and sandstone. (ASH FILL)	
					0.80	39.50		MADE GROUND: greyish-brown, sandy, gravelly CLAY. Gravel is angular to sub-rounded, fine to medium of sandstone, mudstone, brick and concrete.	
		1.20		N=17 (2,1/4,3,4,6)				Stiff, greyish-brown, gravelly, sandy CLAY with grey silt lenses. Gravel is sub-angular to sub-rounded, fine to coarse of mudstone, sandstone and coal.	
								Perched water.	
		2.00		N=27 (6,5/6,8,7,6)					
		3.00		N=30 (5,6/6,7,8,9)					
		4.00		N=18 (3,3/4,4,5,5)					
		4.50 - 4.70	D						
		4.70		50 (8 for 75mm/50 for 95mm)	4.70	35.60		End of borehole at 4.70 m	

Remarks

Service inspection pit hand excavated from GL to 1.20m. Perched water encountered at 1.20m bgl. Borehole terminated at 4.70m bgl due to cobble obstruction.





Merchant Exchange
17-19 Whitworth Street West
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Borehole Log

Borehole No.

WS10

Sheet 1 of 1

Project Name: Chandos Hall (Stage 3)

Project No.
B065374.001 (3)

Co-ords: 384666.42 - 397721.70

Hole Type
WS

Location: Manchester

Level: 40.47

Scale
1:26

Client: IQ Student Accommodation

Dates: 20/01/2018 - 20/01/2018

Logged By
JB

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.50 - 0.60	ES		0.30 0.40 0.50 0.60	40.17 40.07 39.97 39.87		Grass over MADE GROUND of dark brown, sandy, gravelly CLAY with frequent rootlets. Gravel is angular to sub-rounded, fine to medium of tile, brick, concrete, sandstone and coal.	1
								MADE GROUND: very dark grey, fine to coarse SAND and angular to sub-angular, fine to coarse GRAVEL of brick, concrete, ash, clinker and tile with frequent cobbles of whole and part brick (BRICK FILL).	
								MADE GROUND: dark grey, clayey, very gravelly, fine to coarse SAND. Gravel is angular to sub-rounded, fine to coarse of concrete, ash, clinker, brick, tile and sandstone. (ASH FILL)	
		1.20 1.20 - 1.40	ES	N=8 (4,1/1,1,2,4)				MADE GROUND: greyish-brown, sandy, gravelly CLAY. Gravel is angular to sub-rounded, fine to medium of sandstone, mudstone, brick, asphalt, clinker, coal and concrete.	
					1.40 1.50	39.07 38.97		MADE GROUND: dark grey, clayey, very gravelly, fine to coarse SAND. Gravel is angular to sub-rounded, fine to coarse of concrete, ash, clinker, brick, tile and sandstone. (ASH FILL)	
								Soft, greyish-brown, sandy CLAY.	
		2.00		N=19 (1,2/4,5,4,6)				Firm to stiff, greyish-brown, gravelly, sandy CLAY with rare grey silt lenses. Gravel is sub-angular to sub-rounded, fine to coarse of various lithologies including mudstone, sandstone and coal.	
		2.80 - 3.00 3.00	D	N=19 (3,4/4,4,5,6)					
		4.00		N=22 (3,4/4,4,6,8)					
		5.00		N=38 (3,7/7,8,11,12)	5.00	35.47			
								End of borehole at 5.00 m	5

Remarks

Service inspection pit hand excavated from GL to 1.20m.





Merchant Exchange
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Borehole Log

Borehole No.

WS11

Sheet 1 of 1

Project Name: Chandos Hall (Stage 3)

Project No.
B065374.001 (3)

Co-ords: 384703.63 - 397718.89

Hole Type
WS

Location: Manchester

Level: 40.87

Scale
1:26

Client: IQ Student Accommodation

Dates: 20/01/2018 - 20/01/2018

Logged By
JB

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.10 - 0.20	ES		0.05	40.82		ASPHALT.	1
					0.30	40.57		MADE GROUND: light brown, very sandy, angular to sub-angular, fine to coarse GRAVEL of aggregate (HARDCORE).	
		0.50 - 0.60	ES					MADE GROUND: greyish-brown, gravelly, very sandy CLAY with rare cobbles of whole and part bricks. Gravel is angular to sub-rounded, fine to coarse of coal, brick, clinker, ash, sandstone and concrete.	
						<i>Black staining (no odour).</i>			
		1.20		N=15 (2,2/3,3,4,5)	1.20	39.67		MADE GROUND: green, silty, fine SAND.	2
					1.25	39.62		Firm to stiff, greyish-brown, sandy, slightly gravelly CLAY with grey silt lenses. Gravel is sub-angular to sub-rounded, fine to medium of various lithologies including sandstone, coal and mudstone.	
		2.00		N=26 (4,5/6,6,6,8)	2.00	38.87		<i>Becomes stiff to very stiff.</i>	
					2.10	38.77		<i>No grey silt lenses.</i>	
								Greyish-brown, sub-angular to sub-rounded, fine to coarse GRAVEL of chert, sandstone and mudstone.	
								Stiff to very stiff, greyish-brown, sandy, slightly gravelly CLAY. Gravel is sub-angular to sub-rounded, fine to medium of various lithologies including sandstone, mudstone and coal.	
								<i>Common light brown and grey, silt and sand, vertical and horizontal lenses.</i>	3
		3.00		N=25 (4,4/4,5,7,9)				<i>Rare light brown and grey, silt and sand, vertical and horizontal lenses.</i>	
		3.50 - 3.70	D						
		4.00		N=22 (4,4/4,5,6,7)					4
		5.00		23 (10,14/23 for 125mm)	5.00	35.87			5
					End of borehole at 5.00 m				

Remarks

Service inspection pit hand excavated from GL to 1.20m. Black staining (no odour) at 0.50-1.20m bgl.





Merchant Exchange
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Borehole Log

Borehole No.

BH03

Sheet 1 of 3

Project Name: Chandos Hall (Stage 3)

Project No.
B065374.001 (3)

Co-ords: 384678.76 - 397695.80

Hole Type
CP+RC

Location: Manchester

Level: 40.06

Scale
1:50

Client: IQ Student Accommodation

Dates: 19/01/2018 - 20/01/2018

Logged By
JB

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.30 - 0.40	ES		0.05	40.01		ASPHALT.	
								MADE GROUND: dark grey, clayey, very gravelly, fine to coarse SAND. Gravel is angular to sub-rounded, fine to coarse of concrete, ash, clinker, brick, tile and sandstone. (ASH FILL) <i>Cobbles of whole and part bricks.</i>	1
		1.50		N=28 (2,3/7,7,7,7)	1.20 1.40	38.86 38.66		MADE GROUND: very soft, greyish-brown with black mottling, very sandy, slightly gravelly CLAY. Gravel is angular to sub-rounded, fine to coarse of concrete, brick, coal and sandstone.	
		2.20	D					Stiff, greyish-brown, slightly gravelly, slightly sandy CLAY. Gravel is sub-angular to sub-rounded, fine to medium of various lithologies including coal, mudstone and predominantly sandstone.	2
		2.50		N=27 (2,4/6,6,7,8)					3
		4.50		N=27 (3,3/4,7,8,8)					4
		4.50 - 4.70	D						
		5.00 - 5.50	D		4.90	35.16		Loose to very dense, reddish-brown, very clayey, slightly gravelly, fine to medium SAND. Gravel is sub-angular to sub-rounded, fine to medium of weathered sandstone and mudstone.	5
		6.00		111 (25 for 75mm/111 for 75mm)					6
					6.50	33.56		Dense to very dense, reddish-brown, slightly cobbly, gravelly, fine to coarse SAND. Gravel is sub-angular to sub-rounded, fine to coarse of various lithologies including sandstone, mudstone and quartzite. Cobbles are sub-angular to sub-rounded, fine of quartzite and granite.	7
									8
									9
									10

Continued on next sheet

Remarks

Service inspection pit hand excavated from GL to 1.20m. Slight odour noted at 0.05-1.20m bgl. Cable percussion drilling 1.20-6.50m bgl. Rotary open drilling 6.50-15.10m bgl. Rotary core drilling 15.10-25.50m bgl. Refer to alternate logs attached for rock core details.





Merchant Exchange
17-19 Whitworth Street West
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Borehole Log

Borehole No.

BH03

Sheet 2 of 3

Project Name: Chandos Hall (Stage 3)

Project No.
B065374.001 (3)

Co-ords: 384678.76 - 397695.80

Hole Type
CP+RC

Location: Manchester

Level: 40.06

Scale
1:50

Client: IQ Student Accommodation

Dates: 19/01/2018 - 20/01/2018

Logged By
JB

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					13.50	26.56			11
									12
									13
									14
								Strong, reddish-brown, medium grained, arenaceous SANDSTONE with occasional rounded medium to coarse gravel. Generally fresh except where non-intact material completely weathered to a medium sand.	15
								Some drill & transport induced fractures.	16
								Some drill & transport induced fractures.	17
								Some drill & transport induced fractures.	18
								Some drill & transport induced fractures.	19
								Some drill & transport induced fractures.	20

Continued on next sheet

Remarks

Service inspection pit hand excavated from GL to 1.20m. Slight odour noted at 0.05-1.20m bgl. Cable percussion drilling 1.20-6.50m bgl. Rotary open drilling 6.50-15.10m bgl. Rotary core drilling 15.10-25.50m bgl. Refer to alternate logs attached for rock core details.





Merchant Exchange
17-19 Whitworth Street West
Manchester
M1 5WG

Borehole Log

Borehole No.

BH03

Sheet 3 of 3

Project Name: Chandos Hall (Stage 3)

Project No.
B065374.001 (3)

Co-ords: 384678.76 - 397695.80

Hole Type
CP+RC

Location: Manchester

Level: 40.06

Scale
1:50

Client: IQ Student Accommodation

Dates: 19/01/2018 - 20/01/2018

Logged By
JB

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
								Some drill & transport induced fractures.	
								Fracture sub-vertical (470mm), planar, rough and partly open with dark brown discolouration on fracture surface.	21
									22
								Fractures sub-horizontal, extremely loosely spaced, planar, smooth and tight.	23
								Some drill & transport induced fractures.	
									24
								Some drill & transport induced fractures.	
									25
					25.50	14.56		End of borehole at 25.50 m	26
									27
									28
									29
									30

Remarks

Service inspection pit hand excavated from GL to 1.20m. Slight odour noted at 0.05-1.20m bgl. Cable percussion drilling 1.20-6.50m bgl. Rotary open drilling 6.50-15.10m bgl. Rotary core drilling 15.10-25.50m bgl. Refer to alternate logs attached for rock core details.





Merchant Exchange
17-19 Whitworth Street West
Manchester
M1 5WG

Rotary Core Log

Borehole No.

BH03

Sheet 1 of 3

Project Name: Chandos Hall (Stage 3)

Project No.
B065374.001 (3)

Co-ords: 384678.76 - 397695.80

Hole Type
CP+RC

Location: Manchester

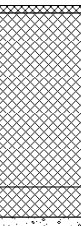
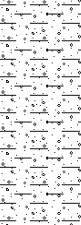
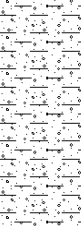
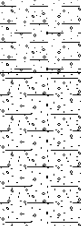
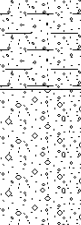
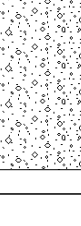
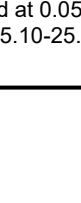
Level: 40.06

Scale
1:50

Client: IQ Student Accommodation

Dates: 19/01/2018 - 20/01/2018

Logged By
JB

Well	Water Strikes	Depth (m)	Type / Fl	Coring			Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD					
		0.30 - 0.40	ES				0.05 1.20 1.40	40.01 38.86 38.66		ASPHALT. MADE GROUND: dark grey, clayey, very gravelly, fine to coarse SAND. Gravel is angular to sub-rounded, fine to coarse of concrete, ash, clinker, brick, tile and sandstone. (ASH FILL) <i>Cobbles of whole and part bricks.</i>	1
		2.20	D							MADE GROUND: very soft, greyish-brown with black mottling, very sandy, slightly gravelly CLAY. Gravel is angular to sub-rounded, fine to coarse of concrete, brick, coal and sandstone. Stiff, greyish-brown, slightly gravelly, slightly sandy CLAY. Gravel is sub-angular to sub-rounded, fine to medium of various lithologies including coal, mudstone and predominantly sandstone.	2
		4.50 - 4.70	D								3
		5.00 - 5.50	D				4.90	35.16		Loose to very dense, reddish-brown, very clayey, slightly gravelly, fine to medium SAND. Gravel is sub-angular to sub-rounded, fine to medium of weathered sandstone and mudstone.	4
							6.50	33.56		Dense to very dense, reddish-brown, slightly cobbly, gravelly, fine to coarse SAND. Gravel is sub-angular to sub-rounded, fine to coarse of various lithologies including sandstone, mudstone and quartzite. Cobbles are sub-angular to sub-rounded, fine of quartzite and granite.	5
											6
											7
											8
											9
											10

Continued on next sheet

Remarks

Service inspection pit hand excavated from GL to 1.20m. Slight odour noted at 0.05-1.20m bgl. Cable percussion drilling 1.20-6.50m bgl. Rotary open drilling 6.50-15.10m bgl. Rotary core drilling 15.10-25.50m bgl. Refer to alternate logs attached for in-situ test results.



Rotary Core Log

Borehole No.

BH03

Sheet 2 of 3

Project Name: Chandos Hall (Stage 3)

Project No.
B065374.001 (3)

Co-ords: 384678.76 - 397695.80

Hole Type
CP+RC

Location: Manchester

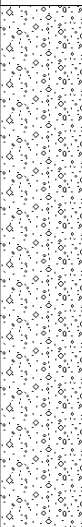
Level: 40.06

Scale
1:50

Client: IQ Student Accommodation

Dates: 19/01/2018 - 20/01/2018

Logged By
JB

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description			
				TCR	SCR	RQD							
							13.50	26.56			11		
											12		
											13		
											14		
											15		
											16		
											17		
											18		
											19		
											20		
											13.50 - 15.00	NI 0 NI 0 NI 0 NI NR	80
		15.00 - 16.50	NI 0 NR	65	50	27	15						
							Some drill & transport induced fractures.	16					
		16.50 - 18.00	0 NR	56	51	27	Some drill & transport induced fractures.	17					
							Some drill & transport induced fractures.	18					
		18.00 - 19.50	0 NI 0 NR NI	93	67	39	Some drill & transport induced fractures.	19					
							Some drill & transport induced fractures.	20					
		Continued on next sheet											

Remarks

Service inspection pit hand excavated from GL to 1.20m. Slight odour noted at 0.05-1.20m bgl. Cable percussion drilling 1.20-6.50m bgl. Rotary open drilling 6.50-15.10m bgl. Rotary core drilling 15.10-25.50m bgl. Refer to alternate logs attached for in-situ test results.





Merchant Exchange
17-19 Whitworth Street West
Manchester
M1 5WG

Rotary Core Log

Borehole No.

BH03

Sheet 3 of 3

Project Name: Chandos Hall (Stage 3)

Project No.
B065374.001 (3)

Co-ords: 384678.76 - 397695.80

Hole Type
CP+RC

Location: Manchester

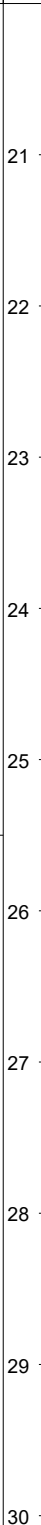
Level: 40.06

Scale
1:50

Client: IQ Student Accommodation

Dates: 19/01/2018 - 20/01/2018

Logged By
JB

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD					
		19.50 - 21.00	0	89	63	33	25.50	14.56		<u>Some drill & transport induced fractures.</u>	
			NI								
			0								
			NR								
		21.00 - 22.50	1.53	75	53	17				<u>Fracture sub-vertical (470mm), planar, rough and partly open with dark brown discolouration on fracture surface.</u>	
			0								
			NI								
			NR								
		22.50 - 24.00	0	53	38	18				<u>Fractures sub-horizontal, extremely loosely spaced, planar, smooth and tight.</u> <u>Some drill & transport induced fractures.</u>	
			NI								
			30.7								
			0								
			NR								
		24.00 - 25.50	NI	91	69	58				<u>Some drill & transport induced fractures.</u>	
			0								
			NR								
			NR								
		End of borehole at 25.50 m									

Remarks

Service inspection pit hand excavated from GL to 1.20m. Slight odour noted at 0.05-1.20m bgl. Cable percussion drilling 1.20-6.50m bgl. Rotary open drilling 6.50-15.10m bgl. Rotary core drilling 15.10-25.50m bgl. Refer to alternate logs attached for in-situ test results.





Merchant Exchange
17-19 Whitworth Street West
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M1 5WG

Borehole Log

Borehole No.

RH01

Sheet 1 of 2

Project Name: Chandos Hall (Stage 3)

Project No.
B065374.001 (3)

Co-ords: 384697.80 - 397699.44

Hole Type
RO

Location: Manchester

Level: 39.97

Scale
1:50

Client: IQ Student Accommodation

Dates: 19/01/2018 - 19/01/2018

Logged By
NF

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.10	39.87		MADE GROUND: Tarmac.	
					0.15	39.82		MADE GROUND: Medium dense cream fine to coarse angular to sub-angular GRAVEL of limestone (sub-base).	
					0.90	39.07		MADE GROUND: Soft to firm brown gravelly CLAY and frequent cobbles. Gravel is fine to coarse angular to sub-rounded brick. Cobbles are brick with a brick wall identified down the north side of pit from 0.15-0.70m bgl.	1
					1.20	38.77		Firm to stiff brown with grey mottling CLAY with occasional fine to coarse gravel of sandstone. Superficial deposits - possible CLAY.	2
									3
									4
									5
					5.20	34.77		Superficial deposits - possible dense SAND.	6
									7
									8
					9.50	30.47		Possible highly weathered, orange SANDSTONE.	9
								Continued on next sheet	10

Remarks

Service inspection pit hand excavated from GL to 1.20m.





Merchant Exchange
17-19 Whitworth Street West
Manchester
M1 5WG

Borehole Log

Borehole No.

RH01

Sheet 2 of 2

Project Name: Chandos Hall (Stage 3)

Project No.
B065374.001 (3)

Co-ords: 384697.80 - 397699.44

Hole Type
RO

Location: Manchester

Level: 39.97

Scale
1:50

Client: IQ Student Accommodation

Dates: 19/01/2018 - 19/01/2018

Logged By
NF

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					11.40	28.57		Orange SANDSTONE.	11
					13.00	26.97		End of borehole at 13.00 m	12
									13
									14
									15
									16
									17
									18
									19
									20

Remarks

Service inspection pit hand excavated from GL to 1.20m.





Merchant Exchange
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M1 5WG

Borehole Log

Borehole No.

RH02

Sheet 1 of 1

Project Name: Chandos Hall (Stage 3)

Project No.
B065374.001 (3)

Co-ords: 384675.15 - 397705.87

Hole Type
RO

Location: Manchester

Level: 40.25

Scale
1:50

Client: IQ Student Accommodation

Dates: 19/01/2018 - 19/01/2018

Logged By
NF

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.20	40.05		TOPSOIL: Brown sandy silt loam.	
					1.20	39.05		MADE GROUND: Dark brown/grey, clayey, clayey in places fine to coarse angular to sub-rounded GRAVEL with occasional cobbles. Gravel is angular to sub-rounded, fine to coarse of concrete, ash, clinker, brick and sandstone. Cobbles are brick. (ASH FILL)	1
								Superficial deposits - possible CLAY.	2
									3
					5.65	34.60		Superficial deposits - possible dense SAND.	4
					7.00	33.25		End of borehole at 7.00 m	5
									6
									7
									8
									9
									10

Remarks

Service inspection pit hand excavated from GL to 1.20m.





Merchant Exchange
17-19 Whitworth Street West
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M1 5WG

Borehole Log

Borehole No.

RH03

Sheet 1 of 1

Project Name: Chandos Hall (Stage 3)

Project No.
B065374.001 (3)

Co-ords: 384694.99 - 397714.68

Hole Type
RO

Location: Manchester

Level: 40.87

Scale
1:50

Client: IQ Student Accommodation

Dates: 19/01/2018 - 19/01/2018

Logged By
NF

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.10	40.77		MADE GROUND: Tarmac hardstanding.	
					0.45	40.42		MADE GROUND: Medium dense grey fine to coarse angular GRAVEL of limestone (sub-base).	
					1.20	39.67		MADE GROUND: Soft brown with some grey mottling gravelly CLAY with frequent cobbles. Gravel is fine to coarse angular to sub-rounded brick, ash and clinker. Cobbles are half brick cobbles.	1
								Superficial deposits - possible CLAY.	2
									3
					5.80	35.07		Superficial deposits - possible dense SAND.	6
					7.00	33.87		End of borehole at 7.00 m	7
									8
									9
									10

Remarks

Service inspection pit hand excavated from GL to 1.20m.





Borehole Log

Borehole No.
BH401 (CP)

Sheet 1 of 3

Project Name: Chandos Hall/Echo Street (Stage 4)

Project No.
B065374.001 (4)

Co-ords: -

Hole Type
CP

Location: Echo St. Manchester

Level: 40.10

Scale
1:50

Client: IQ Student Accommodation

Dates: 28/05/2019 - 30/05/2019

Logged By
MH

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.10 0.20 0.33	40.00 39.90 39.77		MADE GROUND: Grey concrete. MADE GROUND: Grey fine to coarse angular to subangular GRAVEL of limestone.	
		1.20		N=12 (3,3/3,2,2,5)				MADE GROUND: Brown very gravelly fine to coarse SAND. Gravel is fine to coarse angular to subangular concrete, brick and rare sandstone.	1
					1.50 1.65	38.60 38.45		MADE GROUND: Grey sandy fine to coarse angular to subangular GRAVEL and COBBLES of limestone. Pockets of yellowish brown fine and medium sand.	
		1.80 2.00	D	N=27 (3,3/4,6,7,10)				MADE GROUND: Red brick COBBLES.	
								Stiff brown slightly sandy slightly gravelly CLAY. Gravel is fine and medium subangular to subrounded sandstone, mudstone and coal. Rare pockets of sandy clay and sand.	2
								U100 failed to recover. Sandy pocket and seepage recorded at 3.30m bgl.	3
		4.00 4.20	D	N=50 (4,4/5,11,18,16)					4
					4.90	35.20		Very dense light reddish brown medium SAND. Rare fine and medium gravel of sandstone. (Weathered bedrock)	5
		5.50 - 6.00	Bulk						6
		6.00		50 (5,9/50 for 195mm)	6.10	34.00		Very dense light brown and orangish brown slightly gravelly fine to coarse SAND. Gravel is fine to coarse subangular to rounded sandstone and mudstone. (Weathered bedrock)	7
					7.10	33.00		Very dense light reddish brown fine and medium SAND (Weathered bedrock).	7
		7.50		50 (25 for 115mm/50 for 95mm)	7.60	32.50		Very dense light yellowish brown fine and medium SAND (Weathered bedrock).	8
		8.00		50 (25 for 70mm/50 for 10mm)	8.10	32.00		reddish brown Reddish brown weathered SANDSTONE.	8
									9
					10.00	30.10		Continued on next sheet	10

Remarks

Ground level estimated from topographic survey.
Hand excavated service clearance pit to 1.20m bgl. Cable Percussive Drilling to 8.10m bgl, chiselling from 7.10m bgl. Rotary Open Coring 8.10-10m bgl, rotary coring from 10-22m bgl on encountering intact rock.
Water seepage recorded at 3.30m bgl.
Rock log, rock core quality parameters and photographic record within Curtins Rock Core Log (BH401RC).





Borehole Log

Borehole No.
BH401 (CP)

Sheet 2 of 3

Project Name: Chandos Hall/Echo Street (Stage 4)

Project No.
B065374.001 (4)

Co-ords: -

Hole Type
CP

Location: Echo St. Manchester

Level: 40.10

Scale
1:50

Client: IQ Student Accommodation

Dates: 28/05/2019 - 30/05/2019

Logged By
MH

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		10.00		50 (25 for 35mm/50 for 10mm)				See Curtins rock log BH401(RC) for strata descriptions and rock core quality parameters.	
									11
									12
									13
									14
									15
									16
									17
									18
									19
									20

Continued on next sheet

Remarks

Ground level estimated from topographic survey.
Hand excavated service clearance pit to 1.20m bgl. Cable Percussive Drilling to 8.10m bgl, chiselling from 7.10m bgl. Rotary Open Coring 8.10-10m bgl, rotary coring from 10-22m bgl on encountering intact rock.
Water seepage recorded at 3.30m bgl.
Rock log, rock core quality parameters and photographic record within Curtins Rock Core Log (BH401RC).





Borehole Log

Borehole No.
BH401 (CP)

Sheet 3 of 3

Project Name: Chandos Hall/Echo Street (Stage 4)

Project No.
B065374.001 (4)

Co-ords: -

Hole Type
CP

Location: Echo St. Manchester

Level: 40.10

Scale
1:50

Client: IQ Student Accommodation

Dates: 28/05/2019 - 30/05/2019

Logged By
MH

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					22.00	18.10		End of borehole at 22.00 m	21
									22
									23
									24
									25
									26
									27
									28
									29
									30

Remarks

Ground level estimated from topographic survey.
Hand excavated service clearance pit to 1.20m bgl. Cable Percussive Drilling to 8.10m bgl, chiselling from 7.10m bgl. Rotary Open Coring 8.10-10m bgl, rotary coring from 10-22m bgl on encountering intact rock.
Water seepage recorded at 3.30m bgl.
Rock log, rock core quality parameters and photographic record within Curtins Rock Core Log (BH401RC).





Rotary Core Log

Borehole No.

BH401 (RC)

Sheet 1 of 3

Project Name: Chandos Hall/Echo Street (Stage 4)

Project No.
B065374.001 (4)

Co-ords: -

Hole Type
RC

Location: Echo St. Manchester

Level: 40.10

Scale
1:50

Client: IQ Student Accomodation

Dates: 28/05/2019 - 30/05/2019

Logged By
Geocore

Well	Water Strikes	Depth (m)	Type / Fl	Coring			Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD					
										See Curtins cable percussive log ref. BH401 CP.	
											1
											2
											3
											4
											5
											6
											7
											8
											9
							10.00	30.10		Continued on next sheet	10

Remarks

Ground level estimated from topographic survey.
Hand excavated service clearance pit to 1.20m bgl. Cable Percussive Drilling to 8.10m bgl, chiselling from 7.10m bgl. Rotary Open Coring 8.10-10m bgl, rotary coring from 10-22m bgl on encountering intact rock.
Water seepage recorded at 3.30m bgl.
Made Ground and superficial soil log, sampling/ insitu testing log and installation/backfill details included within Curtins Cable Percussive Log (BH401CP).





Rotary Core Log

Borehole No.
BH401 (RC)

Sheet 2 of 3

Project Name: Chandos Hall/Echo Street (Stage 4)

Project No.
B065374.001 (4)

Co-ords: -

Hole Type
RC

Location: Echo St. Manchester

Level: 40.10

Scale
1:50

Client: IQ Student Accommodation

Dates: 28/05/2019 - 30/05/2019

Logged By
Geocore

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD					
		10.00 - 11.50	NI	82	0	0	11.50	28.60		Extremely weak reddish brown medium grained arenaceous SANDSTONE. Frequent interbedded quartz gravels. Residual soil/completed weathered. Recovered as reddish brown gravelly medium sand.	11
		11.50 - 13.00	5.26 NR	71	63	0	12.07	28.03		Very weak reddish brown fine to medium grained arenaceous SANDSTONE. Generally moderately weathered (assuming poor consolidation in fresh state). Completely weathered neighbouring fractures. <i>Fractures medium spaced, dipping at 45°, undulating rough and open with reddish brown clayey weathering products.</i> No recovery. (Drill loss. No evidence of voiding).	12
		13.00 - 14.50	NR	0	0	0					13
		14.50 - 16.00	NR	0	0	0					14
		16.00 - 17.50	NI 5 NR	53	45	0	16.00	24.10		Weak to medium strong light reddish brown medium to coarse grained arenaceous SANDSTONE. Generally moderately weathered but completely weathered in non intact zones where recovered as extremely weak fine to coarse grained sized fragments. <i>Fractures very densely spaced, sub horizontal, undulating, rough and open with slight sandy coatings.</i>	16
		17.50 - 19.00	NI 28.57 NI NR	61	5	0				<i>Fractures very closely spaced, sub horizontal, undulating rough and moderately wide with light grey sandy coatings.</i>	17
		19.00 - 20.50	9.45	49	49	15	19.74	20.36		<i>Fractures sub horizontal, very closely spaced, stepped rough and open with stiff orange brown discolouration on fracture surface.</i>	19
										No recovery. Drill loss, no evidence of voiding.	20
										Continued on next sheet	

Remarks

Ground level estimated from topographic survey.
Hand excavated service clearance pit to 1.20m bgl. Cable Percussive Drilling to 8.10m bgl, chiselling from 7.10m bgl. Rotary Open Coring 8.10-10m bgl, rotary coring from 10-22m bgl on encountering intact rock.
Water seepage recorded at 3.30m bgl.
Made Ground and superficial soil log, sampling/ insitu testing log and installation/backfill details included within Curtins Cable Percussive Log (BH401CP).



Photographic Record of Rock Core

Client Name: IQ Student Accommodation	Project Name: Echo Street, Manchester	Project No: 065374.001	Borehole Location Reference: BH401	Date Core Recovered: 30/05/2019
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Borehole Log

Borehole No.
BH402B (CP)

Sheet 1 of 2

Project Name: Chandos Hall/Echo Street (Stage 4)

Project No.
B065374.001 (4)

Co-ords: -

Hole Type
CP

Location: Echo St. Manchester

Level: 41.00

Scale
1:50

Client: IQ Student Accommodation

Dates: 29/05/2019 - 03/06/2019

Logged By
MH

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.15	40.85		MADE GROUND: Grey concrete.	
					0.25	40.75		MADE GROUND: Grey concrete.	
					0.40	40.60		Geotextile layer at 0.15m bgl.	
					0.60	40.40		MADE GROUND: Brown gravelly fine to coarse SAND. Gravel is fine to coarse brick. Rare cobbles of brick.	
								10mm rebar at the base of the concrete.	
		1.20		N=19 (2,2/3,4,6,6)	1.00	40.00		MADE GROUND: Grey concrete.	1
								Firm brown with grey mottling slightly sandy slightly gravelly CLAY. Gravel is fine angular to subangular brick, sandstone and mudstone (Possibly reworked).	
		2.00		N=21 (2,3/4,5,6,6)				Stiff brown with grey mottling slightly silty slightly sandy slightly gravelly CLAY. Gravel is fine and medium subangular to rounded sandstone and mudstone.	2
		3.00		N=32 (3,4/6,7,8,11)					3
		4.00 - 4.45	U						4
		5.00		N=36 (2,4/5,7,11,13)					5
		5.00 - 5.40	D						
					5.50	35.50		Stiff dark brown sandy slightly gravelly CLAY. Gravel is fine and medium subangular to rounded sandstone and mudstone. Pockets of light brown medium sand.	6
		6.00		N=50 (25 for 60mm/10,13,13,14)					
		6.50 - 7.50	Bulk		6.50	34.50		Very dense light reddish brown and orangish brown slightly gravelly fine and medium SAND. Gravel is fine and medium very weathered sandstone, and mixed lithologies. Rare pockets of reddish brown clay (Possibly very weathered sandstone bedrock).	7
		7.50		50 (25 for 60mm/50 for 45mm)	7.65	33.35		Light reddish brown and orangish brown SAND. (Weathered bedrock)	8
									9
					9.30	31.70		Very dense reddish brown SAND (Weathered bedrock).	
					10.00	31.00			10

Continued on next sheet

Remarks

Ground level estimated from topographic survey.
Hand excavated service clearance pit to 1.20m bgl.
No groundwater strikes were recorded during the progression of the borehole.
Hand Dug Trial Pit 0.0-1.2m bgl. Cable Percussive Drilling 1.2-7.65m. Chisel for 1 hour from 6.80m bgl. Rotary Open Hole Drilling 7.65-10m. Rotary Core Drilling 10-18m bgl.
Borehole terminated at 18m bgl due to core barrel jamming and risk of being unable to recover the barrel.
Rock log rock core quality parameters and photographic record within Curtins rock core log ref. BH402B (RC).





Borehole Log

Borehole No.
BH402B (CP)

Sheet 2 of 2

Project Name: Chandos Hall/Echo Street (Stage 4)

Project No.
B065374.001 (4)

Co-ords: -

Hole Type
CP

Location: Echo St. Manchester

Level: 41.00

Scale
1:50

Client: IQ Student Accommodation

Dates: 29/05/2019 - 03/06/2019

Logged By
MH

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		10.00		50 (25 for 80mm/50 for 35mm)				See Curtins rock log (BH402B RC) for strata descriptions and rock core quality parameters.	11
		12.50 12.50	D	50 (2,2/50 for 195mm)					12
									13
									14
									15
									16
									17
					18.00	23.00		End of borehole at 18.00 m	18
									19
									20

Remarks

Ground level estimated from topographic survey.
Hand excavated service clearance pit to 1.20m bgl.
No groundwater strikes were recorded during the progression of the borehole.
Hand Dug Trial Pit 0.0-1.2m bgl. Cable Percussive Drilling 1.2-7.65m. Chisel for 1 hour from 6.80m bgl. Rotary Open Hole Drilling 7.65-10m. Rotary Core Drilling 10-18m bgl.
Borehole terminated at 18m bgl due to core barrel jamming and risk of being unable to recover the barrel.
Rock log rock core quality parameters and photographic record within Curtins rock core log ref. BH402B (RC).





Rotary Core Log

Borehole No.
BH402B (RC)

Sheet 1 of 2

Project Name: Chandos Hall/Echo Street (Stage 4)

Project No.
B065374.001 (4)

Co-ords: -

Hole Type
RC

Location: Echo St. Manchester

Level: 41.00

Scale
1:50

Client: IQ Student Accommodation

Dates: 29/05/2019 - 03/06/2019

Logged By
Geocore

Well	Water Strikes	Depth (m)	Type / Fl	Coring			Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD					
										See Curtins cable percussive log ref. BH401 CP.	
											1
											2
											3
											4
											5
											6
											7
											8
											9
							10.00	31.00		Continued on next sheet	10

Remarks

Ground level estimated from topographic survey.
Hand excavated service clearance pit to 1.20m bgl.
No groundwater strikes were recorded during the progression of the borehole.
Hand Dug Trial Pit 0.0-1.2m bgl. Cable Percussive Drilling 1.2-7.65m. Chisel for 1 hour from 6.80m bgl. Rotary Open Hole Drilling 7.65-10m. Rotary Core Drilling 10-18m bgl.
Borehole terminated at 18m bgl due to core barrel jamming and risk of being unable to recover the barrel.
Made Ground and superficial soil log, sampling/ in situ testing log and installation/backfill details included in Curtins cable log ref. BH402B (CP).





Rotary Core Log

Borehole No.
BH402B (RC)

Sheet 2 of 2

Project Name: Chandos Hall/Echo Street (Stage 4)

Project No.
B065374.001 (4)

Co-ords: -

Hole Type
RC

Location: Echo St. Manchester

Level: 41.00

Scale
1:50

Client: IQ Student Accommodation

Dates: 29/05/2019 - 03/06/2019

Logged By
Geocore

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD					
		10.00 - 11.00	NR	0	0	0	14.00	27.00		No recovery. (Drill loss no evidence of voiding).	11
		11.00 - 12.50		0	0	0					12
		12.50 - 14.00		0	0	0					13
		14.00 - 15.00	NI	24	47	70	17.00	24.00		Medium strong, locally weak, thickly cross bedded medium to fine grained arenaceous SANDSTONE. Generally fresh/slightly weathered. Completely weathered in non intact zones where recovered as extremely weak gravelly fine to coarse fragments. Fractures closely spaced undulating rough and open with slight grey discolouration on fracture surface. Fractures very closely spaced, sub horizontal, undulating, rough and moderately wide with reddish brown silty sand coatings. Fractures very closely spaced, sub horizontal, undulating, rough and moderately wide with reddish brown silty sand coatings. Unfractured insitu.	14
			4								15
			NR								16
		15.00 - 16.00	10	67	30	0	18.00	23.00		No recovery. (Drill loss no evidence of voiding).	17
			NI								18
			NR								19
		16.00 - 17.00	0	60	60	0					20
			NR								
		17.00 - 18.00		0	0	0				End of borehole at 18.00 m	

Remarks

Ground level estimated from topographic survey.
Hand excavated service clearance pit to 1.20m bgl.
No groundwater strikes were recorded during the progression of the borehole.
Hand Dug Trial Pit 0.0-1.2m bgl, Cable Percussive Drilling 1.2-7.65m, Chisel for 1 hour from 6.80m bgl. Rotary Open Hole Drilling 7.65-10m. Rotary Core Drilling 10-18m bgl.
Borehole terminated at 18m bgl due to core barrel jamming and risk of being unable to recover the barrel.
Made Ground and superficial soil log, sampling/ insitu testing log and installation/backfill details included in Curtins cable log ref. BH402B (CP).



Client Name: IQ Student Accommodation	Project Name: Echo Street, Manchester	Project No: 065374.001	Borehole Location Reference: BH402B	Date Core Recovered: 03/06/2019
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Borehole Log

Borehole No.
BH403 (CP)

Sheet 1 of 3

Project Name: Chandos Hall/Echo Street (Stage 4)

Project No.
B065374.001 (4)

Co-ords: -

Hole Type
CP

Location: Echo St. Manchester

Level: 41.20

Scale
1:50

Client: IQ Student Accommodation

Dates: 29/05/2019 - 04/06/2019

Logged By
MH

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.25			0.25	40.95		TOPSOIL: Dark brown slightly silty slightly gravelly fine and medium SAND. Gravel is fine and medium concrete.	
		1.10	ES	N=4 (1,1/1,1,1,1)	1.00	40.20		MADE GROUND: Light brown and dark brown gravelly fine to coarse SAND. Gravel is fine to coarse angular to subangular brick and concrete. Frequent cobbles of brick.	1
		1.20			1.30	39.90		MADE GROUND: Black sandy fine and medium GRAVEL of ash, clinker and brick.	
					1.50	39.70		MADE GROUND: Soft brown slightly sandy slightly gravelly CLAY (Reworked).	
					1.70	39.50		MADE GROUND: Black fine and medium GRAVEL of ash, clinker and brick.	
		2.00	D	N=7 (15,5/2,1,2,2)				Firm brown with grey mottling slightly sandy slightly gravelly CLAY (Possibly reworked).	2
		3.00			3.00	38.20		Firm brown with grey mottling slightly sandy slightly gravelly CLAY. Gravel is fine angular to subangular brick, sandstone and mudstone.	3
		3.00							
		4.00						Band of very soft clay 4.00m - 4.45m bgl.	4
		5.00	Bulk	N=11 (1,1/4,3,2,2)				Medium dense brown slightly gravelly fine to coarse SAND. Gravel is fine and medium subangular to rounded of mixed lithologies. Deposits slightly clayey between 5.90m - 6.50m bgl.	5
		6.00			5.90	35.30			6
		7.00 - 7.50						Very dense light orangish and light reddish brown slightly silty fine to coarse SAND.	7
		7.50							
		8.00 - 9.00	Bulk	N=8 (1,0/0,1,3,4)	8.00	33.20			8
		9.00						Reddish brown SAND (Weathered bedrock).	9
		9.30			9.30	31.90			
								Continued on next sheet	10

Remarks

Ground level estimated from topographic survey.
Hand excavated service clearance pit to 1.20m bgl. Cable percussive drilling 1.20-9.3m bgl. Chisel for 1 hour from 8.00m bgl. Rotary open hole drilling 9.3-12.0m bgl. Rotary Coring 12-21.0m bgl.
No groundwater strikes were recorded during the progression of the borehole.
Rock log rock core quality parameters and photographic record within Curtins Rock Core Logs (BH403RC).





Borehole Log

Borehole No.
BH403 (CP)

Sheet 2 of 3

Project Name: Chandos Hall/Echo Street (Stage 4)

Project No.
B065374.001 (4)

Co-ords: -

Hole Type
CP

Location: Echo St. Manchester

Level: 41.20

Scale
1:50

Client: IQ Student Accommodation

Dates: 29/05/2019 - 04/06/2019

Logged By
MH

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					12.00	29.20			11
								See Curtins rock log (BH403 RC) for strata descriptions and rock core quality parameters.	12
									13
									14
									15
									16
									17
									18
									19
									20

Continued on next sheet

Remarks

Ground level estimated from topographic survey.
Hand excavated service clearance pit to 1.20m bgl. Cable percussive drilling 1.20-9.3m bgl. Chisel for 1 hour from 8.00m bgl. Rotary open hole drilling 9.3-12.0m bgl. Rotary Coring 12-21.0m bgl.
No groundwater strikes were recorded during the progression of the borehole.
Rock log rock core quality parameters and photographic record within Curtins Rock Core Logs (BH403RC).





Borehole Log

Borehole No.
BH403 (CP)

Sheet 3 of 3

Project Name: Chandos Hall/Echo Street (Stage 4)

Project No.
B065374.001 (4)

Co-ords: -

Hole Type
CP

Location: Echo St. Manchester

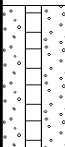
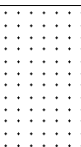
Level: 41.20

Scale
1:50

Client: IQ Student Accommodation

Dates: 29/05/2019 - 04/06/2019

Logged By
MH

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					21.00	20.20			
								End of borehole at 21.00 m	21
									22
									23
									24
									25
									26
									27
									28
									29
									30

Remarks

Ground level estimated from topographic survey.
Hand excavated service clearance pit to 1.20m bgl. Cable percussive drilling 1.20-9.3m bgl. Chisel for 1 hour from 8.00m bgl. Rotary open hole drilling 9.3-12.0m bgl. Rotary Coring 12-21.0m bgl.
No groundwater strikes were recorded during the progression of the borehole.
Rock log rock core quality parameters and photographic record within Curtins Rock Core Logs (BH403RC).





Rotary Core Log

Borehole No.
BH403 (RC)

Sheet 1 of 3

Project Name: Chandos Hall/Echo Street (Stage 4)

Project No.
B065374.001 (4)

Co-ords: -

Hole Type
RC

Location: Echo St. Manchester

Level: 41.20

Scale
1:50

Client: IQ Student Accomodation

Dates: 29/05/2019 - 04/06/2019

Logged By
Geocore

Well	Water Strikes	Depth (m)	Type / Fl	Coring			Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD					
										See Curtins cable percussive log ref. BH403 CP.	1
											2
											3
											4
											5
											6
											7
											8
											9
											10

Continued on next sheet

Remarks

Ground level estimated from topographic survey.
Hand excavated service clearance pit to 1.20m bgl. Cable percussive drilling 1.20-9.3m bgl. Chisel for 1 hour from 8.00m bgl. Rotary open hole drilling 9.3-12.0m bgl. Rotary Coring 12-21.0m bgl.
No groundwater strikes were recorded during the progression of the borehole.
Made Ground and superficial soil log, sampling/ insitu testing log and installation/backfill details included in Curtins cable percussive log ref. (BH403CP).





Rotary Core Log

Borehole No.
BH403 (RC)

Sheet 2 of 3

Project Name: Chandos Hall/Echo Street (Stage 4)

Project No.
B065374.001 (4)

Co-ords: -

Hole Type
RC

Location: Echo St. Manchester

Level: 41.20

Scale
1:50

Client: IQ Student Accommodation

Dates: 29/05/2019 - 04/06/2019

Logged By
Geocore

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD					
							12.00	29.20			11
		12.00 - 13.00	0 NI 13.3 NR	65	46	13				Medium strong, locally extremely weak, thickly cross laminated reddish brown medium to coarse grained arenaceous SANDSTONE. Generally slightly weathered becoming highly weathered neighbouring non intact zones where strength reduction is apparent. Recovered as reddish brown silty sand also most intensely weathered.	12
		13.00 - 14.00	17.1 0 NR	76	70	33				Fractures sub horizontal, very closely spaced, undulating, rough and open with orange brown sandy weathering products. Fractures sub horizontal, very closely spaced, undulating, rough and open with orange brown sandy weathering products.	13
		14.00 - 15.50	2.8 0 36.3 NI NR	67	61	51				1 No. sub horizontal fracture. Planar rough and partially open with clayey infill.	14
		15.50 - 16.50	0 0	95	90	42				Fractures dipping at 45°. Undulating, rough and moderately wide with 2-3mm clayey sand infill.	15
		16.50 - 18.00	5 NI 8.57 0	100	95	47				1 No. sub vertical fracture. Undulating, rough and open. No infill. Fractures very closely spaced, sub horizontal, undulating smooth and partially open with orange brown clayey sandy coatings.	16
		18.00 - 19.50	0 NR	47	47	29				Unfractured insitu.	17
			NI 22.2							Fractures sub horizontal, very extremely closely spaced planar, rough and partially open. Possible transport induced.	18
										Continued on next sheet	19

Remarks

Ground level estimated from topographic survey.
Hand excavated service clearance pit to 1.20m bgl. Cable percussive drilling 1.20-9.3m bgl. Chisel for 1 hour from 8.00m bgl. Rotary open hole drilling 9.3-12.0m bgl. Rotary Coring 12-21.0m bgl.
No groundwater strikes were recorded during the progression of the borehole.
Made Ground and superficial soil log, sampling/ insitu testing log and installation/backfill details included in Curtins cable percussive log ref. (BH403CP).





Rotary Core Log

Borehole No.
BH403 (RC)

Sheet 3 of 3

Project Name: Chandos Hall/Echo Street (Stage 4)

Project No.
B065374.001 (4)

Co-ords: -

Hole Type
RC

Location: Echo St. Manchester

Level: 41.20

Scale
1:50

Client: IQ Student Accommodation

Dates: 29/05/2019 - 04/06/2019

Logged By
Geocore

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD					
		19.50 - 21.00	NI								
			NR	52	36	0					
							21.00	20.20		End of borehole at 21.00 m	21
											22
											23
											24
											25
											26
											27
											28
											29
											30

Remarks

Ground level estimated from topographic survey.
Hand excavated service clearance pit to 1.20m bgl. Cable percussive drilling 1.20-9.3m bgl. Chisel for 1 hour from 8.00m bgl. Rotary open hole drilling 9.3-12.0m bgl. Rotary Coring 12-21.0m bgl.
No groundwater strikes were recorded during the progression of the borehole.
Made Ground and superficial soil log, sampling/ insitu testing log and installation/backfill details included in Curtins cable percussive log ref. (BH403CP).



Client Name: IQ Student Accommodation	Project Name: Echo Street, Manchester	Project No: 065374.001	Inspection Location Reference: BH403	Date Core Recovered: 04/06/2019
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Borehole Log

Borehole No.

WS401

Sheet 1 of 1

Project Name: Chandos Hall/Echo Street (Stage 4)

Project No.
B065374.001 (4)

Co-ords: -

Hole Type
WS

Location: Echo St. Manchester

Level: 40.10

Scale
1:50

Client: IQ Student Accommodation

Dates: 28/05/2019 - 29/05/2019

Logged By
MH

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.12	ES		0.12	39.98		MADE GROUND: Grey concrete.	1
		0.22			0.22	39.88		MADE GROUND: Red and grey SAND and GRAVEL of brick and concrete.	
		0.40	N=12 (2,2/1,3,4,4)		0.80	39.30		MADE GROUND: Dark brown slightly clayey gravelly fine to coarse SAND. Gravel is fine to coarse angular to subrounded brick, concrete, slate and sandstone. Occasional cobbles of brick.	
		1.20						Firm brown with occasional grey mottling slightly sandy slightly gravelly CLAY. <i>Water seepage recorded at 0.80m bgl.</i>	
		2.00			2.00	38.10		Stiff brown with occasional grey mottling slightly sandy slightly gravelly CLAY. <i>Medium SAND band 2.20m - 2.60m bgl.</i>	
		3.00	D	N=27 (5,6/5,7,7,8)					3
		3.00 - 3.45							
		4.00		50 (5,5/50 for 85mm)				Rare light brown plant debris in fractures.	4
					4.23	35.87		End of borehole at 4.23 m	
									5
									6
									7
									8
									9
									10

Remarks

Ground level estimated from topographic survey.
Hand excavated service clearance pit to 1.20m bgl.
No groundwater strikes were recorded during the progression of the borehole.
Borehole terminated due to SPT refusal at 4.00m bgl.





Borehole Log

Borehole No.

WS402

Sheet 1 of 1

Project Name: Chandos Hall/Echo Street (Stage 4)

Project No.
B065374.001 (4)

Co-ords: -

Hole Type
WS

Location: Echo St. Manchester

Level: 41.10

Scale
1:50

Client: IQ Student Accomodation

Dates: 29/05/2019 - 29/05/2019

Logged By
MH

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.14	ES		0.14	40.96		MADE GROUND: Grey concrete.	
		0.27			0.27	40.83		MADE GROUND: Grey concrete.	
		0.40			0.70	40.40		MADE GROUND: Brown and greyish brown gravelly fine to coarse SAND. Gravel is fine to coarse angular to subangular brick and slate. Occasional cobbles of brick.	
		1.20	N=12 (1,2/3,3,3,3)		1.20	39.90		MADE GROUND: Black and dark brown gravelly fine to coarse SAND. Gravel is fine to coarse angular to subangular concrete, brick, rare ash and rare clinker. Rare cobbles of brick and concrete.	
		2.00			2.00	39.10		Firm brown with rare grey mottling slightly silty slightly sandy slightly gravelly CLAY. Gravel is fine and medium subangular to rounded sandstone and mudstone. Rare medium coal gravel.	
		2.80			3.00			Stiff brown with rare grey mottling slightly silty slightly sandy slightly gravelly CLAY. Gravel is fine and medium subangular to rounded sandstone and mudstone.	
		4.00	D	N=30 (4,4/7,7,8,8)					
		5.00							
					5.15	35.95			
					5.20	35.90		Very dense light orangish brown fine and medium SAND (Weathered bedrock). End of borehole at 5.20 m	

Remarks

Ground level estimated from topographic survey.
Hand excavated service clearance pit to 1.20m bgl.
No groundwater strikes were recorded during the progression of the borehole.
Borehole terminated due to SPT refusal at 5.20m bgl.





Borehole Log

Borehole No.

WS403

Sheet 1 of 1

Project Name: Chandos Hall/Echo Street (Stage 4)

Project No.
B065374.001 (4)

Co-ords: -

Hole Type
WS

Location: Echo St. Manchester

Level: 41.10

Scale
1:50

Client: IQ Student Accommodation

Dates: 29/05/2019 - 29/05/2019

Logged By
MH

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.16			0.16	40.94		MADE GROUND: Grey concrete.	
		0.27			0.27	40.83		MADE GROUND: Grey concrete.	
		0.70	ES		0.70	40.40		MADE GROUND: Brown gravelly fine to coarse SAND. Gravel is fine to coarse angular to subangular brick, concrete and sandstone. Frequent cobbles of brick.	
		1.20		N=12 (1,2/2,3,3,4)	1.20	39.90		MADE GROUND: Black sandy gravelly CLAY. Gravel is fine to coarse brick, slate, concrete and ash.	1
		2.00		N=22 (1,2/4,5,7,6)	2.00	39.10		Firm brown with grey mottling silty slightly sandy slightly gravelly CLAY. Gravel is fine and medium angular to subrounded sandstone and mudstone.	2
		3.00		N=35 (6,5/7,8,10,10)				Stiff brown silty slightly sandy slightly gravelly CLAY. Gravel is fine and medium angular to subrounded sandstone and mudstone.	3
		3.60	D						
		4.00		N=23 (3,4/5,6,6,6)					4
		5.00		N=41 (6,6/8,10,10,13)					5
		5.00 - 5.45	ES		5.45	35.65		Hydrocarbon odour at 5.00 - 5.45m bgl.	
								End of borehole at 5.45 m	6
									7
									8
									9
									10

Remarks

Ground level estimated from topographic survey.
Hand excavated service clearance pit to 1.20m bgl.
No groundwater strikes were recorded during the progression of the borehole.
Hydrocarbon odour recorded between 5.00m - 5.45m bgl.





Borehole Log

Borehole No.

WS404

Sheet 1 of 1

Project Name: Chandos Hall/Echo Street (Stage 4)

Project No.
B065374.001 (4)

Co-ords: -

Hole Type
WS

Location: Echo St. Manchester

Level: 41.00

Scale
1:50

Client: IQ Student Accommodation

Dates: 29/05/2019 - 29/05/2019

Logged By
MH

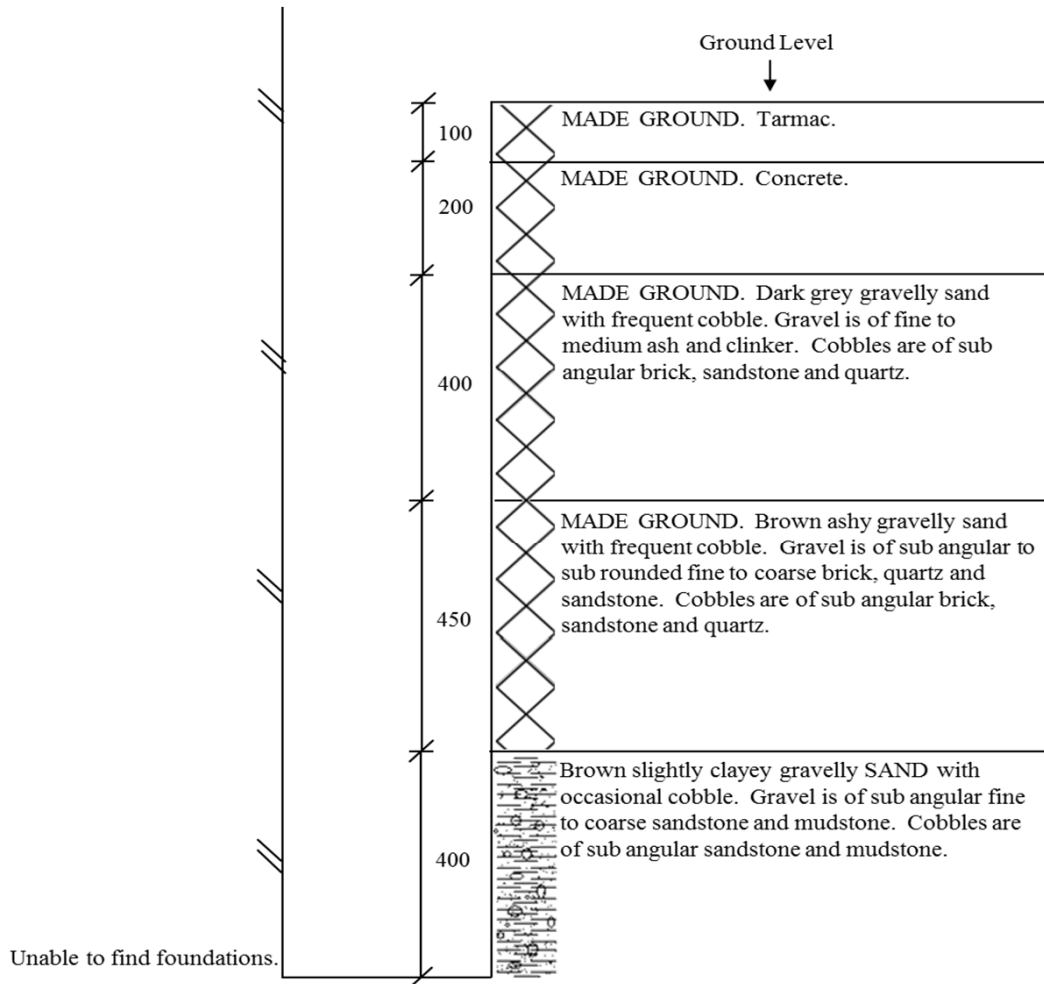
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.17 0.27				40.83 40.73		MADE GROUND: Grey concrete.	
								MADE GROUND: Grey concrete.	
		1.10 1.20	ES	N=19 (2,2/4,4,5,6)	1.00	40.00		Firm brown slightly sandy slightly gravelly CLAY. Gravel is fine brick, sandstone, mudstone and coal (Possibly reworked).	1
		2.00		N=23 (3,4/4,6,6,7)				Stiff brown slightly silty slightly sandy slightly gravelly CLAY. Gravel is fine and medium subangular to rounded sandstone and mudstone. <i>Occasional grey mottling between 1.20m - 2.00m bgl.</i>	2
		3.00		N=26 (4,5/6,5,8,7)					3
		4.00		N=29 (4,6/7,7,7,8)					4
		5.00 5.00 - 5.40	D	50 (8,10/50 for 220mm)	5.35 5.37	35.65 35.63		Very dense light orangish brown medium SAND (Weathered bedrock). End of borehole at 5.37 m	5
									6
									7
									8
									9
									10

Remarks

Ground level estimated from topographic survey.
Hand excavated service clearance pit to 1.20m bgl.
No groundwater strikes were recorded during the progression of the borehole.
Borehole terminated at 5.37m bgl due to SPT refusal.



	FOUNDATION PIT RECORD		
Site Crew:	J Robinson, D Greer, A l'Anson, P Beadnall, M Corner	Date:	18th, 20th and 21st July 2017
Address:	Cranby Row, Manchester, M1 3QT		
Geocore Ref:	RT/17/60015	Client Ref:	EBMA776
Trial Pit No: HP1			



For strata information below 1.55m, please refer to borehole HP1.

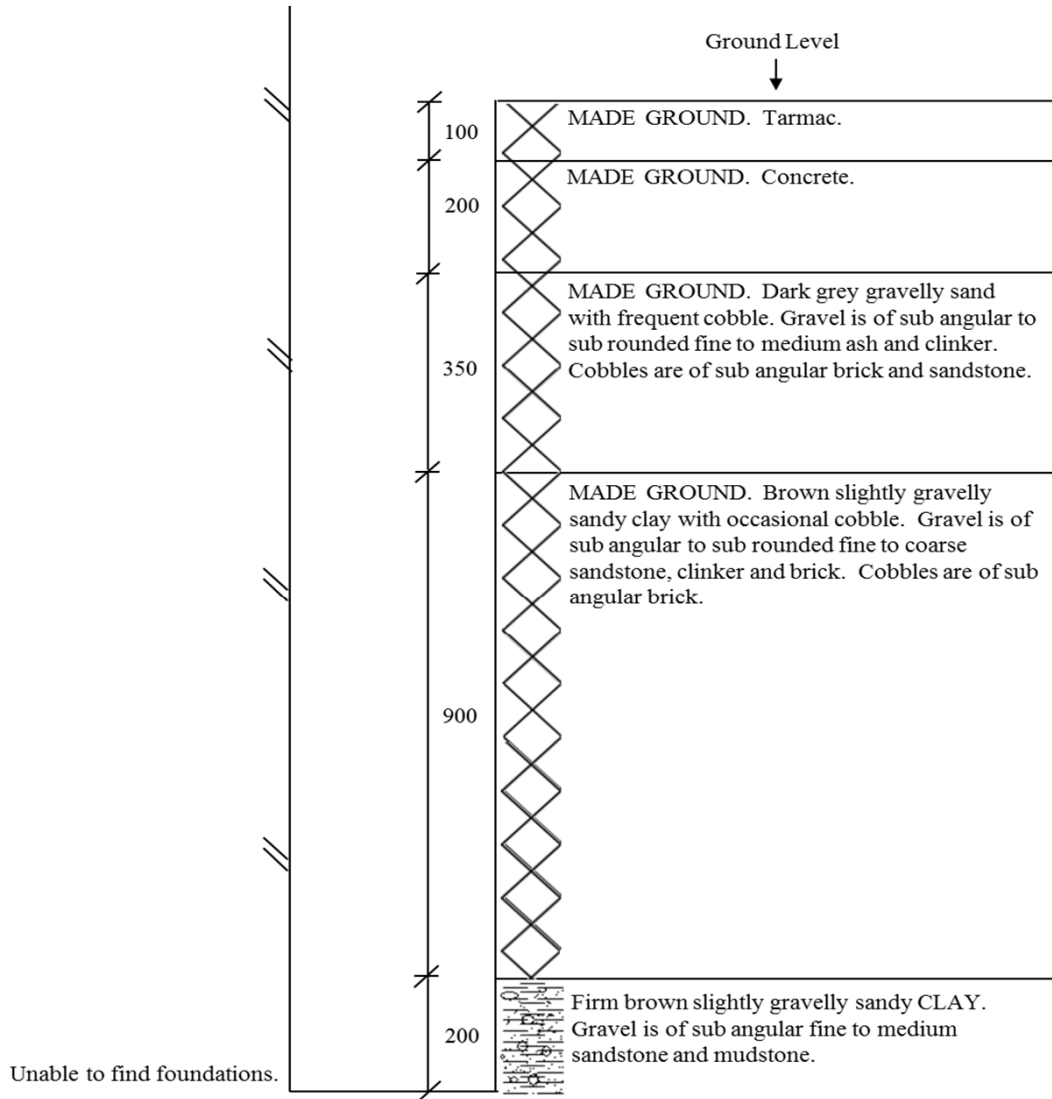
		BOREHOLE LOG RECORD	
Site Crew:	J Robinson, D Greer, A l'Anson, P Beadnall, M Corner	Date:	18th, 20th and 21st July 2017
Address:	Cranby Row, Manchester, M1 3QT		
Geocore Ref:	RT/17/60015	Client Ref:	EBMA776
Borehole No: HP1			

		BOREHOLE LOG				Geocore Site Investigations Ltd		
Location Chandos Hall, Granby Row, Manchester, M1 3QT						BOREHOLE No HP1		
Job No RT/17/60015		Date 20-07-17		Ground Level (m)		Co-Ordinates ()		
Client Curtins Consulting						Sheet 1 of 1		
SAMPLES & TESTS			STRATA					
Depth	Type No	Test Result	Water	Reduced Level	Legend	Depth (Thickness)	DESCRIPTION	
							Trial pit. Unable to establish base of foundation.	
						1.55		
						(0.15) 1.70	Brown slightly clayey gravelly SAND with occasional cobble. Gravel is of sub angular fine to coarse sandstone and mudstone. Cobbles are of sub angular sandstone and mudstone.	
						(0.40) 2.10	Brown slightly gravelly sandy CLAY. Gravel is of sub angular fine to coarse sandstone and mudstone.	
Boring Progress and Water Observations			Chiselling		Water Added		GENERAL REMARKS	
Date	Time	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From		To
								Borehole terminated at 2.1m due to refusal on stiff clay. Excavation remained open and dry on completion.
All dimensions in metres Scale 1:18.125			Client Engineer Niall Farnworth		Method/ Plant Used Hand Auger		Logged By M Corner	

GEOCORE BH 10015 GRP AUGUST 18th GRP 3897

FOUNDATION PIT RECORD

Site Crew:	J Robinson, D Greer, A l'Anson, P Beadnall, M Corner	Date:	18th, 20th and 21st July 2017
Address:	Cranby Row, Manchester, M1 3QT		
Geocore Ref:	RT/17/60015	Client Ref:	EBMA776
Trial Pit No: HP2			



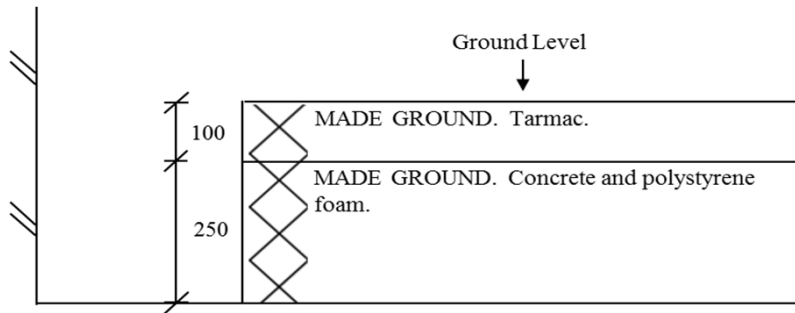
For strata information below 1.75m, please refer to borehole HP2.

		BOREHOLE LOG RECORD	
Site Crew:	J Robinson, D Greer, A l'Anson, P Beadnall, M Corner	Date:	18th, 20th and 21st July 2017
Address:	Cranby Row, Manchester, M1 3QT		
Geocore Ref:	RT/17/60015	Client Ref:	EBMA776
Borehole No: HP2			

		BOREHOLE LOG		Geocore Site Investigations Ltd				
Location Chandos Hall, Granby Row, Manchester, M1 3QT					BOREHOLE No HP2			
Job No RT/17/60015	Date 20-07-17	Ground Level (m)	Co-Ordinates ()					
Client Curtins Consulting					Sheet 1 of 1			
SAMPLES & TESTS			STRATA					
Depth	Type No	Test Result	Water	Reduced Level	Legend	Depth (Thickness)	DESCRIPTION	Instrument Backfill
						(1.75)	Trial pit. Unable to establish base of foundation.	
						1.75		
						(0.35)	Firm brown slightly gravelly sandy CLAY. Gravel is of sub angular fine to medium sandstone and mudstone.	
						2.10		
Boring Progress and Water Observations			Chiselling			Water Added		GENERAL REMARKS Borehole terminated at 2.1m due to refusal on stiff clay. Excavation remained open and dry on completion.
Date	Time	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	
All dimensions in metres Scale 1:18.125			Client Engineer Niall Farnworth			Method/ Plant Used Hand Auger		Logged By M Corner

GEOCORE BH 60015 GRJ AUGUST 18th GRJ 3817

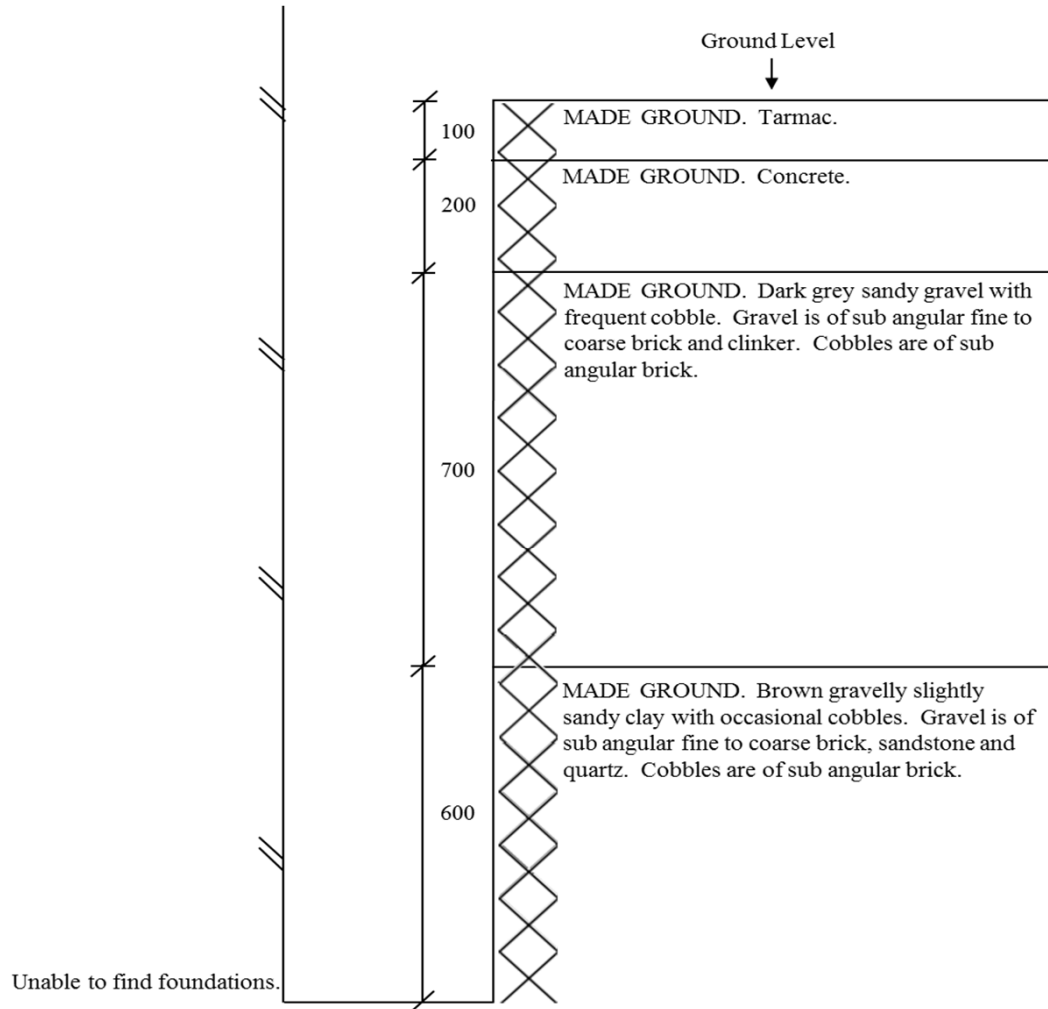
	FOUNDATION PIT RECORD		
Site Crew:	J Robinson, D Greer, A l'Anson, P Beadnall, M Corner	Date:	18th, 20th and 21st July 2017
Address:	Cranby Row, Manchester, M1 3QT		
Geocore Ref:	RT/17/60015	Client Ref:	EBMA776
Trial Pit No: HP3			



HP3 terminated at 0.35m due to being unable to break through concrete.

FOUNDATION PIT RECORD

Site Crew:	J Robinson, D Greer, A l'Anson, P Beadnall, M Corner	Date:	18th, 20th and 21st July 2017
Address:	Cranby Row, Manchester, M1 3QT		
Geocore Ref:	RT/17/60015	Client Ref:	EBMA776
Trial Pit No: HP4			



For strata information below 1.6m, please refer to borehole HP4.



Trial Pit Log

Trialpit No

TP101

Sheet 1 of 1

Project Name: Echo Street Viaduct Foundation
InvestigatoinProject No.
065374Co-ords: -
Level:Date
13/06/2019

Location: Echo Street, Manchester

Dimensions
(m):Depth
3.65Scale
1:25Logged
NF

Client: IQ Student Accomodation

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
				0.05			MADE GROUND: Asphalt MADE GROUND: Concrete	
				0.25			MADE GROUND: Dark brown slightly clayey slightly sandy gravel with cobbles. Gravel includes fine to coarse angular to sub-rounded ash and bricks. Cobbles are concrete and brick. Includes metal fragments.	
				0.80			MADE GROUND: Firm light brown mottled grey and dark brown in places, sandy slightly gravelly clay with occasional cobbles. Gravel is fine to coarse including ash, brick, coal, ceramics and white shells. Cobbles are half and hole bricks and sandstone. Sandstone sink noted.	1
								2
								3
				3.65			End of pit at 3.65 m	4
								5

Remarks: No groundwater encountered. See associated cross section sketch for detail of wall. No foundation identified. Narrow column of Made Ground directly adjacent to the viaduct wall. Hole could not be extended to further depth as it could not be widened due to presence of drain which Connell Brothers requested is not disturbed.

Stability: Some side wall instability through Made Ground deposits.



Drg No:

B065374-SK001

Rev:

P01

Project: ECHO STREET VIADUCT FOUNDATION

Drg Title: TRIAL PIT 101

Drawn: MH

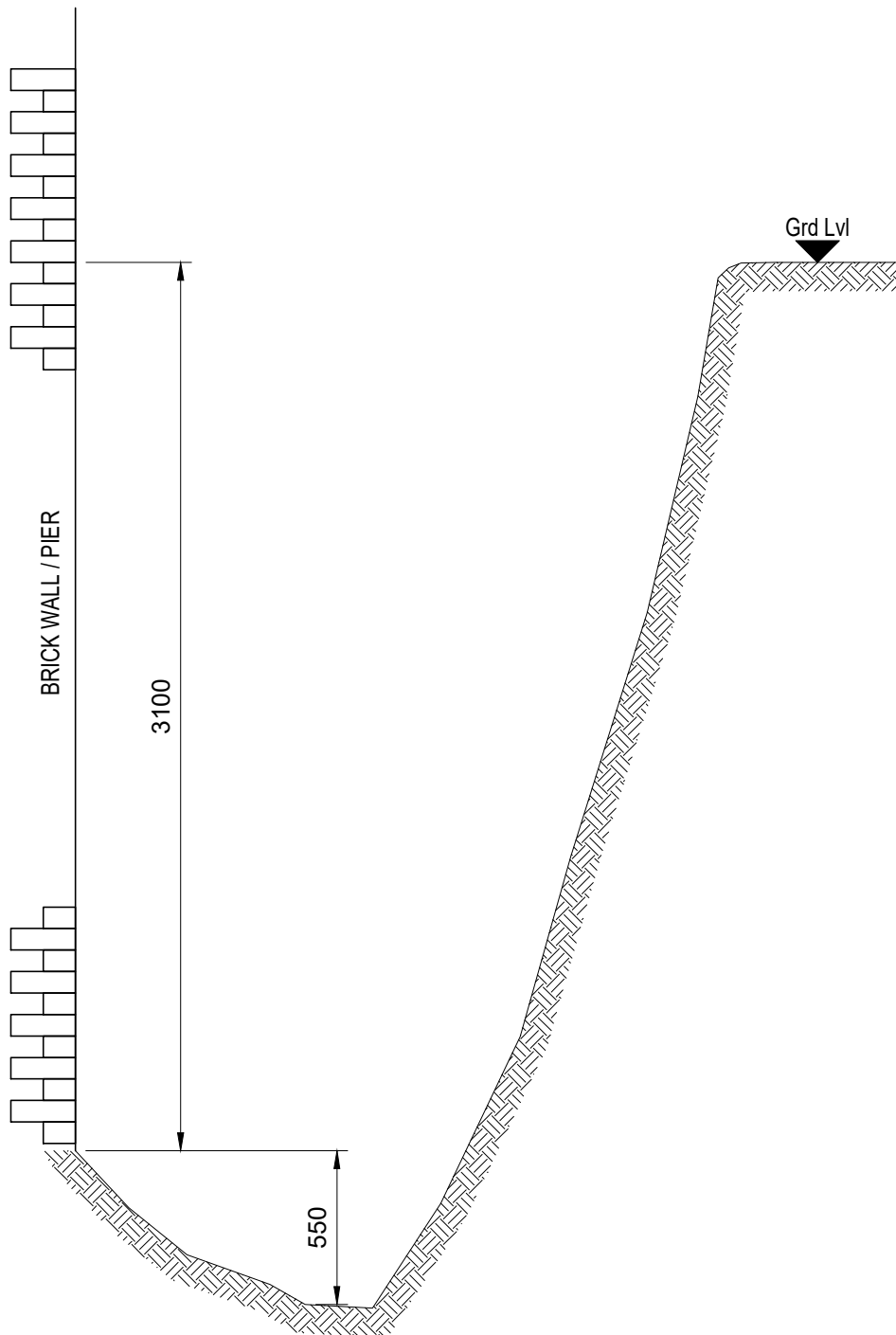
Checked: JJ

Scale: NTS



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NOTES

NO EVIDENCE OF FOUNDATIONS IDENTIFIED TO BASE OF HOLE.
REFER TO CURTINS TRIAL PIT LOG FOR STRATA DETAILS.
TRIAL PIT UNDERTAKEN AGAINST BRICK PIER.



Trial Pit Log

Trialpit No

TP102

Sheet 1 of 1

Project Name: Echo Street Viaduct Foundation
InvestigationProject No.
065374

Co-ords: -

Level:

Date

13/05/2019

Location: Echo Street, Manchester

Dimensions
(m):Depth
3.60Scale
1:25Logged
NF

Client: IQ Student Accommodation

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.05			MADE GROUND: Paving flags.
							MADE GROUND: Concrete.
							Grey
							Green Grey.
				0.30			MADE GROUND: Dark Brown sandy gravel with cobbles and boulders. Gravel is fine to coarse of mixed lithologies including brick, ash, concrete, glass, clinker, mudstone as well as nails and metal fragments. Boulders and cobbles are of concrete and bricks. Metal sheeting on north side of pit which may represent a former tank, filled with scrap metal, cables and bricks.
				2.60			Stiff to very stiff brown grey mottled slightly gravelly CLAY. Gravel is fine to coarse sub angular to sub rounded of mixed lithologies including sandstone and mudstone. <i>Made Ground appears to extend to base of hole immediately adjacent to viaduct.</i>
				3.60			End of pit at 3.60 m

Remarks: Significant groundwater ingress at 1.80m from north side of pit, slowed after approximately 3 minutes. See associated cross section sketch for detail of wall. No foundation identified. Narrow column of Made Ground directly adjacent to the viaduct wall. Hole could not be extended to further depth due to reach of machine excavator.

Stability: Some side wall instability through through Made Ground deposits



Drg No:

B065374-SK002

Rev:

P01



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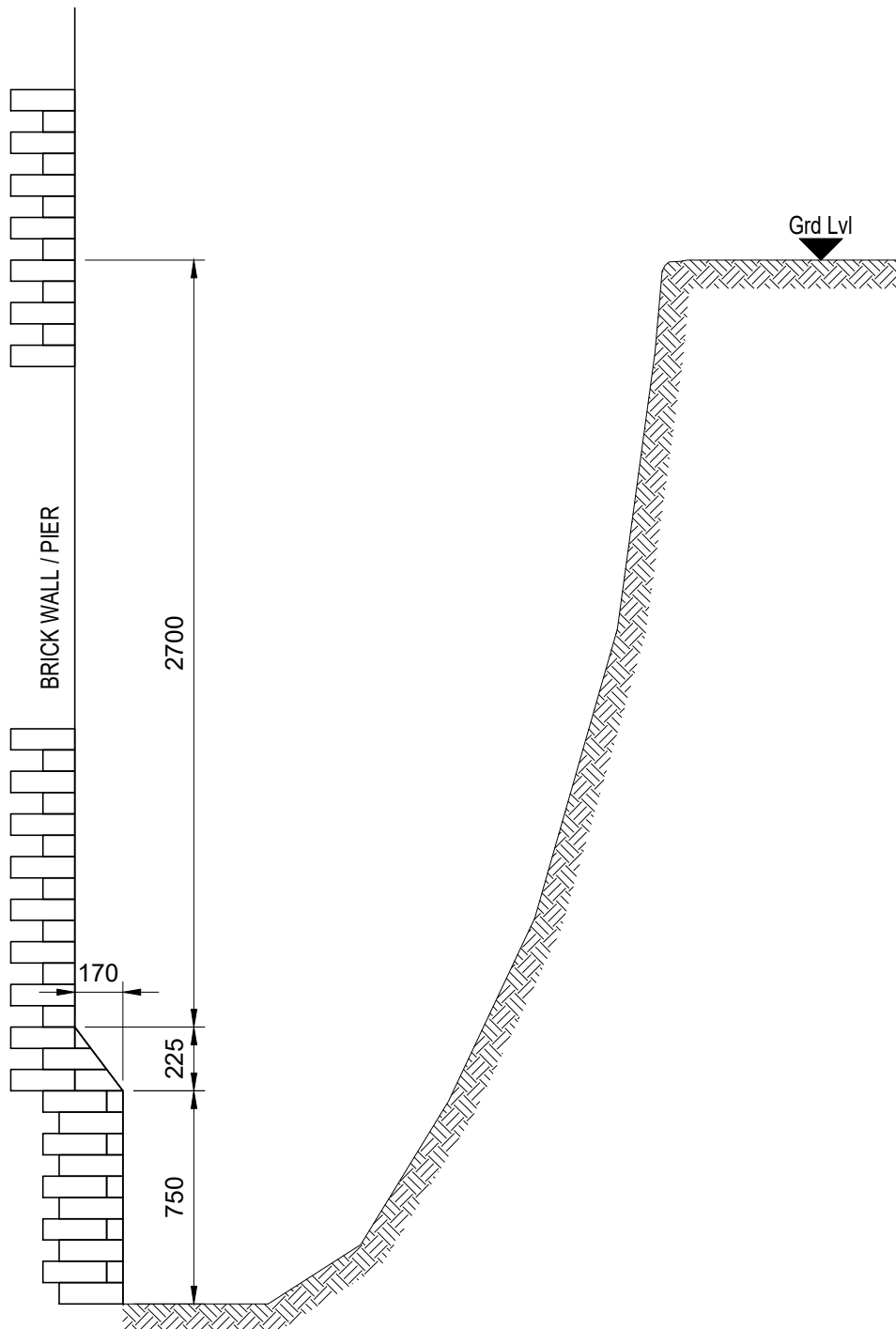
Project: ECHO STREET VIADUCT FOUNDATION

Drg Title: TRIAL PIT 102 (AGAINST BRICK PIER)

Drawn: MH

Checked: JJ

Scale: NTS



NOTES

BASE OF FOUNDATION / WALL NOT IDENTIFIED.
REFER TO CURTINS TRIAL PIT LOG FOR STRATA DETAILS.
TRIAL PIT UNDERTAKEN PARTLY AGAINST BRICK PIER
AND PARTLY AGAINST BRICK INFILL.

Drg No:

B065374-SK003

Rev:

P01

Project: ECHO STREET VIADUCT FOUNDATION

Drg Title: TRIAL PIT 102 (AGAINST BRICK ARCH INFILL)

Drawn: MH

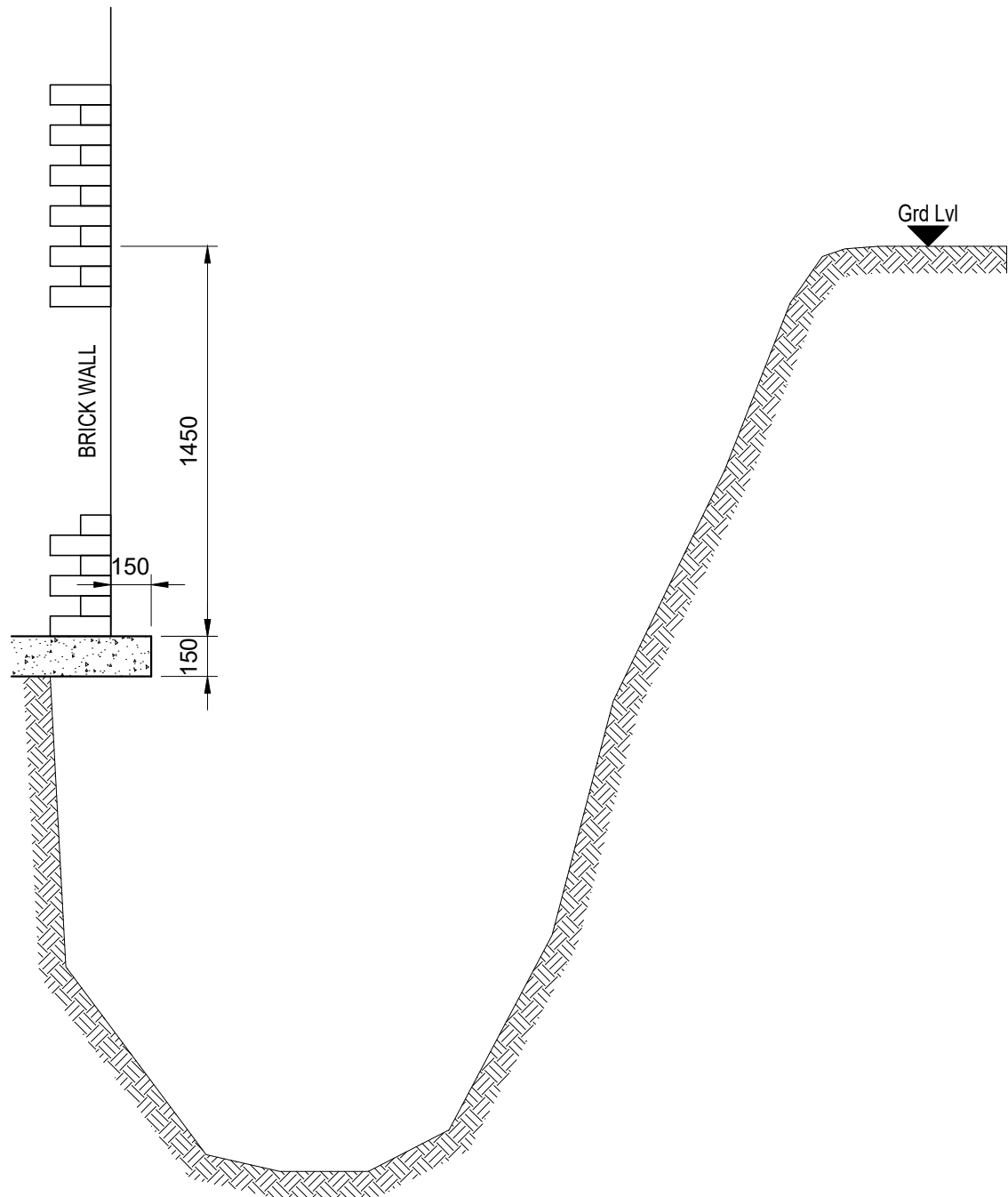
Checked: JJ

Scale: NTS



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NOTES

BASE OF FOUNDATION IDENTIFIED NATURAL GROUND BELOW.
REFER TO CURTINS TRIAL PIT LOG FOR STRATA DETAILS.
TRIAL PIT UNDERTAKEN PARTLY AGAINST BRICK PIER AND
PARTLY AGAINST BRICK ARCH INFILL.



Trial Pit Log

Trialpit No

TP103

Sheet 1 of 1

Project Name: Echo Street Viaduct Foundation Investigataion

Project No.
065374

Co-ords: -

Level:

Date

13/05/2019

Location: Echo Street, Manchester

Dimensions (m):

Depth
2.60

Scale

1:25

Logged
NF

Client: IQ Student Accomodation

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
				0.10			MADE GROUND: Asphalt	
				0.30			MADE GROUND: Dark brown and light brown GRAVEL. Gravel is fine to coarse, angular to sub-rounded gravel of mixed lithologies including limestone, sandstone and clinker.	
							MADE GROUND: Dark brown slightly silty slightly gravelly clay. Gravel is fine to coarse of mixed lithologies including brick, ash, coal and sandstone. Frequent timber pieces with hydrocarbon odour noted on/around timber.	
							Large tree stump c.0.4-0.6m.	1
				1.90			Stiff to very stiff brown grey mottled slightly gravelly CLAY. Gravel is fine to coarse sub angular to sub rounded of mixed lithologies including sandstone and mudstone.	2
							Made Ground appears to extend to base of hole immediately adjacent to viaduct.	
				2.60			End of pit at 2.60 m	3
								4
								5

Remarks: No groundwater ingress encountered. Narrow column of Made Ground directly adjacent to the viaduct wall. Hole terminated due to unknown purpose of rough concrete close to surface, possibly associated with supporting the pier which appeared slightly dilapidated in this area with some signs of movement.

Stability: Some side wall instability through Made Ground deposits.



Drg No:

B065374-SK004

Rev:

P01

Project: ECHO STREET VIADUCT FOUNDATION

Drg Title: TRIAL PIT 103

Drawn: MH

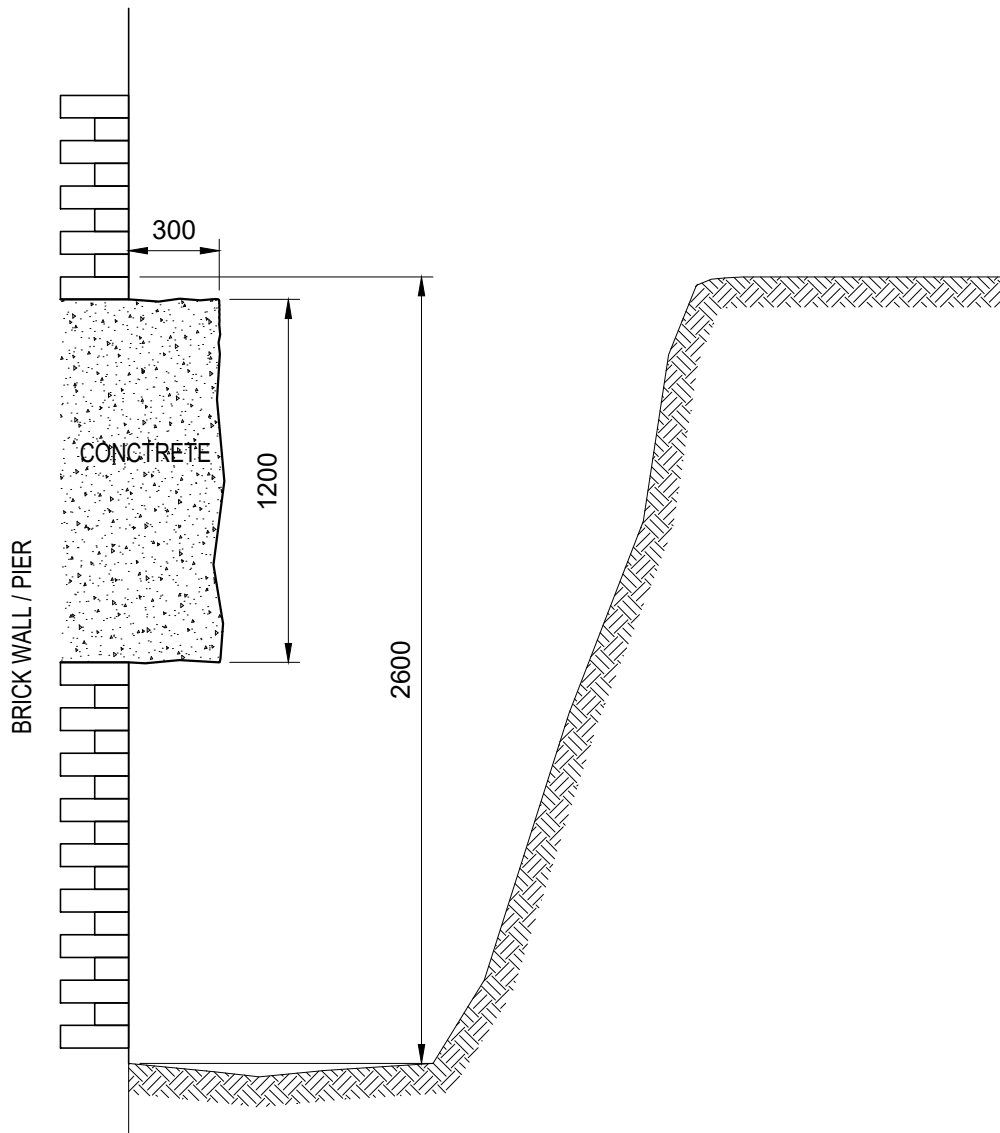
Checked: JJ

Scale: NTS



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NOTES

SHALLOW CONCRETE NOT THOUGHT TO REPRESENT
FOUNDATION HOWEVER IT'S PURPOSE IS UNCLEAR.
NO EVIDENCE OF DEEPER FOUNDATION IDENTIFIED TO
BASE OF HOLE.
REFER TO CURTINS TRIAL PIT LOG FOR STRATA DETAILS.
TRIAL PIT UNDERTAKEN AGAINST BRICK PIER.

Appendix C Chemical Laboratory Testing Results

- Concept Life Sciences, Environmental Chemistry Analysis Results (Soil)
 - Certificate no. 670154-1 (Stage 1)
 - Certificate no. 685998-1 (Stage 2)
 - Certificate no. 710262-1 (Stage 3)
- Envirolab, Environmental Chemistry Analysis Results (Soil)
 - Certificate no. 19/04656 (Stage 5)
- i2 Analytical, Environmental Chemistry Analysis Results (Soil)
 - Certificate no. 19-43368 (Stage 4)
 - Certificate no. 19-43785 (Stage 4)
- Envirolab, Environmental Chemistry Analysis Results (Water)
 - Certificate no. 19-43368 (Stage 4)

Concept Life Sciences

Certificate of Analysis

Hadfield House
Hadfield Street
Cornbrook
Manchester
M16 9FE
Tel : 0161 874 2400
Fax : 0161 874 2468

Report Number: 670154-1

Date of Report: 31-Jul-2017

Customer: Curtins Consulting Ltd.
17-19 Whitworth Street West
Manchester
M1 5WG

Customer Contact: Mr Niall Farnworth

Customer Job Reference: Bo45374.000

Customer Site Reference: Chandos Hall

Date Job Received at Concept: 21-Jul-2017

Date Analysis Started: 24-Jul-2017

Date Analysis Completed: 31-Jul-2017

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.

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

This report should not be reproduced except in full without the written approval of the laboratory

Tests covered by this certificate were conducted in accordance with Concept SOPs

All results have been reviewed in accordance with Section 25 of the Concept, Analytical Quality Quality Manual



Report checked
and authorised by :
Bianca Prince
Customer Service Manager

Issued by :
Bianca Prince
Customer Service Manager

Concept Reference: 670154 Project Site: Chandos Hall Customer Reference: Bo45374.000 Soil Analysed as Soil Heavy Metals(9)								
Concept Reference					670154 001	670154 002	670154 003	670154 004
Customer Sample Reference					BH01 ES1	BH01 ES2	BH02 ES1	BH02 ES2
Depth					0.20	0.25	0.20	0.40
Date Sampled					18-JUL-2017	18-JUL-2017	18-JUL-2017	18-JUL-2017
Matrix Class					Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil
Determinand	Method	Test Sample	LOD	Units				
Arsenic	T6	M40	2	mg/kg	3	11	3	45
Cadmium	T6	M40	1	mg/kg	<1	<1	<1	<1
Chromium	T6	M40	1	mg/kg	10	9	8	17
Copper	T6	M40	1	mg/kg	11	16	7	44
Lead	T6	M40	1	mg/kg	28	23	15	36
Mercury	T6	M40	1	mg/kg	<1	<1	<1	<1
Nickel	T6	M40	1	mg/kg	25	36	23	27
Selenium	T6	M40	3	mg/kg	<3	<3	<3	<3
Zinc	T6	M40	1	mg/kg	54	43	34	48

Concept Reference: 670154 Project Site: Chandos Hall Customer Reference: Bo45374.000 Soil Analysed as Soil Curtins Suite A								
Concept Reference					670154 001	670154 002	670154 003	670154 004
Customer Sample Reference					BH01 ES1	BH01 ES2	BH02 ES1	BH02 ES2
Depth					0.20	0.25	0.20	0.40
Date Sampled					18-JUL-2017	18-JUL-2017	18-JUL-2017	18-JUL-2017
Matrix Class					Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil
Determinand	Method	Test Sample	LOD	Units				
Asbestos ID	T27	AR			N.D.	N.D.	N.D.	N.D.
Boron (water-soluble)	T6	AR	1	mg/kg	<1	<1	<1	<1
Chromium VI	T6	AR	1	mg/kg	<1	<1	<1	<1
Cyanide(Total)	T546	AR	1	mg/kg	<1	<1	<1	<1
pH	T7	AR			7.5	7.8	8.0	7.8
Phenols(Mono)	T546	AR	1	mg/kg	<1	<1	<1	<1
Retained on 10mm sieve	T2	M40	0.1	%	<0.1	<0.1	<0.1	<0.1
Soil Organic Matter	T287	A40	0.1	%	0.5	5.2	2.0	21
(Water Soluble) SO4 expressed as SO4	T242	AR	0.01	g/l	0.01	0.01	<0.01	0.02

				<0.10
mg/kg	(13) <1	(13) <1	(13) <1	(13) 1
mg/kg	(13) <1	(13) <1	(13) <1	(13) 4
mg/kg	(13) <1	(13) <1	(13) <1	(13) 4
mg/kg	(13) 1	(13) <1	(13) 1	(13) 9
mg/kg	<0.010	<0.010	<0.010	(110,100) <0.10
mg/kg	<0.010	<0.010	<0.010	(100,110) <0.10
mg/kg	<0.010	<0.010	<0.010	(100,110) <0.10
mg/kg	(13) <1	(13) <1	(13) <1	(13) 1
mg/kg	(13) 5	(13) 2	(13) 3	(13) 2
mg/kg	(13) 47	(13) 23	(13) 33	(13) 3
mg/kg	(13) 64	(13) 36	(13) 61	(13) 8

Reference	670154 001	670154 002	670154 003	670154 004
Reference	BH01 ES1	BH01 ES2	BH02 ES1	BH02 ES2
Depth	0.20	0.25	0.20	0.40
Sampled	18-JUL-2017	18-JUL-2017	18-JUL-2017	18-JUL-2017
Soil Class	Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil
Units				
%	<0.1	<0.1	<0.1	<0.1
%	6.8	8.2	7.4	17

Concept Reference: 670154								
Project Site: Chandos Hall								
Customer Reference: Bo45374.000								
Soil			Analysed as Soil					
PAH US EPA 16 (B and K split)								
Concept Reference					670154 001	670154 002	670154 003	670154 004
Customer Sample Reference					BH01 ES1	BH01 ES2	BH02 ES1	BH02 ES2
Depth					0.20	0.25	0.20	0.40
Date Sampled					18-JUL-2017	18-JUL-2017	18-JUL-2017	18-JUL-2017
Matrix Class					Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil
Determinand	Method	Test Sample	LOD	Units				
Naphthalene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	1.0
Acenaphthylene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	0.2
Acenaphthene	T207	M105	0.1	mg/kg	0.9	0.5	1.0	0.4
Fluorene	T207	M105	0.1	mg/kg	0.6	0.5	0.7	0.4
Phenanthrene	T207	M105	0.1	mg/kg	8.8	6.4	11	2.3
Anthracene	T207	M105	0.1	mg/kg	1.9	1.5	2.3	0.6
Fluoranthene	T207	M105	0.1	mg/kg	6.6	7.3	10	1.9
Pyrene	T207	M105	0.1	mg/kg	5.3	6.2	8.5	1.9
Benzo(a)Anthracene	T207	M105	0.1	mg/kg	2.8	3.7	4.8	1.0
Chrysene	T207	M105	0.1	mg/kg	2.7	3.6	4.5	1.0
Benzo(b)fluoranthene	T207	M105	0.1	mg/kg	1.7	2.3	3.6	0.7
Benzo(k)fluoranthene	T207	M105	0.1	mg/kg	2.4	2.5	3.7	0.8
Benzo(a)Pyrene	T207	M105	0.1	mg/kg	1.9	2.7	3.5	0.8
Indeno(123-cd)Pyrene	T207	M105	0.1	mg/kg	0.9	1.3	1.7	0.4
Dibenzo(ah)Anthracene	T207	M105	0.1	mg/kg	0.4	0.6	0.8	0.2
Benzo(ghi)Perylene	T207	M105	0.1	mg/kg	0.8	1.0	1.5	0.4
PAH(total)	T207	M105	0.1	mg/kg	38	40	58	14

Index to symbols used in 670154-1

Value	Description
M105	Analysis conducted on an "as received" aliquot. Results are reported on a dry weight basis where moisture content was determined by assisted drying of sample at 105C
A40	Assisted dried < 40C
M40	Analysis conducted on sample assisted dried at no more than 40C. Results are reported on a dry weight basis.
AR	As Received
N.D.	Not Detected
110	LOD raised due to low internal standard recovery.
100	LOD determined by sample aliquot used for analysis
13	Results have been blank corrected.
S	Analysis was subcontracted
M	Analysis is MCERTS accredited
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Notes

Asbestos was subcontracted to REC Asbestos.

Method Index

Value	Description
T27	PLM
T546	Colorimetry (CF)
T2	Grav
T207	GC/MS (MCERTS)
T242	2:1 Extraction/ICP/OES (TRL 447 T1)
T7	Probe
T8	GC/FID
T6	ICP/OES
T54	GC/MS (Headspace)
T287	Calc TOC/0.58
T162	Grav (1 Dec) (105 C)

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	Concept References
Moisture @105C	T162	AR	0.1	%	N	001-004
Asbestos ID	T27	AR			SU	001-004
Boron (water-soluble)	T6	AR	1	mg/kg	N	001-004
Chromium VI	T6	AR	1	mg/kg	N	001-004
Cyanide(Total)	T546	AR	1	mg/kg	M	001-004
pH	T7	AR			M	001-004
Phenols(Mono)	T546	AR	1	mg/kg	M	001-004
Retained on 10mm sieve	T2	M40	0.1	%	N	001-004
Soil Organic Matter	T287	A40	0.1	%	N	001-004
(Water Soluble) SO4 expressed as SO4	T242	AR	0.01	g/l	N	001-004
Benzene	T54	AR	1	µg/kg	U	001-004
Toluene	T54	AR	1	µg/kg	U	001-004
EthylBenzene	T54	AR	1	µg/kg	U	001-004
M/P Xylene	T54	AR	1	µg/kg	U	001-004
O Xylene	T54	AR	1	µg/kg	U	001-004
Methyl tert-Butyl Ether	T54	AR	1	µg/kg	U	001-004
TPH (C5-C6 aliphatic)	T54	AR	0.010	mg/kg	N	001-004
TPH (C6-C8 aliphatic)	T54	AR	0.010	mg/kg	N	001-004
TPH (C8-C10 aliphatic)	T54	AR	0.010	mg/kg	N	001-004
TPH (C10-C12 aliphatic)	T8	M105	1	mg/kg	N	001-004
TPH (C12-C16 aliphatic)	T8	M105	1	mg/kg	N	001-004
TPH (C16-C21 aliphatic)	T8	M105	1	mg/kg	N	001-004
TPH (C21-C35 aliphatic)	T8	M105	1	mg/kg	N	001-004
TPH (C6-C7 aromatic)	T54	AR	0.010	mg/kg	N	001-004
TPH (C7-C8 aromatic)	T54	AR	0.010	mg/kg	N	001-004
TPH (C8-C10 aromatic)	T54	AR	0.010	mg/kg	N	001-004
TPH (C10-C12 aromatic)	T8	M105	1	mg/kg	N	001-004
TPH (C12-C16 aromatic)	T8	M105	1	mg/kg	N	001-004
TPH (C16-C21 aromatic)	T8	M105	1	mg/kg	N	001-004
TPH (C21-C35 aromatic)	T8	M105	1	mg/kg	N	001-004
Arsenic	T6	M40	2	mg/kg	M	001-004
Cadmium	T6	M40	1	mg/kg	M	001-004
Chromium	T6	M40	1	mg/kg	M	001-004
Copper	T6	M40	1	mg/kg	M	001-004
Lead	T6	M40	1	mg/kg	M	001-004
Mercury	T6	M40	1	mg/kg	M	001-004
Nickel	T6	M40	1	mg/kg	M	001-004
Selenium	T6	M40	3	mg/kg	M	001-004
Zinc	T6	M40	1	mg/kg	M	001-004
Naphthalene	T207	M105	0.1	mg/kg	M	001-004
Acenaphthylene	T207	M105	0.1	mg/kg	U	001-004
Acenaphthene	T207	M105	0.1	mg/kg	M	001-004
Fluorene	T207	M105	0.1	mg/kg	M	001-004
Phenanthrene	T207	M105	0.1	mg/kg	M	001-004
Anthracene	T207	M105	0.1	mg/kg	U	001-004
Fluoranthene	T207	M105	0.1	mg/kg	M	001-004
Pyrene	T207	M105	0.1	mg/kg	M	001-004
Benzo(a)Anthracene	T207	M105	0.1	mg/kg	M	001-004
Chrysene	T207	M105	0.1	mg/kg	M	001-004
Benzo(b)fluoranthene	T207	M105	0.1	mg/kg	M	001-004
Benzo(k)fluoranthene	T207	M105	0.1	mg/kg	M	001-004
Benzo(a)Pyrene	T207	M105	0.1	mg/kg	M	001-004
Indeno(123-cd)Pyrene	T207	M105	0.1	mg/kg	M	001-004
Dibenzo(ah)Anthracene	T207	M105	0.1	mg/kg	M	001-004
Benzo(ghi)Perylene	T207	M105	0.1	mg/kg	M	001-004
PAH(total)	T207	M105	0.1	mg/kg	U	001-004

Concept Life Sciences

Certificate of Analysis

Hadfield House
Hadfield Street
Cornbrook
Manchester
M16 9FE
Tel : 0161 874 2400
Fax : 0161 874 2468

Report Number: 685998-1

Date of Report: 09-Oct-2017

Customer: Curtins Consulting Ltd.
17-19 Whitworth Street West
Manchester
M1 5WG

Customer Contact: Ms Jess Bailey

Customer Job Reference: B065374

Customer Purchase Order: EBMA892

Customer Site Reference: Chandos Hall Stage 2

Date Job Received at Concept: 28-Sep-2017

Date Analysis Started: 29-Sep-2017

Date Analysis Completed: 09-Oct-2017

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.

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

This report should not be reproduced except in full without the written approval of the laboratory

Tests covered by this certificate were conducted in accordance with Concept Life Sciences SOPs

All results have been reviewed in accordance with Section 25 of the Concept Life Sciences, Analytical Services Quality Manual



Report checked
and authorised by :
Aleksandra Pacula
Customer Service Advisor

Issued by :
Aleksandra Pacula
Customer Service Advisor

Concept Reference: 685998 Project Site: Chandos Hall Stage 2 Customer Reference: B065374											
Soil		Analysed as Soil									
Heavy Metals(9)											
Concept Reference		685998 001		685998 002		685998 003		685998 005		685998 007	
Customer Sample Reference		WS02		WS02A		WS03		WS04		WS01	
Bottom Depth		0.2		0.4		0.6		0.25		0.5	
Top Depth		0.1		0.3		0.5		0.15		0.4	
Date Sampled		27-SEP-2017		27-SEP-2017		27-SEP-2017		27-SEP-2017		27-SEP-2017	
Matrix Class		Sandy Soil		Sandy Soil		Sandy Soil		Sandy Soil		Sandy Soil	
Determinand	Method	Test Sample	LOD	Units							
Arsenic	T6	M40	2	mg/kg	6	50	120	6	13		
Cadmium	T6	M40	1	mg/kg	<1	<1	1	<1	<1		
Chromium	T6	M40	1	mg/kg	9	15	17	10	12		
Copper	T6	M40	1	mg/kg	15	56	72	12	41		
Lead	T6	M40	1	mg/kg	38	35	44	27	35		
Mercury	T6	M40	1	mg/kg	<1	<1	<1	<1	<1		
Nickel	T6	M40	1	mg/kg	14	30	39	15	27		
Selenium	T6	M40	3	mg/kg	<3	<3	<3	<3	<3		
Zinc	T6	M40	1	mg/kg	60	46	55	47	35		

Concept Reference: 685998 Project Site: Chandos Hall Stage 2 Customer Reference: B065374 Soil Analysed as Soil Heavy Metals(9)					
Concept Reference		685998 008			
Customer Sample Reference		WS01			
Bottom Depth		1.0			
Top Depth		0.7			
Date Sampled		27-SEP-2017			
Matrix Class		Sandy Soil			
Determinand	Method	Test Sample	LOD	Units	
Arsenic	T6	M40	2	mg/kg	8
Cadmium	T6	M40	1	mg/kg	<1
Chromium	T6	M40	1	mg/kg	14
Copper	T6	M40	1	mg/kg	24
Lead	T6	M40	1	mg/kg	64
Mercury	T6	M40	1	mg/kg	<1
Nickel	T6	M40	1	mg/kg	17
Selenium	T6	M40	3	mg/kg	<3
Zinc	T6	M40	1	mg/kg	49

Concept Reference: 685998									
Project Site: Chandos Hall Stage 2									
Customer Reference: B065374									
Soil					Analysed as Soil				
Curtins Suite A									
Concept Reference					685998 001	685998 002	685998 003	685998 005	685998 007
Customer Sample Reference					WS02	WS02A	WS03	WS04	WS01
Bottom Depth					0.2	0.4	0.6	0.25	0.5
Top Depth					0.1	0.3	0.5	0.15	0.4
Date Sampled					27-SEP-2017	27-SEP-2017	27-SEP-2017	27-SEP-2017	27-SEP-2017
Matrix Class					Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil
Determinand		Method	Test Sample	LOD	Units				
Asbestos ID		T27	AR			N.D.	N.D.	N.D.	N.D.
Boron (water-soluble)		T6	AR	1	mg/kg	<1	<1	<1	<1
Chromium VI		T6	AR	1	mg/kg	<1	<1	<1	<1
Cyanide(Total)		T546	AR	1	mg/kg	<1	<1	<1	<1
pH		T7	AR			8.1	8.2	7.9	8.0
Phenols(Mono)		T546	AR	1	mg/kg	<1	<1	<1	<1
Retained on 10mm sieve		T2	M40	0.1	%	<0.1	<0.1	<0.1	<0.1
Soil Organic Matter		T287	A40	0.1	%	4.7	27	29	3.6
(Water Soluble) SO4 expressed as SO4		T242	AR	0.01	g/l	<0.01	0.04	0.03	<0.01
									<0.01

Concept Reference: 685998					
Project Site: Chandos Hall Stage 2					
Customer Reference: B065374					
Soil		Analysed as Soil			
Curtins Suite A					
Concept Reference					685998 008
Customer Sample Reference					WS01
Bottom Depth					1.0
Top Depth					0.7
Date Sampled					27-SEP-2017
Matrix Class					Sandy Soil
Determinand	Method	Test Sample	LOD	Units	
Asbestos ID	T27	AR			N.D.
Boron (water-soluble)	T6	AR	1	mg/kg	<1
Chromium VI	T6	AR	1	mg/kg	<1
Cyanide(Total)	T546	AR	1	mg/kg	<1
pH	T7	AR			8.3
Phenols(Mono)	T546	AR	1	mg/kg	<1
Retained on 10mm sieve	T2	M40	0.1	%	<0.1
Soil Organic Matter	T287	A40	0.1	%	2.1
(Water Soluble) SO4 expressed as SO4	T242	AR	0.01	g/l	<0.01

Concept Reference: 685998
Project Site: Chandos Hall Stage 2
Customer Reference: B065374

Soil
TPH (CWG) Analysed as Soil

Concept Reference					685998 001	685998 002	685998 003	685998 005	685998 007
Customer Sample Reference					WS02	WS02A	WS03	WS04	WS01
Bottom Depth					0.2	0.4	0.6	0.25	0.5
Top Depth					0.1	0.3	0.5	0.15	0.4
Date Sampled					27-SEP-2017	27-SEP-2017	27-SEP-2017	27-SEP-2017	27-SEP-2017
Matrix Class					Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil
Determinand	Method	Test Sample	LOD	Units					
Benzene	T54	AR	1	µg/kg	(13) <1	(110,13,100) <10	(110,100,13) <20	(13) <1	(13) <1
Toluene	T54	AR	1	µg/kg	(13) <1	(110,13,100) <10	(13) 30	(13) <1	(13) 3
EthylBenzene	T54	AR	1	µg/kg	<1	(110,100) <10	(110,100) <20	<1	<1
M/P Xylene	T54	AR	1	µg/kg	<1	(110,100) <10	(100,110) <20	<1	1
O Xylene	T54	AR	1	µg/kg	<1	(110,100) <10	(110,100) <20	<1	1
Methyl tert-Butyl Ether	T54	AR	1	µg/kg	<1	(100,110) <10	(100,110) <20	<1	<1
TPH (C5-C6 aliphatic)	T54	AR	0.010	mg/kg	<0.010	(110,100) <0.10	(100,110) <0.20	<0.010	<0.010
TPH (C6-C8 aliphatic)	T54	AR	0.010	mg/kg	<0.010	(100,110) <0.10	(100,110) <0.20	<0.010	<0.010
TPH (C8-C10 aliphatic)	T54	AR	0.010	mg/kg	<0.010	(100,110) <0.10	(110,100) <0.20	<0.010	<0.010
TPH (C10-C12 aliphatic)	T8	M105	1	mg/kg	(9,13) <10	(9,13) <10	(13) <1	(9,13) <10	(13) <1
TPH (C12-C16 aliphatic)	T8	M105	1	mg/kg	(13,9) <10	(13,9) <10	(13) 2	(13,9) <10	(13) <1
TPH (C16-C21 aliphatic)	T8	M105	1	mg/kg	(13) 23	(9,13) <10	(13) 3	(13) 10	(13) 2
TPH (C21-C35 aliphatic)	T8	M105	1	mg/kg	(13) 24	(13) 16	(13) 9	(13) 17	(13) 2
TPH (C6-C7 aromatic)	T54	AR	0.010	mg/kg	<0.010	(110,100) <0.10	(110,100) <0.20	<0.010	<0.010
TPH (C7-C8 aromatic)	T54	AR	0.010	mg/kg	<0.010	(100,110) <0.10	(100,110) <0.20	<0.010	<0.010
TPH (C8-C10 aromatic)	T54	AR	0.010	mg/kg	0.088	(110,100) <0.10	(100,110) <0.20	0.023	<0.010
TPH (C10-C12 aromatic)	T8	M105	1	mg/kg	(13,9) <10	(13,9) <10	(13) 1	(9,13) <10	(13) <1
TPH (C12-C16 aromatic)	T8	M105	1	mg/kg	(13) 130	(13) 12	(13) 8	(13) 110	(13) 3
TPH (C16-C21 aromatic)	T8	M105	1	mg/kg	(13) 1000	(13) 91	(13) 35	(13) 940	(13) 29
TPH (C21-C35 aromatic)	T8	M105	1	mg/kg	(13) 1700	(13) 170	(13) 48	(13) 1100	(13) 50

Concept Reference: 685998 Project Site: Chandos Hall Stage 2 Customer Reference: B065374 Soil Analysed as Soil PAH US EPA 16 (B and K split)									
Concept Reference					685998 001	685998 002	685998 003	685998 005	685998 007
Customer Sample Reference					WS02	WS02A	WS03	WS04	WS01
Bottom Depth					0.2	0.4	0.6	0.25	0.5
Top Depth					0.1	0.3	0.5	0.15	0.4
Date Sampled					27-SEP-2017	27-SEP-2017	27-SEP-2017	27-SEP-2017	27-SEP-2017
Matrix Class					Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil
Determinand	Method	Test Sample	LOD	Units					
Naphthalene	T207	M105	0.1	mg/kg	2.9	1.0	0.2	6.0	0.3
Acenaphthylene	T207	M105	0.1	mg/kg	⁽⁹⁾ <1.0	0.1	<0.1	⁽⁹⁾ <1.0	<0.1
Acenaphthene	T207	M105	0.1	mg/kg	9.8	2.8	0.4	30	0.6
Fluorene	T207	M105	0.1	mg/kg	6.7	2.5	0.3	18	0.4
Phenanthrene	T207	M105	0.1	mg/kg	100	40	3.0	290	6.6
Anthracene	T207	M105	0.1	mg/kg	19	6.6	0.7	51	1.3
Fluoranthene	T207	M105	0.1	mg/kg	110	36	3.6	230	6.0
Pyrene	T207	M105	0.1	mg/kg	92	30	3.0	190	4.9
Benzo(a)Anthracene	T207	M105	0.1	mg/kg	48	12	1.6	86	2.4
Chrysene	T207	M105	0.1	mg/kg	43	9.9	1.3	72	2.0
Benzo(b)fluoranthene	T207	M105	0.1	mg/kg	40	14	0.9	52	1.6
Benzo(k)fluoranthene	T207	M105	0.1	mg/kg	27	6.2	1.1	53	1.4
Benzo(a)Pyrene	T207	M105	0.1	mg/kg	33	10	1.0	54	1.5
Indeno(123-cd)Pyrene	T207	M105	0.1	mg/kg	22	4.4	0.5	28	0.7
Dibenzo(ah)Anthracene	T207	M105	0.1	mg/kg	11	2.2	0.3	13	0.3
Benzo(ghi)Perylene	T207	M105	0.1	mg/kg	28	5.3	0.6	34	0.9
PAH(total)	T207	M105	0.1	mg/kg	590	180	19	1200	31

Concept Reference: 685998 Project Site: Chandos Hall Stage 2 Customer Reference: B065374 Soil Analysed as Soil PAH US EPA 16 (B and K split)					
Concept Reference					685998 008
Customer Sample Reference					WS01
Bottom Depth					1.0
Top Depth					0.7
Date Sampled					27-SEP-2017
Matrix Class					Sandy Soil
Determinand	Method	Test Sample	LOD	Units	
Naphthalene	T207	M105	0.1	mg/kg	<0.1
Acenaphthylene	T207	M105	0.1	mg/kg	<0.1
Acenaphthene	T207	M105	0.1	mg/kg	0.3
Fluorene	T207	M105	0.1	mg/kg	0.3
Phenanthrene	T207	M105	0.1	mg/kg	4.7
Anthracene	T207	M105	0.1	mg/kg	1.0
Fluoranthene	T207	M105	0.1	mg/kg	5.4
Pyrene	T207	M105	0.1	mg/kg	4.8
Benzo(a)Anthracene	T207	M105	0.1	mg/kg	2.4
Chrysene	T207	M105	0.1	mg/kg	2.0
Benzo(b)fluoranthene	T207	M105	0.1	mg/kg	1.8
Benzo(k)fluoranthene	T207	M105	0.1	mg/kg	1.4
Benzo(a)Pyrene	T207	M105	0.1	mg/kg	1.6
Indeno(123-cd)Pyrene	T207	M105	0.1	mg/kg	0.7
Dibenzo(ah)Anthracene	T207	M105	0.1	mg/kg	0.4
Benzo(ghi)Perylene	T207	M105	0.1	mg/kg	0.8
PAH(total)	T207	M105	0.1	mg/kg	28

Index to symbols used in 685998-1

Value	Description
A40	Assisted dried < 40C
M40	Analysis conducted on sample assisted dried at no more than 40C. Results are reported on a dry weight basis.
AR	As Received
M105	Analysis conducted on an "as received" aliquot. Results are reported on a dry weight basis where moisture content was determined by assisted drying of sample at 105C
N.D.	Not Detected
100	LOD determined by sample aliquot used for analysis
13	Results have been blank corrected.
9	LOD raised due to dilution of sample
110	LOD raised due to low internal standard recovery.
S	Analysis was subcontracted
M	Analysis is MCERTS accredited
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Notes

Asbestos was subcontracted to REC Asbestos.

Method Index

Value	Description
T8	GC/FID
T6	ICP/OES
T546	Colorimetry (CF)
T2	Grav
T27	PLM
T7	Probe
T207	GC/MS (MCERTS)
T242	2:1 Extraction/ICP/OES (TRL 447 T1)
T162	Grav (1 Dec) (105 C)
T287	Calc TOC/0.58
T54	GC/MS (Headspace)

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	Concept References
Asbestos ID	T27	AR			SU	001-003,005,007-008
Boron (water-soluble)	T6	AR	1	mg/kg	N	001-003,005,007-008
Chromium VI	T6	AR	1	mg/kg	N	001-003,005,007-008
Cyanide(Total)	T546	AR	1	mg/kg	M	001-003,005,007-008
pH	T7	AR			M	001-003,005,007-008
Phenols(Mono)	T546	AR	1	mg/kg	M	001-003,005,007-008
Retained on 10mm sieve	T2	M40	0.1	%	N	001-003,005,007-008
Soil Organic Matter	T287	A40	0.1	%	N	001-003,005,007-008
(Water Soluble) SO4 expressed as SO4	T242	AR	0.01	g/l	N	001-003,005,007-008
Benzene	T54	AR	1	µg/kg	U	001-003,005,007-008
Toluene	T54	AR	1	µg/kg	U	001-003,005,007-008
EthylBenzene	T54	AR	1	µg/kg	U	001-003,005,007-008
M/P Xylene	T54	AR	1	µg/kg	U	001-003,005,007-008
O Xylene	T54	AR	1	µg/kg	U	001-003,005,007-008
Methyl tert-Butyl Ether	T54	AR	1	µg/kg	U	001-003,005,007-008
TPH (C5-C6 aliphatic)	T54	AR	0.010	mg/kg	N	001-003,005,007-008
TPH (C6-C8 aliphatic)	T54	AR	0.010	mg/kg	N	001-003,005,007-008
TPH (C8-C10 aliphatic)	T54	AR	0.010	mg/kg	N	001-003,005,007-008
TPH (C10-C12 aliphatic)	T8	M105	1	mg/kg	N	001-003,005,007-008
TPH (C12-C16 aliphatic)	T8	M105	1	mg/kg	N	001-003,005,007-008
TPH (C16-C21 aliphatic)	T8	M105	1	mg/kg	N	001-003,005,007-008
TPH (C21-C35 aliphatic)	T8	M105	1	mg/kg	N	001-003,005,007-008
TPH (C6-C7 aromatic)	T54	AR	0.010	mg/kg	N	001-003,005,007-008
TPH (C7-C8 aromatic)	T54	AR	0.010	mg/kg	N	001-003,005,007-008
TPH (C8-C10 aromatic)	T54	AR	0.010	mg/kg	N	001-003,005,007-008
TPH (C10-C12 aromatic)	T8	M105	1	mg/kg	N	001-003,005,007-008
TPH (C12-C16 aromatic)	T8	M105	1	mg/kg	N	001-003,005,007-008
TPH (C16-C21 aromatic)	T8	M105	1	mg/kg	N	001-003,005,007-008
TPH (C21-C35 aromatic)	T8	M105	1	mg/kg	N	001-003,005,007-008

Determinand	Method	Test Sample	LOD	Units	Symbol	Concept References
Arsenic	T6	M40	2	mg/kg	M	001-003,005,007-008
Cadmium	T6	M40	1	mg/kg	M	001-003,005,007-008
Chromium	T6	M40	1	mg/kg	M	001-003,005,007-008
Copper	T6	M40	1	mg/kg	M	001-003,005,007-008
Lead	T6	M40	1	mg/kg	M	001-003,005,007-008
Mercury	T6	M40	1	mg/kg	M	001-003,005,007-008
Nickel	T6	M40	1	mg/kg	M	001-003,005,007-008
Selenium	T6	M40	3	mg/kg	M	001-003,005,007-008
Zinc	T6	M40	1	mg/kg	M	001-003,005,007-008
Naphthalene	T207	M105	0.1	mg/kg	M	001-003,005,007-008
Acenaphthylene	T207	M105	0.1	mg/kg	U	001-003,005,007-008
Acenaphthene	T207	M105	0.1	mg/kg	M	001-003,005,007-008
Fluorene	T207	M105	0.1	mg/kg	M	001-003,005,007-008
Phenanthrene	T207	M105	0.1	mg/kg	M	001-003,005,007-008
Anthracene	T207	M105	0.1	mg/kg	U	001-003,005,007-008
Fluoranthene	T207	M105	0.1	mg/kg	M	001-003,005,007-008
Pyrene	T207	M105	0.1	mg/kg	M	001-003,005,007-008
Benzo(a)Anthracene	T207	M105	0.1	mg/kg	M	001-003,005,007-008
Chrysene	T207	M105	0.1	mg/kg	M	001-003,005,007-008
Benzo(b)fluoranthene	T207	M105	0.1	mg/kg	M	001-003,005,007-008
Benzo(k)fluoranthene	T207	M105	0.1	mg/kg	M	001-003,005,007-008
Benzo(a)Pyrene	T207	M105	0.1	mg/kg	M	001-003,005,007-008
Indeno(123-cd)Pyrene	T207	M105	0.1	mg/kg	M	001-003,005,007-008
Dibenzo(ah)Anthracene	T207	M105	0.1	mg/kg	M	001-003,005,007-008
Benzo(ghi)Perylene	T207	M105	0.1	mg/kg	M	001-003,005,007-008
PAH(total)	T207	M105	0.1	mg/kg	U	001-003,005,007-008
Moisture @105C	T162	AR	0.1	%	N	001-003,005,007-008



Concept Life Sciences

Certificate of Analysis

Hadfield House
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M16 9FE
Tel : 0161 874 2400
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Report Number: 710262-1

Date of Report: 29-Jan-2018

Customer: Curtins Consulting Ltd.
17-19 Whitworth Street West
Manchester
M1 5WG

Customer Contact: Mr Niall Farnworth

Customer Job Reference: B065374

Customer Site Reference: Chandos Hall

Date Job Received at Concept: 22-Jan-2018

Date Analysis Started: 23-Jan-2018

Date Analysis Completed: 29-Jan-2018

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.

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

This report should not be reproduced except in full without the written approval of the laboratory

Tests covered by this certificate were conducted in accordance with Concept Life Sciences SOPs

All results have been reviewed in accordance with Section 25 of the Concept Life Sciences, Analytical Services Quality Manual



Report checked
and authorised by :
Aleksandra Pacula
Customer Service Advisor

Issued by :
Aleksandra Pacula
Customer Service Advisor

Concept Reference: 710262 Project Site: Chandos Hall Customer Reference: B065374									
Soil					Analysed as Soil				
Heavy Metals(9)									
Concept Reference					710262 001	710262 002	710262 003	710262 004	710262 005
Customer Sample Reference					BH03	WS05	WS06	WS07	WS08
Top Depth					0.3	0.2	0.7		0.1
Bottom Depth					0.4	0.3	0.8	0.6	0.2
Date Sampled					19-JAN-2018	19-JAN-2018	19-JAN-2018	19-JAN-2018	20-JAN-2018
Matrix Class					Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil
Determinand	Method	Test Sample	LOD	Units					
Arsenic	T6	M40	2	mg/kg	51	12	7	16	23
Cadmium	T6	M40	1	mg/kg	2	<1	1	<1	<1
Chromium	T6	M40	1	mg/kg	22	23	19	20	15
Copper	T6	M40	1	mg/kg	510	93	21	90	82
Lead	T6	M40	1	mg/kg	3800	160	120	260	40
Mercury	T6	M40	1	mg/kg	1	<1	<1	<1	<1
Nickel	T6	M40	1	mg/kg	52	26	29	27	47
Selenium	T6	M40	3	mg/kg	<3	<3	<3	<3	<3
Zinc	T6	M40	1	mg/kg	730	140	96	150	52

Concept Reference: 710262									
Project Site: Chandos Hall									
Customer Reference: B065374									
Soil					Analysed as Soil				
Heavy Metals(9)									
Concept Reference					710262 006	710262 007	710262 008	710262 009	710262 010
Customer Sample Reference					WS08	WS09	WS10	WS10	WS11
Top Depth					1.8	0.3	0.5	1.2	0.1
Bottom Depth					2.0	0.4	0.6	1.4	0.2
Date Sampled					20-JAN-2018	20-JAN-2018	20-JAN-2018	20-JAN-2018	20-JAN-2018
Matrix Class					Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil
Determinand	Method	Test Sample	LOD	Units					
Arsenic	T6	M40	2	mg/kg	140	19	17	21	11
Cadmium	T6	M40	1	mg/kg	3	<1	3	<1	<1
Chromium	T6	M40	1	mg/kg	49	19	21	21	21
Copper	T6	M40	1	mg/kg	460	100	54	65	53
Lead	T6	M40	1	mg/kg	6400	330	140	65	150
Mercury	T6	M40	1	mg/kg	17	<1	<1	<1	<1
Nickel	T6	M40	1	mg/kg	65	29	26	47	25
Selenium	T6	M40	3	mg/kg	<3	<3	<3	<3	<3
Zinc	T6	M40	1	mg/ka	690	140	280	85	100

Concept Reference: 710262 Project Site: Chandos Hall Customer Reference: B065374					
Soil Heavy Metals(9)					
Concept Reference					710262 011
Customer Sample Reference					WS11
Top Depth					0.5
Bottom Depth					0.6
Date Sampled					20-JAN-2018
Matrix Class					Sandy Soil
Determinand	Method	Test Sample	LOD	Units	
Arsenic	T6	M40	2	mg/kg	18
Cadmium	T6	M40	1	mg/kg	<1
Chromium	T6	M40	1	mg/kg	29
Copper	T6	M40	1	mg/kg	52
Lead	T6	M40	1	mg/kg	130
Mercury	T6	M40	1	mg/kg	<1
Nickel	T6	M40	1	mg/kg	35
Selenium	T6	M40	3	mg/kg	<3
Zinc	T6	M40	1	mg/kg	75

Concept Reference: 710262 Project Site: Chandos Hall Customer Reference: B065374										
Soil Curtins Suite A										
Concept Reference					710262 001	710262 002	710262 003	710262 004	710262 005	
Customer Sample Reference					BH03	WS05	WS06	WS07	WS08	
Top Depth					0.3	0.2	0.7		0.1	
Bottom Depth					0.4	0.3	0.8	0.6	0.2	
Date Sampled					19-JAN-2018	19-JAN-2018	19-JAN-2018	19-JAN-2018	20-JAN-2018	
Matrix Class					Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil	
Determinand	Method	Test Sample	LOD	Units						
Asbestos ID	T27	AR			N.D.	N.D.	N.D.	N.D.	N.D.	
Boron (water-soluble)	T6	AR	1	mg/kg	<1	<1	<1	<1	<1	
Chromium VI	T6	AR	1	mg/kg	<1	<1	<1	<1	<1	
Cyanide(Total)	T546	AR	1	mg/kg	<1	<1	<1	<1	<1	
pH	T7	AR			7.7	8.9	11.4	8.6	8.1	
Phenols(Mono)	T546	AR	1	mg/kg	<1	<1	<1	<1	<1	
Retained on 10mm sieve	T2	M40	0.1	%	<0.1	<0.1	<0.1	<0.1	<0.1	
Soil Organic Matter	T287	A40	0.1	%	26	2.4	0.4	4.3	40	
(Water Soluble) SO4 expressed as SO4	T242	AR	0.01	g/l	0.09	0.16	0.11	1.0	0.02	

Concept Reference: 710262									
Project Site: Chandos Hall									
Customer Reference: B065374									
Soil					Analysed as Soil				
Curtins Suite A									
Concept Reference					710262 006	710262 007	710262 008	710262 009	710262 010
Customer Sample Reference					WS08	WS09	WS10	WS10	WS11
Top Depth					1.8	0.3	0.5	1.2	0.1
Bottom Depth					2.0	0.4	0.6	1.4	0.2
Date Sampled					20-JAN-2018	20-JAN-2018	20-JAN-2018	20-JAN-2018	20-JAN-2018
Matrix Class					Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil
Determinand		Method	Test Sample	LOD	Units				
Asbestos ID		T27	AR			N.D.	N.D.	N.D.	N.D.
Boron (water-soluble)		T6	AR	1	mg/kg	<1	<1	<1	<1
Chromium VI		T6	AR	1	mg/kg	<1	<1	<1	<1
Cyanide(Total)		T546	AR	1	mg/kg	<1	<1	<1	<1
pH		T7	AR			8.4	8.6	8.7	8.8
Phenols(Mono)		T546	AR	1	mg/kg	<1	<1	<1	<1
Retained on 10mm sieve		T2	M40	0.1	%	<0.1	<0.1	<0.1	<0.1
Soil Organic Matter		T287	A40	0.1	%	28	13	5.7	23
(Water Soluble) SO4 expressed as SO4		T242	AR	0.01	g/l	0.02	0.01	0.01	0.05
									0.01

Concept Reference: 710262					
Project Site: Chandos Hall					
Customer Reference: B065374					
Soil		Analysed as Soil			
Curtins Suite A					
Concept Reference					710262 011
Customer Sample Reference					WS11
Top Depth					0.5
Bottom Depth					0.6
Date Sampled					20-JAN-2018
Matrix Class					Sandy Soil
Determinand	Method	Test Sample	LOD	Units	
Asbestos ID	T27	AR			N.D.
Boron (water-soluble)	T6	AR	1	mg/kg	<1
Chromium VI	T6	AR	1	mg/kg	<1
Cyanide(Total)	T546	AR	1	mg/kg	<1
pH	T7	AR			8.6
Phenols(Mono)	T546	AR	1	mg/kg	<1
Retained on 10mm sieve	T2	M40	0.1	%	<0.1
Soil Organic Matter	T287	A40	0.1	%	4.1
(Water Soluble) SO4 expressed as SO4	T242	AR	0.01	g/l	0.03

Concept Reference: 710262
Project Site: Chandos Hall
Customer Reference: B065374

Soil
TPH (CWG) Analysed as Soil

Concept Reference					710262 001	710262 002	710262 003	710262 004	710262 005
Customer Sample Reference					BH03	WS05	WS06	WS07	WS08
Top Depth					0.3	0.2	0.7		0.1
Bottom Depth					0.4	0.3	0.8	0.6	0.2
Date Sampled					19-JAN-2018	19-JAN-2018	19-JAN-2018	19-JAN-2018	20-JAN-2018
Matrix Class					Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil
Determinand	Method	Test Sample	LOD	Units					
Benzene	T54	AR	1	µg/kg	(13) 4	(13) <1	(13) <1	(13) <1	(13,110) <2
Toluene	T54	AR	1	µg/kg	(13) 11	(13) <1	(13) <1	(13) <1	(13) 9
EthylBenzene	T54	AR	1	µg/kg	(110) <2	<1	<1	<1	(110) <2
M/P Xylene	T54	AR	1	µg/kg	(110) <2	<1	<1	<1	5
O Xylene	T54	AR	1	µg/kg	3	<1	<1	<1	3
Methyl tert-Butyl Ether	T54	AR	1	µg/kg	(110) <2	<1	<1	<1	(110) <2
TPH (C5-C6 aliphatic)	T54	AR	0.010	mg/kg	(110) <0.020	<0.010	<0.010	<0.010	(110) <0.020
TPH (C6-C8 aliphatic)	T54	AR	0.010	mg/kg	(110) <0.020	<0.010	<0.010	<0.010	(110) <0.020
TPH (C8-C10 aliphatic)	T54	AR	0.010	mg/kg	(110) <0.020	<0.010	<0.010	<0.010	(110) <0.020
TPH (C10-C12 aliphatic)	T8	M105	1	mg/kg	(13) 1	(13) <1	(13) <1	(13) <1	(13) <1
TPH (C12-C16 aliphatic)	T8	M105	1	mg/kg	(13) 13	(13) <1	(13) <1	(13) <1	(13) 2
TPH (C16-C21 aliphatic)	T8	M105	1	mg/kg	(13) 3	(13) 1	(13) <1	(13) <1	(13) 4
TPH (C21-C35 aliphatic)	T8	M105	1	mg/kg	(13) 16	(13) 29	(13) <1	(13) 2	(13) 5
TPH (C6-C7 aromatic)	T54	AR	0.010	mg/kg	(110) <0.020	<0.010	<0.010	<0.010	(110) <0.020
TPH (C7-C8 aromatic)	T54	AR	0.010	mg/kg	(110) <0.020	<0.010	<0.010	<0.010	(110) <0.020
TPH (C8-C10 aromatic)	T54	AR	0.010	mg/kg	(110) <0.020	<0.010	<0.010	<0.010	(110) <0.020
TPH (C10-C12 aromatic)	T8	M105	1	mg/kg	(13) 2	(13) <1	(13) <1	(13) <1	(13) 2
TPH (C12-C16 aromatic)	T8	M105	1	mg/kg	(13) 9	(13) <1	(13) <1	(13) <1	(13) 5
TPH (C16-C21 aromatic)	T8	M105	1	mg/kg	(13) 18	(13) 1	(13) <1	(13) 4	(13) 7
TPH (C21-C35 aromatic)	T8	M105	1	mg/kg	(13) 49	(13) 8	(13) <1	(13) 16	(13) 15



Concept Reference: 710262

Project Site: Chandos Hall

Customer Reference: B065374

Soil
TPH (CWG) Analysed as Soil

Concept Reference					710262 006	710262 007	710262 008	710262 009	710262 010
Customer Sample Reference					WS08	WS09	WS10	WS10	WS11
Top Depth					1.8	0.3	0.5	1.2	0.1
Bottom Depth					2.0	0.4	0.6	1.4	0.2
Date Sampled					20-JAN-2018	20-JAN-2018	20-JAN-2018	20-JAN-2018	20-JAN-2018
Matrix Class					Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil
Determinand	Method	Test Sample	LOD	Units					
Benzene	T54	AR	1	µg/kg	(100,13) <5	(13) <1	(13) <1	(110,13) <2	(13) <1
Toluene	T54	AR	1	µg/kg	(13) 8	(13) <1	(13) <1	(13) 6	(13) 3
EthylBenzene	T54	AR	1	µg/kg	(100) <5	<1	<1	(110) <2	<1
M/P Xylene	T54	AR	1	µg/kg	(100) <5	<1	<1	(110) <2	3
O Xylene	T54	AR	1	µg/kg	(100) <5	<1	<1	(110) <2	2
Methyl tert-Butyl Ether	T54	AR	1	µg/kg	(100) <5	<1	<1	(110) <2	<1
TPH (C5-C6 aliphatic)	T54	AR	0.010	mg/kg	(100) <0.050	<0.010	<0.010	(110) <0.020	<0.010
TPH (C6-C8 aliphatic)	T54	AR	0.010	mg/kg	(100) <0.050	<0.010	<0.010	(110) <0.020	<0.010
TPH (C8-C10 aliphatic)	T54	AR	0.010	mg/kg	(100) <0.050	<0.010	<0.010	9.2	<0.010
TPH (C10-C12 aliphatic)	T8	M105	1	mg/kg	(13) <1	(13) <1	(13) <1	(100,13) <10	(13) <1
TPH (C12-C16 aliphatic)	T8	M105	1	mg/kg	(13) <1	(13) <1	(13) <1	(13,100) <10	(13) <1
TPH (C16-C21 aliphatic)	T8	M105	1	mg/kg	(13) <1	(13) <1	(13) <1	(13,100) <10	(13) <1
TPH (C21-C35 aliphatic)	T8	M105	1	mg/kg	(13) 3	(13) 5	(13) <1	(100,13) <10	(13) <1
TPH (C6-C7 aromatic)	T54	AR	0.010	mg/kg	(100) <0.050	<0.010	<0.010	(110) <0.020	<0.010
TPH (C7-C8 aromatic)	T54	AR	0.010	mg/kg	(100) <0.050	<0.010	<0.010	(110) <0.020	<0.010
TPH (C8-C10 aromatic)	T54	AR	0.010	mg/kg	(100) <0.050	<0.010	<0.010	(110) <0.020	0.053
TPH (C10-C12 aromatic)	T8	M105	1	mg/kg	(13) <1	(13) <1	(13) <1	(13,100) <10	(13) <1
TPH (C12-C16 aromatic)	T8	M105	1	mg/kg	(13) <1	(13) 2	(13) 2	(100,13) <10	(13) 1
TPH (C16-C21 aromatic)	T8	M105	1	mg/kg	(13) 6	(13) 4	(13) 7	(13,100) <10	(13) 5
TPH (C21-C35 aromatic)	T8	M105	1	mg/kg	(13) 36	(13) 13	(13) 24	(13) 29	(13) 16

Concept Reference: 710262 Project Site: Chandos Hall Customer Reference: B065374 Soil Analysed as Soil Miscellaneous					
Concept Reference					710262 011
Customer Sample Reference					WS11
Top Depth					0.5
Bottom Depth					0.6
Date Sampled					20-JAN-2018
Matrix Class					Sandy Soil
Determinand	Method	Test Sample	LOD	Units	
Moisture @105C	T162	AR	0.1	%	22

Concept Reference: 710262									
Project Site: Chandos Hall									
Customer Reference: B065374									
Soil		Analysed as Soil							
PAH US EPA 16 (B and K split)									
Concept Reference					710262 001	710262 002	710262 003	710262 004	710262 005
Customer Sample Reference					BH03	WS05	WS06	WS07	WS08
Top Depth					0.3	0.2	0.7		0.1
Bottom Depth					0.4	0.3	0.8	0.6	0.2
Date Sampled					19-JAN-2018	19-JAN-2018	19-JAN-2018	19-JAN-2018	20-JAN-2018
Matrix Class					Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil
Determinand	Method	Test Sample	LOD	Units					
Naphthalene	T207	M105	0.1	mg/kg	0.2	<0.1	<0.1	<0.1	0.7
Acenaphthylene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fluorene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene	T207	M105	0.1	mg/kg	0.4	<0.1	<0.1	0.2	0.3
Anthracene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene	T207	M105	0.1	mg/kg	0.7	0.1	<0.1	1.0	0.2
Pyrene	T207	M105	0.1	mg/kg	0.7	0.1	<0.1	1.1	0.2
Benzo(a)Anthracene	T207	M105	0.1	mg/kg	0.3	<0.1	<0.1	0.5	<0.1
Chrysene	T207	M105	0.1	mg/kg	0.4	<0.1	<0.1	0.6	0.1
Benzo(b)fluoranthene	T207	M105	0.1	mg/kg	0.3	<0.1	<0.1	0.3	<0.1
Benzo(k)fluoranthene	T207	M105	0.1	mg/kg	0.3	<0.1	<0.1	0.3	<0.1
Benzo(a)Pyrene	T207	M105	0.1	mg/kg	0.3	<0.1	<0.1	0.3	<0.1
Indeno(123-cd)Pyrene	T207	M105	0.1	mg/kg	0.2	<0.1	<0.1	0.1	<0.1
Dibenzo(ah)Anthracene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(ghi)Perylene	T207	M105	0.1	mg/kg	0.2	<0.1	<0.1	<0.1	<0.1
PAH(total)	T207	M105	0.1	mg/ka	4.1	0.3	<0.1	4.4	1.6

Concept Reference: 710262									
Project Site: Chandos Hall									
Customer Reference: B065374									
Soil		Analysed as Soil							
PAH US EPA 16 (B and K split)									
Concept Reference				710262 006	710262 007	710262 008	710262 009	710262 010	
Customer Sample Reference				WS08	WS09	WS10	WS10	WS11	
Top Depth				1.8	0.3	0.5	1.2	0.1	
Bottom Depth				2.0	0.4	0.6	1.4	0.2	
Date Sampled				20-JAN-2018	20-JAN-2018	20-JAN-2018	20-JAN-2018	20-JAN-2018	
Matrix Class				Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil	
Determinand	Method	Test Sample	LOD	Units					
Naphthalene	T207	M105	0.1	mg/kg	0.2	1.0	<0.1	0.2	(9) <1.0
Acenaphthylene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	(9) <1.0
Acenaphthene	T207	M105	0.1	mg/kg	<0.1	1.0	<0.1	<0.1	(9) <1.0
Fluorene	T207	M105	0.1	mg/kg	<0.1	0.7	<0.1	<0.1	(9) <1.0
Phenanthrene	T207	M105	0.1	mg/kg	1.1	3.8	0.3	<0.1	(9) <1.0
Anthracene	T207	M105	0.1	mg/kg	0.2	0.8	<0.1	<0.1	(9) <1.0
Fluoranthene	T207	M105	0.1	mg/kg	2.4	3.5	0.6	0.2	(9) <1.0
Pyrene	T207	M105	0.1	mg/kg	2.4	3.4	0.5	0.2	(9) <1.0
Benzo(a)Anthracene	T207	M105	0.1	mg/kg	1.2	1.6	0.3	<0.1	(9) <1.0
Chrysene	T207	M105	0.1	mg/kg	1.2	1.6	0.3	<0.1	(9) <1.0
Benzo(b)fluoranthene	T207	M105	0.1	mg/kg	1.2	1.3	0.2	<0.1	1.0
Benzo(k)fluoranthene	T207	M105	0.1	mg/kg	1.0	1.1	0.3	<0.1	(9) <1.0
Benzo(a)Pyrene	T207	M105	0.1	mg/kg	1.2	1.3	0.2	<0.1	1.4
Indeno(123-cd)Pyrene	T207	M105	0.1	mg/kg	0.5	0.5	<0.1	<0.1	(9) <1.0
Dibenzo(ah)Anthracene	T207	M105	0.1	mg/kg	0.2	0.2	<0.1	<0.1	(9) <1.0
Benzo(ghi)Perylene	T207	M105	0.1	mg/kg	0.6	0.5	0.1	<0.1	1.2
PAH(total)	T207	M105	0.1	mg/kg	13	22	2.7	0.5	3.5

Concept Reference: 710262 Project Site: Chandos Hall Customer Reference: B065374 Soil Analysed as Soil PAH US EPA 16 (B and K split)					
Concept Reference		710262 011			
Customer Sample Reference		WS11			
Top Depth		0.5			
Bottom Depth		0.6			
Date Sampled		20-JAN-2018			
Matrix Class		Sandy Soil			
Determinand	Method	Test Sample	LOD	Units	
Naphthalene	T207	M105	0.1	mg/kg	<0.1
Acenaphthylene	T207	M105	0.1	mg/kg	<0.1
Acenaphthene	T207	M105	0.1	mg/kg	<0.1
Fluorene	T207	M105	0.1	mg/kg	<0.1
Phenanthrene	T207	M105	0.1	mg/kg	<0.1
Anthracene	T207	M105	0.1	mg/kg	<0.1
Fluoranthene	T207	M105	0.1	mg/kg	<0.1
Pyrene	T207	M105	0.1	mg/kg	<0.1
Benzo(a)Anthracene	T207	M105	0.1	mg/kg	<0.1
Chrysene	T207	M105	0.1	mg/kg	<0.1
Benzo(b)fluoranthene	T207	M105	0.1	mg/kg	<0.1
Benzo(k)fluoranthene	T207	M105	0.1	mg/kg	<0.1
Benzo(a)Pyrene	T207	M105	0.1	mg/kg	<0.1
Indeno(123-cd)Pyrene	T207	M105	0.1	mg/kg	<0.1
Dibenzo(ah)Anthracene	T207	M105	0.1	mg/kg	<0.1
Benzo(ghi)Perylene	T207	M105	0.1	mg/kg	<0.1
PAH(total)	T207	M105	0.1	mg/kg	<0.1

Index to symbols used in 710262-1

Value	Description
M40	Analysis conducted on sample assisted dried at no more than 40C. Results are reported on a dry weight basis.
AR	As Received
M105	Analysis conducted on an "as received" aliquot. Results are reported on a dry weight basis where moisture content was determined by assisted drying of sample at 105C
A40	Assisted dried < 40C
N.D.	Not Detected
9	LOD raised due to dilution of sample
110	LOD raised due to low internal standard recovery.
13	Results have been blank corrected.
100	LOD determined by sample aliquot used for analysis
S	Analysis was subcontracted
M	Analysis is MCERTS accredited
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Notes

Asbestos was subcontracted to REC Asbestos.

Method Index

Value	Description
T287	Calc TOC/0.58
T2	Grav
T27	PLM
T242	2:1 Extraction/ICP/OES (TRL 447 T1)
T7	Probe
T8	GC/FID
T546	Colorimetry (CF)
T207	GC/MS (MCERTS)
T6	ICP/OES
T54	GC/MS (Headspace)
T162	Grav (1 Dec) (105 C)

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	Concept References
Moisture @105C	T162	AR	0.1	%	N	001-011
Asbestos ID	T27	AR			SU	001-011
Boron (water-soluble)	T6	AR	1	mg/kg	N	001-011
Chromium VI	T6	AR	1	mg/kg	N	001-011
Cyanide(Total)	T546	AR	1	mg/kg	M	001-011
pH	T7	AR			M	001-011
Phenols(Mono)	T546	AR	1	mg/kg	M	001-011
Retained on 10mm sieve	T2	M40	0.1	%	N	001-011
Soil Organic Matter	T287	A40	0.1	%	N	001-011
(Water Soluble) SO4 expressed as SO4	T242	AR	0.01	g/l	N	001-011
Benzene	T54	AR	1	µg/kg	U	001-011
Toluene	T54	AR	1	µg/kg	U	001-011
EthylBenzene	T54	AR	1	µg/kg	U	001-011
M/P Xylene	T54	AR	1	µg/kg	U	001-011
O Xylene	T54	AR	1	µg/kg	U	001-011
Methyl tert-Butyl Ether	T54	AR	1	µg/kg	U	001-011
TPH (C5-C6 aliphatic)	T54	AR	0.010	mg/kg	N	001-011
TPH (C6-C8 aliphatic)	T54	AR	0.010	mg/kg	N	001-011
TPH (C8-C10 aliphatic)	T54	AR	0.010	mg/kg	N	001-011
TPH (C10-C12 aliphatic)	T8	M105	1	mg/kg	N	001-011
TPH (C12-C16 aliphatic)	T8	M105	1	mg/kg	N	001-011
TPH (C16-C21 aliphatic)	T8	M105	1	mg/kg	N	001-011
TPH (C21-C35 aliphatic)	T8	M105	1	mg/kg	N	001-011
TPH (C6-C7 aromatic)	T54	AR	0.010	mg/kg	N	001-011
TPH (C7-C8 aromatic)	T54	AR	0.010	mg/kg	N	001-011
TPH (C8-C10 aromatic)	T54	AR	0.010	mg/kg	N	001-011
TPH (C10-C12 aromatic)	T8	M105	1	mg/kg	N	001-011
TPH (C12-C16 aromatic)	T8	M105	1	mg/kg	N	001-011
TPH (C16-C21 aromatic)	T8	M105	1	mg/kg	N	001-011

Determinand	Method	Test Sample	LOD	Units	Symbol	Concept References
TPH (C21-C35 aromatic)	T8	M105	1	mg/kg	N	001-011
Arsenic	T6	M40	2	mg/kg	M	001-011
Cadmium	T6	M40	1	mg/kg	M	001-011
Chromium	T6	M40	1	mg/kg	M	001-011
Copper	T6	M40	1	mg/kg	M	001-011
Lead	T6	M40	1	mg/kg	M	001-011
Mercury	T6	M40	1	mg/kg	M	001-011
Nickel	T6	M40	1	mg/kg	M	001-011
Selenium	T6	M40	3	mg/kg	M	001-011
Zinc	T6	M40	1	mg/kg	M	001-011
Naphthalene	T207	M105	0.1	mg/kg	M	001-011
Acenaphthylene	T207	M105	0.1	mg/kg	U	001-011
Acenaphthene	T207	M105	0.1	mg/kg	M	001-011
Fluorene	T207	M105	0.1	mg/kg	M	001-011
Phenanthrene	T207	M105	0.1	mg/kg	M	001-011
Anthracene	T207	M105	0.1	mg/kg	U	001-011
Fluoranthene	T207	M105	0.1	mg/kg	M	001-011
Pyrene	T207	M105	0.1	mg/kg	M	001-011
Benzo(a)Anthracene	T207	M105	0.1	mg/kg	M	001-011
Chrysene	T207	M105	0.1	mg/kg	M	001-011
Benzo(b)fluoranthene	T207	M105	0.1	mg/kg	M	001-011
Benzo(k)fluoranthene	T207	M105	0.1	mg/kg	M	001-011
Benzo(a)Pyrene	T207	M105	0.1	mg/kg	M	001-011
Indeno(123-cd)Pyrene	T207	M105	0.1	mg/kg	M	001-011
Dibenzo(ah)Anthracene	T207	M105	0.1	mg/kg	M	001-011
Benzo(ghi)Perylene	T207	M105	0.1	mg/kg	M	001-011
PAH(total)	T207	M105	0.1	mg/kg	U	001-011



FINAL ANALYTICAL TEST REPORT

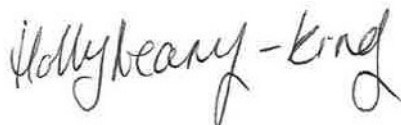
Envirolab Job Number: 19/04656
Issue Number: 1

Date: 24 May, 2019

Client: Curtins Consulting
Merchant Exchange
17-19 Whitworth Street
Manchester
UK
M1 5WG

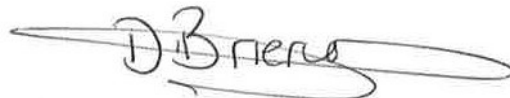
Project Manager: Niall Farnworth
Project Name: Not specified
Project Ref: B065374
Order No: EBMA1861
Date Samples Received: 15/05/19
Date Instructions Received: 16/05/19
Date Analysis Completed: 23/05/19

Prepared by:



Holly Neary-King
Client Manager

Approved by:



Danielle Brierley
Client Manager

Envirolab Job Number: 19/04656

Client Project Name: Not specified

Client Project Ref: B065374

Lab Sample ID	19/04656/1	19/04656/2						Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	TP103	TP102								
Depth to Top	0.50	1.50								
Depth To Bottom										
Date Sampled	13-May-19	13-May-19								
Sample Type	Soil	Soil								
Sample Matrix Code	5A									
% Stones >10mm _A	6.6	16.6						% w/w	0.1	A-T-044
pH _D ^{M#}	8.15	8.28						pH	0.01	A-T-031s
Sulphate (water sol 2:1) _D ^{M#}	0.07	0.18						g/l	0.01	A-T-026s
Cyanide (total) _A ^{M#}	<1	<1						mg/kg	1	A-T-042sTCN
Phenols - Total by HPLC _A	<0.2	<0.2						mg/kg	0.2	A-T-050s
Organic matter _D ^{M#}	15.0	8.5						% w/w	0.1	A-T-032 OM
Arsenic _D ^{M#}	11	16						mg/kg	1	A-T-024s
Boron (water soluble) _D ^{M#}	<1.0	<1.0						mg/kg	1	A-T-027s
Cadmium _D ^{M#}	0.9	2.0						mg/kg	0.5	A-T-024s
Copper _D ^{M#}	50	565						mg/kg	1	A-T-024s
Chromium _D ^{M#}	36	24						mg/kg	1	A-T-024s
Chromium (hexavalent) _D	<1	<1						mg/kg	1	A-T-040s
Lead _D ^{M#}	70	857						mg/kg	1	A-T-024s
Mercury _D	<0.17	0.45						mg/kg	0.17	A-T-024s
Nickel _D ^{M#}	34	34						mg/kg	1	A-T-024s
Selenium _D ^{M#}	<1	<1						mg/kg	1	A-T-024s
Zinc _D ^{M#}	233	845						mg/kg	5	A-T-024s

Envirolab Job Number: 19/04656

Client Project Name: Not specified

Client Project Ref: B065374

Lab Sample ID	19/04656/1	19/04656/2						Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	TP103	TP102								
Depth to Top	0.50	1.50								
Depth To Bottom										
Date Sampled	13-May-19	13-May-19								
Sample Type	Soil	Soil								
Sample Matrix Code	5A									
Asbestos in Soil (inc. matrix)										
Asbestos in soil [#]	NAD	NAD								A-T-045
Asbestos ACM - Suitable for Water Absorption Test?	N/A	N/A								

Envirolab Job Number: 19/04656

Client Project Name: Not specified

Client Project Ref: B065374

Lab Sample ID	19/04656/1	19/04656/2						Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	TP103	TP102								
Depth to Top	0.50	1.50								
Depth To Bottom										
Date Sampled	13-May-19	13-May-19								
Sample Type	Soil	Soil								
Sample Matrix Code	5A									
PAH-16MS										
Acenaphthene _A ^{M#}	0.04	0.04						mg/kg	0.01	A-T-019s
Acenaphthylene _A ^{M#}	<0.01	0.04						mg/kg	0.01	A-T-019s
Anthracene _A ^{M#}	0.10	0.23						mg/kg	0.02	A-T-019s
Benzo(a)anthracene _A ^{M#}	0.45	0.68						mg/kg	0.04	A-T-019s
Benzo(a)pyrene _A ^{M#}	0.54	0.58						mg/kg	0.04	A-T-019s
Benzo(b)fluoranthene _A ^{M#}	0.68	0.68						mg/kg	0.05	A-T-019s
Benzo(ghi)perylene _A ^{M#}	0.25	0.29						mg/kg	0.05	A-T-019s
Benzo(k)fluoranthene _A ^{M#}	0.25	0.22						mg/kg	0.07	A-T-019s
Chrysene _A ^{M#}	0.51	0.73						mg/kg	0.06	A-T-019s
Dibenzo(ah)anthracene _A ^{M#}	0.08	0.08						mg/kg	0.04	A-T-019s
Fluoranthene _A ^{M#}	0.89	1.45						mg/kg	0.08	A-T-019s
Fluorene _A ^{M#}	0.03	0.07						mg/kg	0.01	A-T-019s
Indeno(123-cd)pyrene _A ^{M#}	0.31	0.33						mg/kg	0.03	A-T-019s
Naphthalene _A ^{M#}	<0.03	<0.03						mg/kg	0.03	A-T-019s
Phenanthrene _A ^{M#}	0.48	0.99						mg/kg	0.03	A-T-019s
Pyrene _A ^{M#}	0.87	1.49						mg/kg	0.07	A-T-019s
Total PAH-16MS _A ^{M#}	5.48	7.90						mg/kg	0.01	A-T-019s

Envirolab Job Number: 19/04656

Client Project Name: Not specified

Client Project Ref: B065374

Lab Sample ID	19/04656/1	19/04656/2						Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	TP103	TP102								
Depth to Top	0.50	1.50								
Depth To Bottom										
Date Sampled	13-May-19	13-May-19								
Sample Type	Soil	Soil								
Sample Matrix Code	5A									
TPH CWG										
Ali >C5-C6 _A [#]	<0.01	<0.01						mg/kg	0.01	A-T-022s
Ali >C6-C8 _A [#]	<0.01	<0.02						mg/kg	0.01	A-T-022s
Ali >C8-C10 _A	3	<1						mg/kg	1	A-T-055s
Ali >C10-C12 _A ^{M#}	<1	<1						mg/kg	1	A-T-055s
Ali >C12-C16 _A ^{M#}	1	2						mg/kg	1	A-T-055s
Ali >C16-C21 _A ^{M#}	3	3						mg/kg	1	A-T-055s
Ali >C21-C35 _A	34	49						mg/kg	1	A-T-055s
Total Aliphatics _A	41	55						mg/kg	1	A-T-055s
Aro >C5-C7 _A [#]	<0.01	<0.01						mg/kg	0.01	A-T-022s
Aro >C7-C8 _A [#]	<0.01	<0.01						mg/kg	0.01	A-T-022s
Aro >C8-C10 _A	6	2						mg/kg	1	A-T-055s
Aro >C10-C12 _A ^{M#}	3	2						mg/kg	1	A-T-055s
Aro >C12-C16 _A	4	6						mg/kg	1	A-T-055s
Aro >C16-C21 _A ^{M#}	6	37						mg/kg	1	A-T-055s
Aro >C21-C35 _A ^{M#}	68	117						mg/kg	1	A-T-055s
Total Aromatics _A	87	164						mg/kg	1	A-T-055s
TPH (Ali & Aro >C5-C35) _A	127	219						mg/kg	1	A-T-055s
BTEX - Benzene _A [#]	<0.01	<0.01						mg/kg	0.01	A-T-022s
BTEX - Toluene _A [#]	<0.01	<0.01						mg/kg	0.01	A-T-022s
BTEX - Ethyl Benzene _A [#]	<0.01	<0.01						mg/kg	0.01	A-T-022s
BTEX - m & p Xylene _A [#]	<0.01	<0.01						mg/kg	0.01	A-T-022s
BTEX - o Xylene _A [#]	<0.01	<0.01						mg/kg	0.01	A-T-022s
MTBE _A [#]	<0.01	<0.01						mg/kg	0.01	A-T-022s

REPORT NOTES

General

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

The results reported herein relate only to the material supplied to the laboratory.

The residue of any samples contained within this report, and any received with the same delivery, will be disposed of six weeks after initial scheduling. For samples tested for Asbestos we will retain a portion of the dried sample for a minimum of six months after the initial Asbestos testing is completed.

Analytical results reflect the quality of the sample at the time of analysis only.

Opinions and interpretations expressed are outside the scope of our accreditation.

If results are in italic font they are associated with an AQC failure, these are not accredited and are unreliable.

A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

Soil chemical analysis:

All results are reported as dry weight (<40°C).

For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.

For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any "A" subscripts

All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:

Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:

Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

Asbestos:

Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.

Stones etc. are not removed from the sample prior to analysis.

Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:

1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample.

Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.

Secondary Matrix Codes:

A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal,

E = contains roots/twigs.

Key:

IS indicates Insufficient Sample for analysis.

US indicates Unsuitable Sample for analysis.

NDP indicates No Determination Possible.

NAD indicates No Asbestos Detected.

N/A indicates Not Applicable.

Superscript # indicates method accredited to ISO 17025.

Superscript "M" indicates method accredited to MCERTS.

Subscript "A" indicates analysis performed on the sample as received.

Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

Please contact us if you need any further information.

Envirolab Deviating Samples Report

Units 7&8 Sandpits Business Park, Mottram Road, Hyde, SK14 3AR
Tel. 0161 368 4921 email. ask@envlab.co.uk

Client: Curtins Consulting, Merchant Exchange, 17-19 Whitworth Street , Manchester,
UK, M1 5WG

Project No: 19/04656

Date Received: 16/05/2019 (am)

Project: **Cool Box Temperatures (°C):** 14.5

Clients Project No: B065374

NO DEVIATIONS IDENTIFIED

If, at any point before reaching the laboratory, the temperature of the samples has breached those set in published standards, e.g. BS-EN 5667-3, ISO 18400-102:2017, then the concentration of any affected analytes may differ from that at the time of sampling.



Matthew Holroyd
Curtins
17-19 Whitworth Street West
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M1 5WG

e: matthew.holroyd@curtins.com

i2 Analytical Ltd.
7 Woodshots Meadow,
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Herts,
WD18 8YS

t: 01923 225404
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e: reception@i2analytical.com

Analytical Report Number : 19-43368

Project / Site name:	Chados S4	Samples received on:	29/05/2019
Your job number:	B065374	Samples instructed on:	29/05/2019
Your order number:	EBMA1880	Analysis completed by:	05/06/2019
Report Issue Number:	1	Report issued on:	05/06/2019
Samples Analysed:	4 soil samples		

Signed:

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

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

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

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

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

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

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

Iss No 19-43368-1 Chados S4 B065374

This certificate should not be reproduced, except in full, without the express permission of the laboratory.

The results included within the report are representative of the samples submitted for analysis.

Page 1 of 5

Analytical Report Number: 19-43368

Project / Site name: Chados S4

Your Order No: EBMA1880

Lab Sample Number				1233149	1233150	1233151	1233152	
Sample Reference				WS401	BH402	WS402	BH402A	
Sample Number				ES1	ES1	ES1	ES1	
Depth (m)				0.40	0.60	0.40	0.80	
Date Sampled				28/05/2019	28/05/2019	29/05/2019	29/05/2019	
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	
Moisture Content	%	N/A	NONE	18	13	16	17	
Total mass of sample received	kg	0.001	NONE	1.2	1.1	1.1	1.1	

Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	Not-detected	
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General Inorganics

pH - Automated	pH Units	N/A	MCERTS	8.7	9.5	8.4	9.5	
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	2	
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	1.3	0.32	1.7	1.8	
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	1310	323	1740	1790	
Organic Matter	%	0.1	MCERTS	3.8	3.4	2.0	3.3	

Total Phenols

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

Naphthalene	mg/kg	0.05	MCERTS	2.6	2.4	0.36	0.51	
Acenaphthylene	mg/kg	0.05	MCERTS	1.3	0.35	< 0.05	< 0.05	
Acenaphthene	mg/kg	0.05	MCERTS	1.5	11	0.83	0.35	
Fluorene	mg/kg	0.05	MCERTS	2.5	5.9	0.51	0.24	
Phenanthrene	mg/kg	0.05	MCERTS	21	60	5.5	2.8	
Anthracene	mg/kg	0.05	MCERTS	8.6	14	1.2	0.64	
Fluoranthene	mg/kg	0.05	MCERTS	67	98	9.0	5.3	
Pyrene	mg/kg	0.05	MCERTS	82	91	8.6	5.4	
Benzo(a)anthracene	mg/kg	0.05	MCERTS	45	44	5.1	3.0	
Chrysene	mg/kg	0.05	MCERTS	36	44	4.1	3.7	
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	40	54	5.7	4.6	
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	19	19	2.2	1.7	
Benzo(a)pyrene	mg/kg	0.05	MCERTS	38	40	4.0	3.1	
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	22	23	2.8	2.4	
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	5.7	7.6	0.93	0.82	
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	27	31	4.0	3.8	

Total PAH

Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	418	545	54.7	38.3	
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Heavy Metals / Metalloids

Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	17	21	14	25	
Boron (water soluble)	mg/kg	0.2	MCERTS	4.1	2.1	2.0	1.9	
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	0.2	0.3	0.3	0.4	
Chromium (hexavalent)	mg/kg	1.2	MCERTS	< 1.2	< 1.2	< 1.2	< 1.2	
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	24	16	14	16	
Copper (aqua regia extractable)	mg/kg	1	MCERTS	120	53	89	82	
Lead (aqua regia extractable)	mg/kg	1	MCERTS	320	220	470	870	
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	0.6	< 0.3	0.8	1.8	
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	34	19	17	14	
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	1.3	< 1.0	1.3	
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	140	110	230	140	

Analytical Report Number: 19-43368

Project / Site name: Chados S4

Your Order No: EBMA1880

Lab Sample Number	1233149	1233150	1233151	1233152	
Sample Reference	WS401	BH402	WS402	BH402A	
Sample Number	ES1	ES1	ES1	ES1	
Depth (m)	0.40	0.60	0.40	0.80	
Date Sampled	28/05/2019	28/05/2019	29/05/2019	29/05/2019	
Time Taken	None Supplied	None Supplied	None Supplied	None Supplied	
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status		

Monoaromatics & Oxygenates

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

Petroleum Hydrocarbons

TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	3.0	1.9	< 1.0	< 1.0	
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	7.9	18	3.4	12	
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	25	38	< 8.0	22	
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	110	57	13	58	
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	150	110	24	92	

TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	17	13	3.0	< 1.0	
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	36	59	11	< 2.0	
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	180	270	24	16	
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	230	320	38	29	
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	470	670	76	45	



Analytical Report Number : 19-43368

Project / Site name: Chados S4

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

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

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1233149	WS401	ES1	0.40	Brown clay and sand with brick and clinker
1233150	BH402	ES1	0.60	Brown sand with gravel and brick.
1233151	WS402	ES1	0.40	Brown sand with brick and rubble.
1233152	BH402A	ES1	0.80	Brown sand with clinker and gravel

Analytical Report Number : 19-43368

Project / Site name: Chados S4

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

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L0738-PL	W	MCERTS
Hexavalent chromium in soil (Lower Level)	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	MCERTS
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 2, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
Monohydric phenols in soil	Determination of phenols in soil by extraction with sodium hydroxide followed by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	MCERTS
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	BS1377 Part 3, 1990, Chemical and Electrochemical Tests""	L009-PL	D	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests, 2:1 water:soil extraction, analysis by ICP-OES.	L038-PL	D	MCERTS
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
TPHCWG (Soil)	Determination of hexane extractable hydrocarbons in soil by GC-MS/GC-FID.	In-house method with silica gel split/clean up.	L088/76-PL	W	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.

For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.

Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 300c.



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Analytical Report Number : 19-43785

Project / Site name:	Chandos 54	Samples received on:	31/05/2019
Your job number:	B065374	Samples instructed on:	31/05/2019
Your order number:	EBMA1881	Analysis completed by:	11/06/2019
Report Issue Number:	1	Report issued on:	11/06/2019
Samples Analysed:	4 soil samples		

Signed:

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

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

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

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

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

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

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

Iss No 19-43785-1 Chandos 54 B065374

This certificate should not be reproduced, except in full, without the express permission of the laboratory.

The results included within the report are representative of the samples submitted for analysis.

Page 1 of 5

Analytical Report Number: 19-43785

Project / Site name: Chandos 54

Your Order No: EBMA1881

Lab Sample Number				1235480	1235481	1235482	1235483	
Sample Reference				BH403	WS403	WS404	WS403	
Sample Number				ES1	ES1	ES1	ES2	
Depth (m)				1.10	0.80	1.10	5.00-5.45	
Date Sampled				29/05/2019	29/05/2019	29/05/2019	29/05/2019	
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	
Moisture Content	%	N/A	NONE	15	20	13	10	
Total mass of sample received	kg	0.001	NONE	1.0	1.1	0.75	0.48	

Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	Not-detected	
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General Inorganics

pH - Automated	pH Units	N/A	MCERTS	8.0	8.0	8.2	8.4	
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.20	2.1	0.11	0.14	
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	197	2060	109	139	
Organic Matter	%	0.1	MCERTS	4.4	4.2	1.5	1.6	

Total Phenols

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

Naphthalene	mg/kg	0.05	MCERTS	< 0.05	0.30	0.21	< 0.05	
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	0.20	0.26	< 0.05	
Fluorene	mg/kg	0.05	MCERTS	< 0.05	0.18	0.19	< 0.05	
Phenanthrene	mg/kg	0.05	MCERTS	1.0	2.3	1.4	< 0.05	
Anthracene	mg/kg	0.05	MCERTS	0.38	0.74	0.34	< 0.05	
Fluoranthene	mg/kg	0.05	MCERTS	1.4	4.7	1.1	< 0.05	
Pyrene	mg/kg	0.05	MCERTS	1.2	4.6	1.0	< 0.05	
Benzo(a)anthracene	mg/kg	0.05	MCERTS	0.78	2.6	0.49	< 0.05	
Chrysene	mg/kg	0.05	MCERTS	0.53	2.9	0.52	< 0.05	
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	0.66	2.8	0.40	< 0.05	
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	0.47	1.6	0.23	< 0.05	
Benzo(a)pyrene	mg/kg	0.05	MCERTS	0.68	2.6	0.34	< 0.05	
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	0.40	2.0	0.23	< 0.05	
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	0.56	< 0.05	< 0.05	
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	0.72	2.6	0.31	< 0.05	

Total PAH

Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	8.24	30.7	7.04	< 0.80	
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Heavy Metals / Metalloids

Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	20	33	9.1	5.3	
Boron (water soluble)	mg/kg	0.2	MCERTS	2.0	3.7	0.7	0.7	
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	0.4	0.9	< 0.2	< 0.2	
Chromium (hexavalent)	mg/kg	1.2	MCERTS	< 1.2	< 1.2	< 1.2	< 1.2	
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	20	25	33	25	
Copper (aqua regia extractable)	mg/kg	1	MCERTS	64	93	30	27	
Lead (aqua regia extractable)	mg/kg	1	MCERTS	79	290	10	16	
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	0.4	1.0	< 0.3	< 0.3	
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	35	17	33	28	
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	2.8	< 1.0	< 1.0	
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	82	210	54	45	

Analytical Report Number: 19-43785

Project / Site name: Chandos 54

Your Order No: EBMA1881

Lab Sample Number				1235480	1235481	1235482	1235483	
Sample Reference				BH403	WS403	WS404	WS403	
Sample Number				ES1	ES1	ES1	ES2	
Depth (m)				1.10	0.80	1.10	5.00-5.45	
Date Sampled				29/05/2019	29/05/2019	29/05/2019	29/05/2019	
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					

Monoaromatics & Oxygenates

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

Petroleum Hydrocarbons

TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	2.3	
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	< 2.0	< 2.0	19	
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	< 8.0	< 8.0	< 8.0	13	
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	35	39	< 8.0	14	
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	38	45	< 10	47	

TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	< 2.0	< 2.0	< 2.0	
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	< 10	25	< 10	< 10	
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	< 10	85	< 10	< 10	
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10	110	< 10	< 10	



Analytical Report Number : 19-43785

Project / Site name: Chandos 54

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

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

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1235480	BH403	ES1	1.10	Grey clay and sand with gravel and vegetation.
1235481	WS403	ES1	0.80	Grey clay and sand with gravel and vegetation.
1235482	WS404	ES1	1.10	Brown clay.
1235483	WS403	ES2	5.00-5.45	Brown clay.

Analytical Report Number : 19-43785

Project / Site name: Chandos 54

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

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L0738-PL	W	MCERTS
Hexavalent chromium in soil (Lower Level)	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	MCERTS
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 2, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
Monohydric phenols in soil	Determination of phenols in soil by extraction with sodium hydroxide followed by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	MCERTS
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	BS1377 Part 3, 1990, Chemical and Electrochemical Tests""	L009-PL	D	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests, 2:1 water:soil extraction, analysis by ICP-OES.	L038-PL	D	MCERTS
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
TPHCWG (Soil)	Determination of hexane extractable hydrocarbons in soil by GC-MS/GC-FID.	In-house method with silica gel split/clean up.	L088/76-PL	W	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.

For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.

Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 19/06134
Issue Number: 1

Date: 02 July, 2019

Client: Curtins Consulting
Merchant Exchange
17-19 Whitworth Street
Manchester
UK
M1 5WG

Project Manager: Niall Farnworth/Philippa Neesham
Project Name: Chandos Hall
Project Ref: 69374
Order No: EBMA1938
Date Samples Received: 27/06/19
Date Instructions Received: 28/06/19
Date Analysis Completed: 02/07/19

Prepared by:



Sophie France
Admin Assistant

Approved by:



Holly Neary-King
Client Manager

Envirolab Job Number: 19/06134

Client Project Name: Chandos Hall

Client Project Ref: 69374

Lab Sample ID	19/06134/1	19/06134/2	19/06134/3					Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	BH401	BH402B	BH403							
Depth to Top	7.35	12.45	12.48							
Depth To Bottom										
Date Sampled	26-Jun-19	26-Jun-19	26-Jun-19							
Sample Type	Water - EW	Water - EW	Water - EW							
Sample Matrix Code	N/A	N/A	N/A							
pH (w) _A [#]	8.29	8.24	8.16					pH	0.01	A-T-031w
Hardness Total _A [#]	475	155	354					mg/l Ca CO ₃	2	A-T-049w
Sulphate (w) _A [#]	412	74	57					mg/l	1	A-T-026w
Cyanide (total) (w) _A [#]	<0.005	<0.005	<0.005					mg/l	0.005	A-T-042wTCN
Phenols - Total by HPLC (w) _A	<0.01	<0.01	<0.01					mg/l	0.01	A-T-050w
Sulphide (w) _A	<0.1	<0.1	<0.1					mg/l	0.1	A-T-S2-w
DOC (w) _A [#]	4.6	4.2	2.5					mg/l	0.2	A-T-032w
Arsenic (dissolved) _A [#]	<1	<1	<1					µg/l	1	A-T-025w
Boron (dissolved) _A [#]	232	53	115					µg/l	10	A-T-025w
Cadmium (dissolved) _A [#]	<0.2	<0.2	<0.2					µg/l	0.2	A-T-025w
Calcium (dissolved) _A [#]	134	36	79					mg/l	1	A-T-049w
Copper (dissolved) _A [#]	7	5	3					µg/l	1	A-T-025w
Chromium (dissolved) _A [#]	2	<1	5					µg/l	1	A-T-025w
Lead (dissolved) _A [#]	<1	<1	<1					µg/l	1	A-T-025w
Mercury (dissolved) _A [#]	<0.1	<0.1	<0.1					µg/l	0.1	A-T-025w
Nickel (dissolved) _A [#]	2	3	<1					µg/l	1	A-T-025w
Selenium (dissolved) _A [#]	3	<1	5					µg/l	1	A-T-025w
Zinc (dissolved) _A [#]	6	9	7					µg/l	1	A-T-025w

Envirolab Job Number: 19/06134

Client Project Name: Chandos Hall

Client Project Ref: 69374

Lab Sample ID	19/06134/1	19/06134/2	19/06134/3					Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	BH401	BH402B	BH403							
Depth to Top	7.35	12.45	12.48							
Depth To Bottom										
Date Sampled	26-Jun-19	26-Jun-19	26-Jun-19							
Sample Type	Water - EW	Water - EW	Water - EW							
Sample Matrix Code	N/A	N/A	N/A							
PAH 16MS (w)										
Acenaphthene (w) _A [#]	<0.01	<0.01	<0.01					µg/l	0.01	A-T-019w
Acenaphthylene (w) _A [#]	<0.01	<0.01	<0.01					µg/l	0.01	A-T-019w
Anthracene (w) _A [#]	<0.01	<0.01	<0.01					µg/l	0.01	A-T-019w
Benzo(a)anthracene (w) _A [#]	0.04	0.02	0.02					µg/l	0.01	A-T-019w
Benzo(a)pyrene (w) _A [#]	0.03	0.01	0.02					µg/l	0.01	A-T-019w
Benzo(b)fluoranthene (w) _A [#]	0.06	0.02	0.02					µg/l	0.01	A-T-019w
Benzo(ghi)perylene (w) _A [#]	0.03	0.01	0.01					µg/l	0.01	A-T-019w
Benzo(k)fluoranthene (w) _A [#]	0.02	<0.01	<0.01					µg/l	0.01	A-T-019w
Chrysene (w) _A [#]	0.06	0.02	0.02					µg/l	0.01	A-T-019w
Dibenzo(ah)anthracene (w) _A [#]	<0.01	<0.01	<0.01					µg/l	0.01	A-T-019w
Fluoranthene (w) _A [#]	0.09	0.06	0.04					µg/l	0.01	A-T-019w
Fluorene (w) _A [#]	<0.01	<0.01	<0.01					µg/l	0.01	A-T-019w
Indeno(123-cd)pyrene (w) _A [#]	0.03	0.01	0.01					µg/l	0.01	A-T-019w
Naphthalene (w) _A [#]	<0.01	<0.01	<0.01					µg/l	0.01	A-T-019w
Phenanthrene (w) _A [#]	0.04	0.03	0.02					µg/l	0.01	A-T-019w
Pyrene (w) _A [#]	0.10	0.06	0.03					µg/l	0.01	A-T-019w
Total PAH 16MS (w)_A[#]	0.50	0.24	0.19					µg/l	0.01	A-T-019w

Envirolab Job Number: 19/06134

Client Project Name: Chandos Hall

Client Project Ref: 69374

Lab Sample ID	19/06134/1	19/06134/2	19/06134/3					Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	BH401	BH402B	BH403							
Depth to Top	7.35	12.45	12.48							
Depth To Bottom										
Date Sampled	26-Jun-19	26-Jun-19	26-Jun-19							
Sample Type	Water - EW	Water - EW	Water - EW							
Sample Matrix Code	N/A	N/A	N/A							
TPH CWG (w)										
Ali >C5-C6 (w) _A [#]	1	1	2					µg/l	1	A-T-022w
Ali >C6-C8 (w) _A [#]	<1	<1	<1					µg/l	1	A-T-022w
Ali >C8-C10 (w) _A [#]	<5	<5	<5					µg/l	5	A-T-055w
Ali >C10-C12 (w) _A [#]	<5	<5	<5					µg/l	5	A-T-055w
Ali >C12-C16 (w) _A [#]	<5	<5	<5					µg/l	5	A-T-055w
Ali >C16-C21 (w) _A [#]	<5	<5	<5					µg/l	5	A-T-055w
Ali >C21-C35 (w) _A [#]	<5	22	<5					µg/l	5	A-T-055w
Total Aliphatics (w) _A [#]	<5	22	<5					µg/l	5	A-T-055w
Aro >C5-C7 (w) _A [#]	<1	<1	<1					µg/l	1	A-T-022w
Aro >C7-C8 (w) _A [#]	<1	<1	<1					µg/l	1	A-T-022w
Aro >C8-C10 (w) _A	<5	16	<5					µg/l	5	A-T-055w
Aro >C10-C12 (w) _A [#]	<5	<5	<5					µg/l	5	A-T-055w
Aro >C12-C16 (w) _A [#]	<5	9	<5					µg/l	5	A-T-055w
Aro >C16-C21 (w) _A [#]	<5	13	<5					µg/l	5	A-T-055w
Aro >C21-C35 (w) _A [#]	<10	16	<10					µg/l	10	A-T-055w
Total Aromatics (w) _A	<10	54	<10					µg/l	10	A-T-055w
TPH (Ali & Aro >C5-C35) (w) _A	<10	76	<10					µg/l	10	A-T-055w
BTEX - Benzene (w) _A [#]	<1	<1	<1					µg/l	1	A-T-022w
BTEX - Toluene (w) _A [#]	<1	<1	<1					µg/l	1	A-T-022w
BTEX - Ethyl Benzene (w) _A [#]	<1	<1	<1					µg/l	1	A-T-022w
BTEX - m & p Xylene (w) _A [#]	<1	<1	<1					µg/l	1	A-T-022w
BTEX - o Xylene (w) _A [#]	<1	<1	<1					µg/l	1	A-T-022w
MTBE (w) _A [#]	<1	<1	<1					µg/l	1	A-T-022w

REPORT NOTES

General

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

The results reported herein relate only to the material supplied to the laboratory.

The residue of any samples contained within this report, and any received with the same delivery, will be disposed of six weeks after initial scheduling. For samples tested for Asbestos we will retain a portion of the dried sample for a minimum of six months after the initial Asbestos testing is completed.

Analytical results reflect the quality of the sample at the time of analysis only.

Opinions and interpretations expressed are outside the scope of our accreditation.

If results are in italic font they are associated with an AQC failure, these are not accredited and are unreliable.

A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

Soil chemical analysis:

All results are reported as dry weight (<40°C).

For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.

For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any "A" subscripts

All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:

Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:

Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

Asbestos:

Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.

Stones etc. are not removed from the sample prior to analysis.

Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:

1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample.

Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.

Secondary Matrix Codes:

A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal,

E = contains roots/twigs.

Key:

IS indicates Insufficient Sample for analysis.

US indicates Unsuitable Sample for analysis.

NDP indicates No Determination Possible.

NAD indicates No Asbestos Detected.

N/A indicates Not Applicable.

Superscript # indicates method accredited to ISO 17025.

Superscript "M" indicates method accredited to MCERTS.

Subscript "A" indicates analysis performed on the sample as received.

Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

Please contact us if you need any further information.

Envirolab Deviating Samples Report

Units 7&8 Sandpits Business Park, Mottram Road, Hyde, SK14 3AR
Tel. 0161 368 4921 email. ask@envlab.co.uk

Client:	Curtins Consulting, Merchant Exchange, 17-19 Whitworth Street , Manchester, UK, M1 5WG	Project No:	19/06134
Project:	Chandos Hall	Date Received:	28/06/2019 (am)
Clients Project No:	69374	Cool Box Temperatures (°C):	22.0

NO DEVIATIONS IDENTIFIED

If, at any point before reaching the laboratory, the temperature of the samples has breached those set in published standards, e.g. BS-EN 5667-3, ISO 18400-102:2017, then the concentration of any affected analytes may differ from that at the time of sampling.

Appendix D Geotechnical Laboratory Testing Results

- Geotechnical Analysis Results (Stage 1):
 - Professional Soils Laboratory, test report PSL17/3663
 - Derwentside Environmental Testing Services, certificate no. 17-06805
 - i2 Analytical, test report 17-57432
- Geotechnical Analysis Results (Stage 3):
 - i2 Analytical, test report & certificate 18-73908
 - Professional Soils Laboratory, test report PSL18/0467
- Geotechnical Analysis Results (Stage 4):
 - i2 Analytical, test report & certificate:
 - No. 19-43458
 - No. 19-43459
 - No. 19-43964
 - Professional Soils Laboratory, test report & certificate No. PSL19/3693



LABORATORY REPORT REPORT



4043

Contract Number: PSL17/3663

Report Date: 21 August 2017

Client's Reference:

Client Name: Curtins Consulting
Rose Wharf
East Street
Leeds
LS9 8EE

For the attention of: Niall Farnworth

Contract Title: Chandos Hall, Manchester

Date Received: 28/7/2017

Date Commenced: 28/7/2017

Date Completed: 21/8/2017

Notes: Opinions and Interpretations are outside the UKAS Accreditation

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced other than in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

R Gunson
(Director)

A Watkins
(Director)

R Berriman
(Quality Manager)

L Knight
(Senior Technician)

C Marshall
(Laboratory Manager)

A Fry
(Senior Technician)

5 – 7 Hexthorpe Road, Hexthorpe,
Doncaster DN4 0AR
tel: +44 (0)844 815 6641
fax: +44 (0)844 815 6642
e-mail: rgunson@prosoils.co.uk
awatkins@prosoils.co.uk

Page 1 of

SUMMARY OF LABORATORY SOIL DESCRIPTIONS

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Description of Sample
BH1	D1	D	1.00		Brown slightly gravelly sandy CLAY.
BH1		B	5.00	5.50	Reddish brown very silty SAND.
BH1		C&B	6.00	6.45	Brown very sandy slightly silty GRAVEL with cobbles.
BH02	D1	D	1.00		Brown slightly gravelly sandy CLAY.

		Chandos Hall, Manchester	Contract No:
			PSL17/3663
			Client Ref:

SUMMARY OF SOIL CLASSIFICATION TESTS

(BS1377 : PART 2 : 1990)

[illegible]

SYMBOLS : NP : Non Plastic

*** : Liquid Limit and Plastic Limit Wet Sieved.**



PSL
Professional Soils Laboratory

Chandos Hall, Manchester

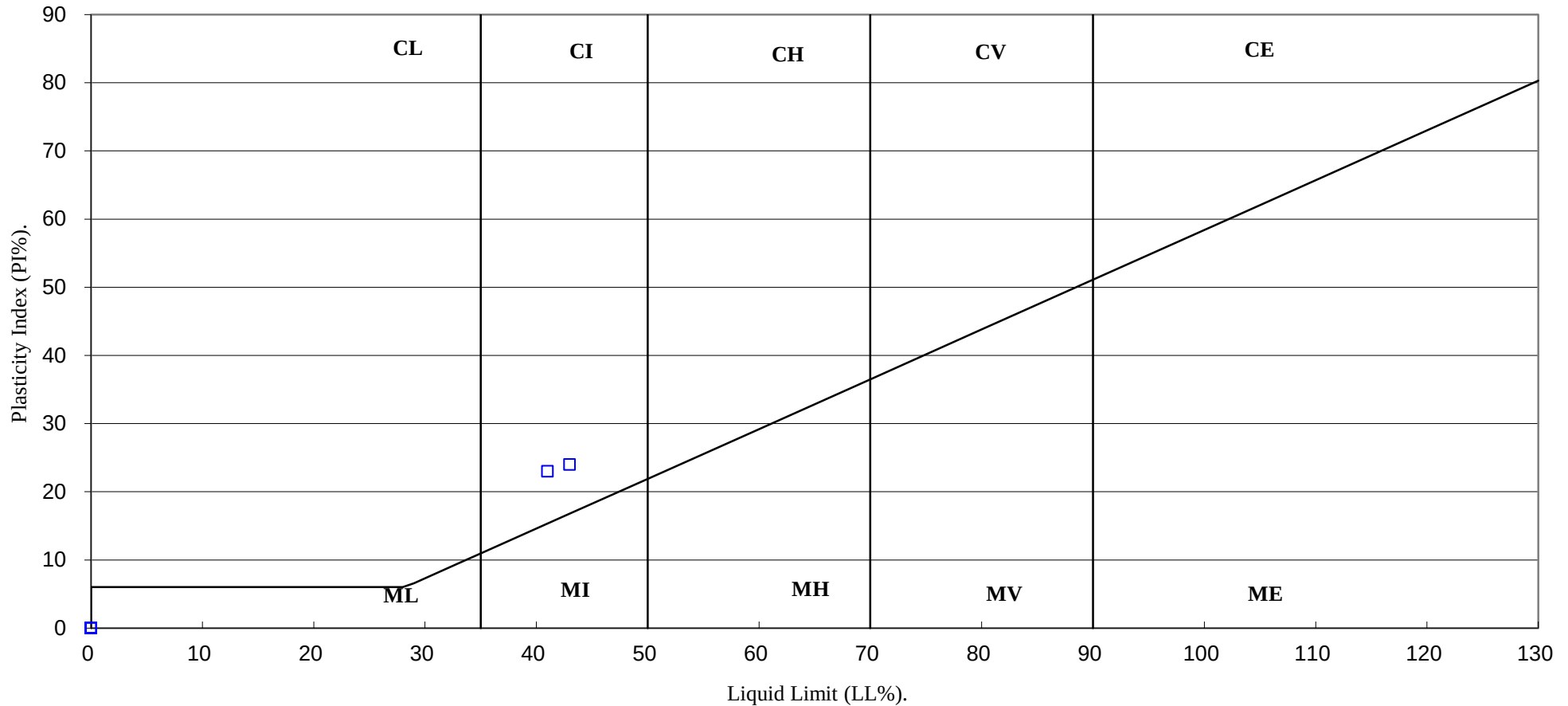
Contract No:

PSL17/3663

Client Ref:

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.

(BS5930 :2015)



PSL
Professional Soils Laboratory

Chandos Hall, Manchester

Contract No:

PSL17/3663

Client Ref:

PARTICLE SIZE DISTRIBUTION TEST

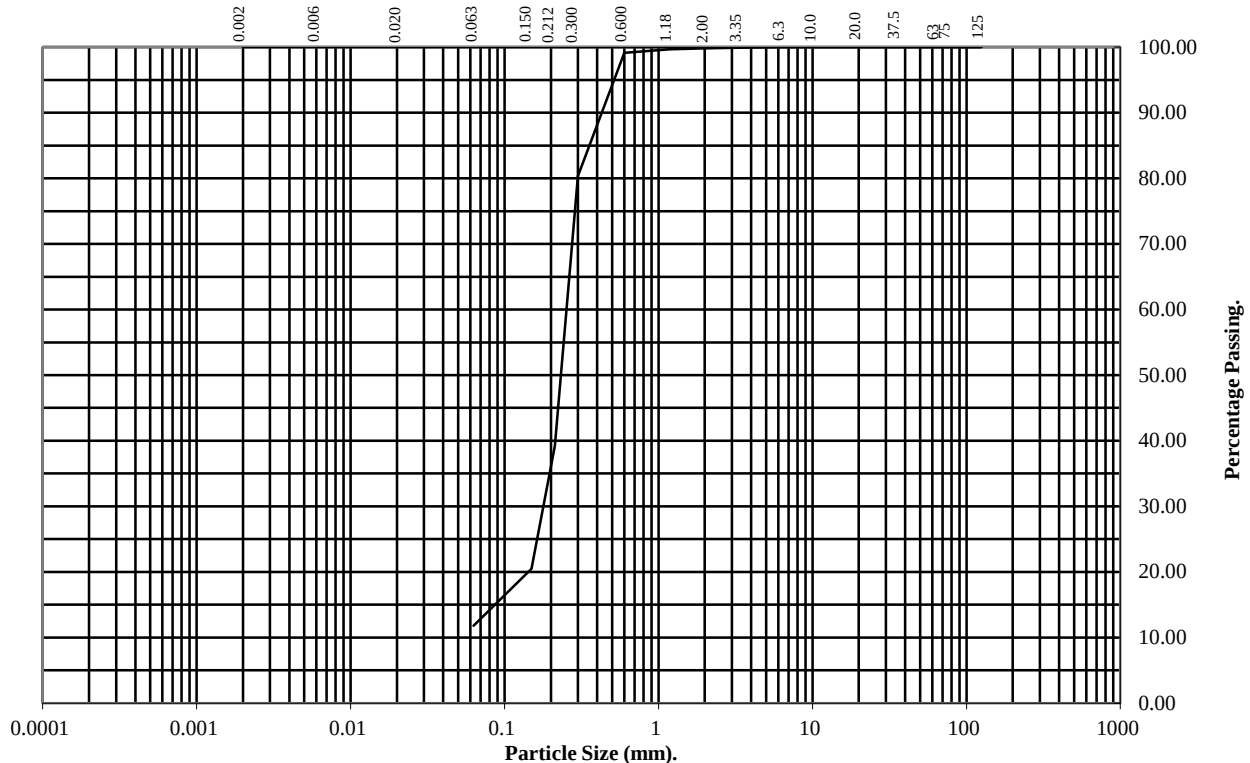
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: BH1 Top Depth (m): 5.00

Sample Number: Base Depth(m): 5.50

Sample Type: B



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	100
20	100
10	100
6.3	100
3.35	100
2	100
1.18	100
0.6	99
0.3	80
0.212	39
0.15	20
0.063	12

Soil Fraction	Total Percentage
Cobbles	0
Gravel	0
Sand	88
Silt/Clay	12

Remarks:
See Summary of Soil Descriptions



Chandos Hall, Manchester

Contract No:
PSL17/3663
Client Ref:

PARTICLE SIZE DISTRIBUTION TEST

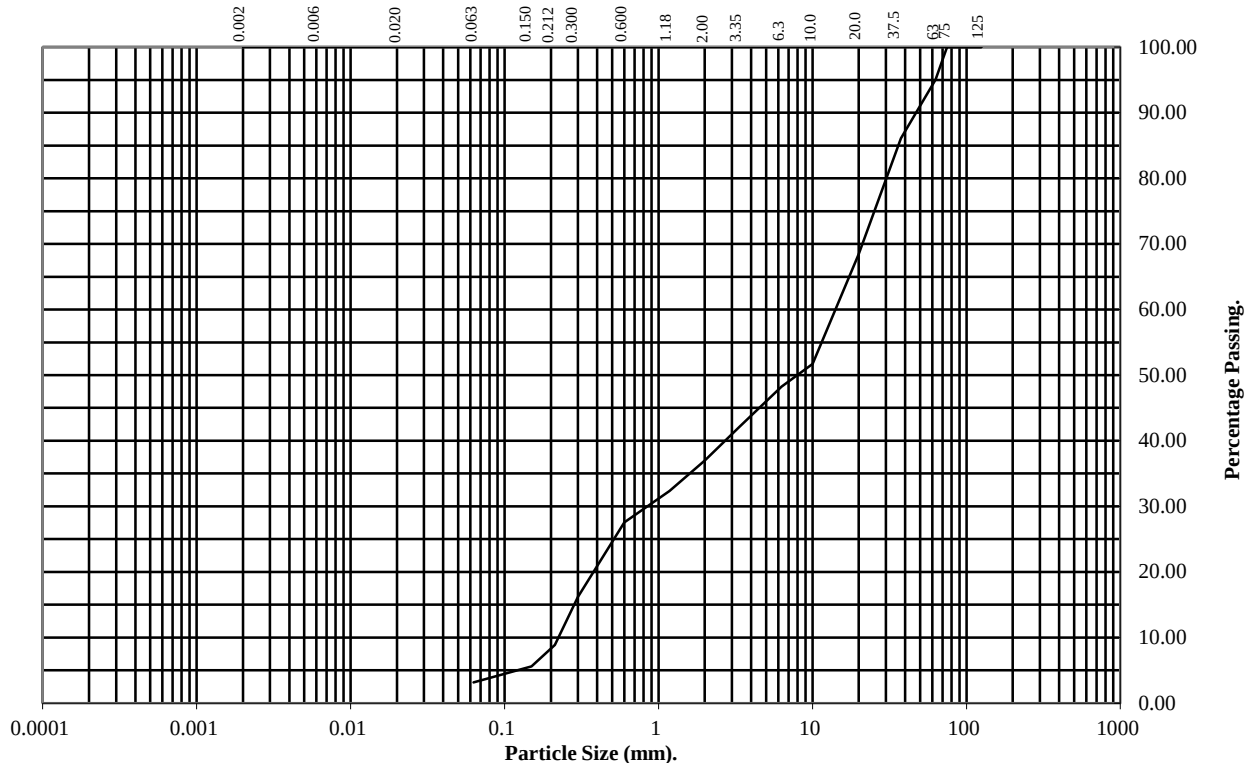
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: BH1 Top Depth (m): 6.00

Sample Number: Base Depth(m): 6.45

Sample Type: C&B



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	95
37.5	86
20	68
10	52
6.3	48
3.35	42
2	37
1.18	32
0.6	28
0.3	16
0.212	9
0.15	6
0.063	3

Soil Fraction	Total Percentage
Cobbles	5
Gravel	58
Sand	34
Silt/Clay	3

Remarks:

See Summary of Soil Descriptions



Chandos Hall, Manchester

Contract No:

PSL17/3663

Client Ref:



Certificate of Analysis

Certificate Number 17-06805

03-Aug-17

Client Professional Soils Laboratory Ltd
5/7 Hexthorpe Road
Hexthorpe
DN4 0AR

Our Reference 17-06805

Client Reference PSL17/3663

Order No (not supplied)

Contract Title Chandos Hall, Manchester

Description 4 Soil samples.

Date Received Tuesday, August 1, 2017

Date Started Tuesday, August 1, 2017

Date Completed Thursday, August 3, 2017

Test Procedures Identified by prefix DETSn (details on request).

Notes Opinions and interpretations are outside the laboratory's scope of ISO 10725 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

A handwritten signature in black ink, appearing to read "A Fenwick", is written over a light blue circular stamp.

Adam Fenwick
Contracts Manager



Summary of Chemical Analysis

Soil Samples

Our Ref 17-06805

Client Ref PSL17/3663

Contract Title Chandos Hall, Manchester

Lab No	1211958	1211959	1211960	1211961
Sample ID	BH1	BH1	BH1	BH02
Depth	1.20-1.65	5.00-5.50	9.00-9.45	4.50-4.95
Other ID				
Sample Type	SPT	B	SPT	SPT
Sampling Date	n/s	n/s	n/s	n/s
Sampling Time	n/s	n/s	n/s	n/s

Test	Method	LOD	Units				
Inorganics							
pH	DETSC 2008#			8.6	8.4	8.6	8.6
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	23	61	24	14

Information in Support of the Analytical Results

Our Ref 17-06805
 Client Ref PSL17/3663
 Contract Chandos Hall, Manchester

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
1211958	BH1 1.20-1.65 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1211959	BH1 5.00-5.50 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1211960	BH1 9.00-9.45 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1211961	BH02 4.50-4.95 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	

Key: P-Plastic T-Tub

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

TEST CERTIFICATE

Unconfined Compressive Strength Test

I.S.R.M. Suggested Methods 1981 for Determination of Uniaxial Compressive Strength Part 1

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



Client: Geocore Site Investigations
Client Address: Tralee Close
Kirkleatham Business Park
Redcar, Cleveland
TS10 5SG
Contact: Beverley Grace
Site Name: Chandos Hall
Site Address: Not Given

Client Reference: RT-17-60015
Job Number: 17-57432
Date Sampled: Not Given
Date Received: 15/08/2017
Date Tested: 24/08/2017
Sampled By: Not Given

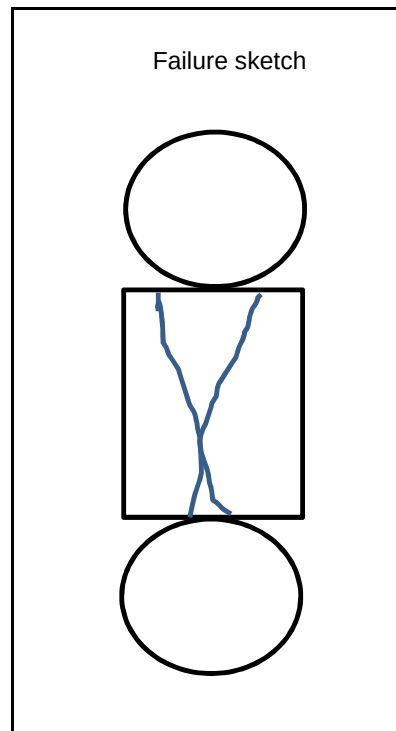
Test results

Laboratory Reference: 799583
Hole No.: BH1
Sample Reference: Not Given
Sample Description: Orangish brown SANDSTONE
Specimen Reference: Not Given
Storage history and environment: Not Given

Depth Top [m]: 10.70
Depth Base [m]: Not Given
Sample Type: U
Specimen Depth [m]: Not Given
Date and method of sampling: Not Given

Specimen length	mm	164.7
Specimen diameter	mm	71.0
Test duration	min	1
Stress rate	kN/s	1
Machine type		Autocon
U.C.S.	MPa	7.7
Mode of failure		Cleavage
Loading axis relative to anisotropy		
Water content	%	11.6
Bulk density	Mg/m ³	2.11
Dry density	Mg/m ³	1.89
Degree of saturation	%	N/A

Failure sketch



Remarks:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section

Signed:

Mark Beastall
Geotechnical Commercial
Manager

Date Reported: 29/08/2017

for and on behalf of i2 Analytical Ltd

"Opinions and interpretations expressed herein are outside of the scope of the UKAS Accreditation.
This report may not be reproduced other than in full without the prior written approval of the issuing laboratory.
The results included within the report are representative of the samples submitted for analysis.
The analysis was carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland."

TEST CERTIFICATE

Unconfined Compressive Strength Test

I.S.R.M. Suggested Methods 1981 for Determination of Uniaxial Compressive Strength Part 1

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



Client: Geocore Site Investigations
Client Address: Tralee Close
Kirkleatham Business Park
Redcar, Cleveland
TS10 5SG
Contact: Beverley Grace
Site Name: Chandos Hall
Site Address: Not Given

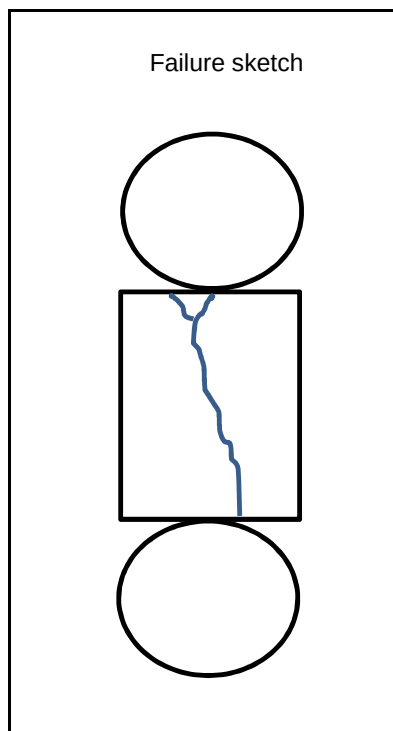
Client Reference: RT-17-60015
Job Number: 17-57432
Date Sampled: Not Given
Date Received: 15/08/2017
Date Tested: 24/08/2017
Sampled By: Not Given

Test results

Laboratory Reference: 799584
Hole No.: BH1
Sample Reference: Not Given
Sample Description: Orangish brown SANDSTONE
Specimen Reference: Not Given
Storage history and environment: Not Given

Depth Top [m]: 15.00
Depth Base [m]: Not Given
Sample Type: U
Specimen Depth [m]: Not Given
Date and method of sampling: Not Given

Specimen length	mm	134.9
Specimen diameter	mm	71.5
Test duration	min	1
Stress rate	kN/s	1
Machine type		Autocon
U.C.S.	MPa	6.8
Mode of failure		Cleavage
Loading axis relative to anisotropy		
Water content	%	11.7
Bulk density	Mg/m ³	2.08
Dry density	Mg/m ³	1.86
Degree of saturation	%	N/A



Remarks: Sample is too short

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section

Signed:

Mark Beastall
Geotechnical Commercial
Manager

Date Reported: 29/08/2017

for and on behalf of i2 Analytical Ltd

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TEST CERTIFICATE

Unconfined Compressive Strength Test

I.S.R.M. Suggested Methods 1981 for Determination of Uniaxial Compressive Strength Part 1

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



Client: Geocore Site Investigations
Client Address: Tralee Close
Kirkleatham Business Park
Redcar, Cleveland
TS10 5SG
Contact: Beverley Grace
Site Name: Chandos Hall
Site Address: Not Given

Client Reference: RT-17-60015
Job Number: 17-57432
Date Sampled: Not Given
Date Received: 15/08/2017
Date Tested: 24/08/2017
Sampled By: Not Given

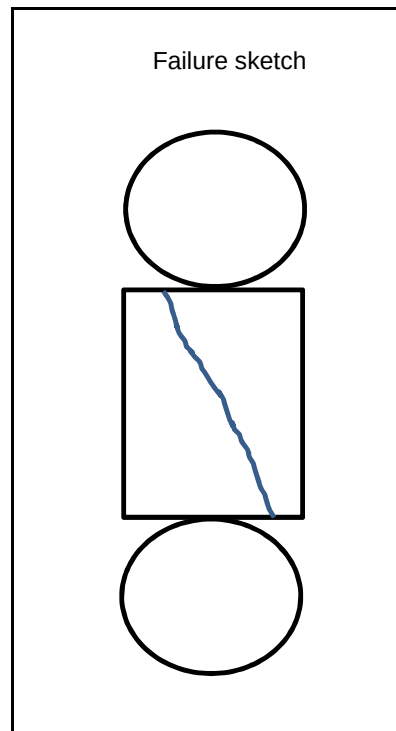
Test results

Laboratory Reference: 799585
Hole No.: BH1
Sample Reference: Not Given
Sample Description: Orangish brown SANDSTONE
Specimen Reference: Not Given
Storage history and environment: Not Given

Depth Top [m]: 18.20
Depth Base [m]: Not Given
Sample Type: U
Specimen Depth [m]: Not Given
Date and method of sampling: Not Given

Specimen length	mm	183.0
Specimen diameter	mm	70.9
Test duration	min	1
Stress rate	kN/s	1
Machine type		Autocon
U.C.S.	MPa	11.3
Mode of failure		Cleavage
Loading axis relative to anisotropy		
Water content	%	10.2
Bulk density	Mg/m ³	2.15
Dry density	Mg/m ³	1.95
Degree of saturation	%	N/A

Failure sketch



Remarks:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section

Date Reported: 29/08/2017

Signed:

Mark Beastall
Geotechnical Commercial
Manager

for and on behalf of i2 Analytical Ltd

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TEST CERTIFICATE

Unconfined Compressive Strength Test

I.S.R.M. Suggested Methods 1981 for Determination of Uniaxial Compressive Strength Part 1

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



Client: Geocore Site Investigations
Client Address: Tralee Close
Kirkleatham Business Park
Redcar, Cleveland
TS10 5SG
Contact: Beverley Grace
Site Name: Chandos Hall
Site Address: Not Given

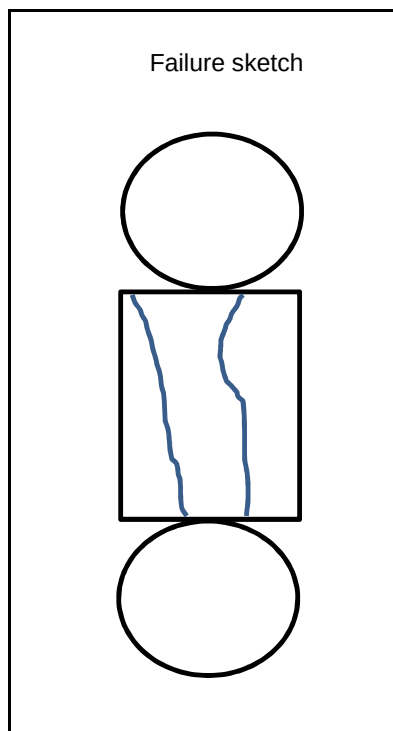
Client Reference: RT-17-60015
Job Number: 17-57432
Date Sampled: Not Given
Date Received: 15/08/2017
Date Tested: 24/08/2017
Sampled By: Not Given

Test results

Laboratory Reference: 799586
Hole No.: BH2
Sample Reference: Not Given
Sample Description: Orangish brown SANDSTONE
Specimen Reference: Not Given
Storage history and environment: Not Given

Depth Top [m]: 11.50
Depth Base [m]: Not Given
Sample Type: U
Specimen Depth [m]: Not Given
Date and method of sampling: Not Given

Specimen length	mm	155.4
Specimen diameter	mm	71.1
Test duration	min	1
Stress rate	kN/s	1
Machine type		Autocon
U.C.S.	MPa	2.6
Mode of failure		Cleavage
Loading axis relative to anisotropy		
Water content	%	11.8
Bulk density	Mg/m ³	1.98
Dry density	Mg/m ³	1.77
Degree of saturation	%	N/A



Remarks:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section

Signed:

Mark Beastall
Geotechnical Commercial
Manager

Date Reported: 29/08/2017

for and on behalf of i2 Analytical Ltd

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TEST CERTIFICATE

Unconfined Compressive Strength Test

I.S.R.M. Suggested Methods 1981 for Determination of Uniaxial Compressive Strength Part 1

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



Client: Geocore Site Investigations
Client Address: Tralee Close
Kirkleatham Business Park
Redcar, Cleveland
TS10 5SG
Contact: Beverley Grace
Site Name: Chandos Hall
Site Address: Not Given

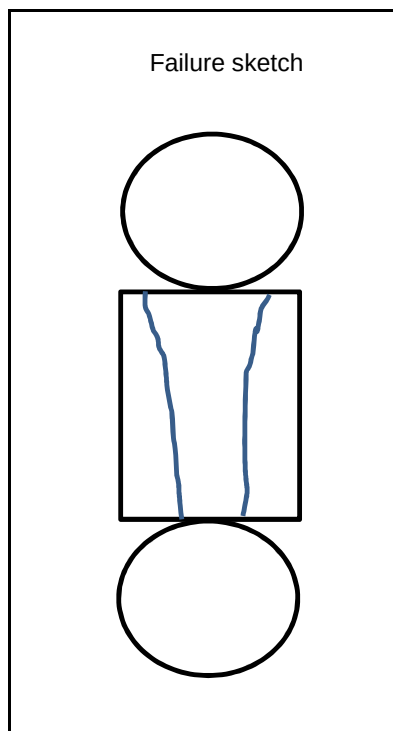
Client Reference: RT-17-60015
Job Number: 17-57432
Date Sampled: Not Given
Date Received: 15/08/2017
Date Tested: 24/08/2017
Sampled By: Not Given

Test results

Laboratory Reference: 799587
Hole No.: BH2
Sample Reference: Not Given
Sample Description: Orangish brown SANDSTONE
Specimen Reference: Not Given
Storage history and environment: Not Given

Depth Top [m]: 15.00
Depth Base [m]: Not Given
Sample Type: U
Specimen Depth [m]: Not Given
Date and method of sampling: Not Given

Specimen length	mm	185.2
Specimen diameter	mm	72.1
Test duration	min	1
Stress rate	kN/s	1
Machine type		Autocon
U.C.S.	MPa	10.3
Mode of failure		Cleavage
Loading axis relative to anisotropy		
Water content	%	11.3
Bulk density	Mg/m ³	2.08
Dry density	Mg/m ³	1.87
Degree of saturation	%	N/A



Remarks:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section

Signed:

Mark Beastall
Geotechnical Commercial
Manager

Date Reported: 29/08/2017

for and on behalf of i2 Analytical Ltd

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TEST CERTIFICATE

Unconfined Compressive Strength Test

I.S.R.M. Suggested Methods 1981 for Determination of Uniaxial Compressive Strength Part 1

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



Client: Geocore Site Investigations
Client Address: Tralee Close
Kirkleatham Business Park
Redcar, Cleveland
TS10 5SG
Contact: Beverley Grace
Site Name: Chandos Hall
Site Address: Not Given

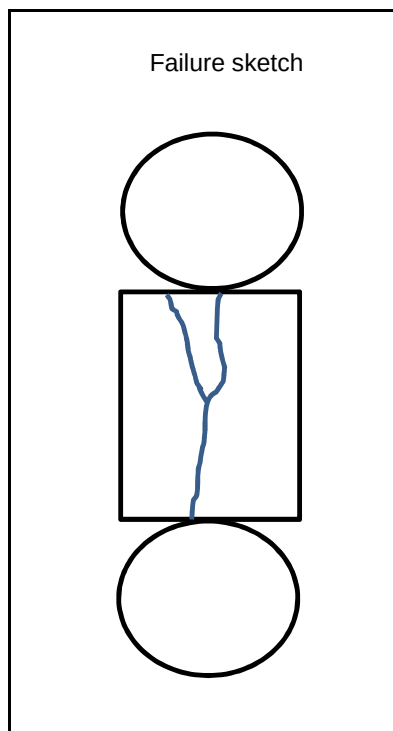
Client Reference: RT-17-60015
Job Number: 17-57432
Date Sampled: Not Given
Date Received: 15/08/2017
Date Tested: 24/08/2017
Sampled By: Not Given

Test results

Laboratory Reference: 799588
Hole No.: BH2
Sample Reference: Not Given
Sample Description: Orangish brown SANDSTONE
Specimen Reference: Not Given
Storage history and environment: Not Given

Depth Top [m]: 18.00
Depth Base [m]: Not Given
Sample Type: U
Specimen Depth [m]: Not Given
Date and method of sampling: Not Given

Specimen length	mm	137.1
Specimen diameter	mm	71.1
Test duration	min	1
Stress rate	kN/s	1
Machine type		Autocon
U.C.S.	MPa	4.0
Mode of failure		Cleavage
Loading axis relative to anisotropy		
Water content	%	14.5
Bulk density	Mg/m ³	2.08
Dry density	Mg/m ³	1.82
Degree of saturation	%	N/A



Remarks: Sample is too short

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section

Signed:

Mark Beastall
Geotechnical Commercial
Manager

Date Reported: 29/08/2017

for and on behalf of i2 Analytical Ltd

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TEST CERTIFICATE

Point Load Strength Index Tests Summary of Results

Tested in Accordance with ISRM : 2007, pages 125-132

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



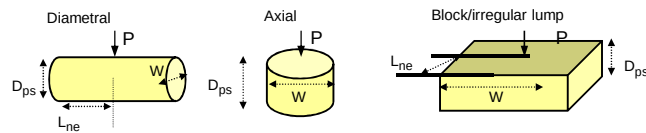
Client: Geocore Site Investigations
Client Address: Tralee Close
Kirkleatham Business Park
Redcar, Cleveland
TS10 5SG
Contact: Beverley Grace
Site Name: Chandos Hall
Site Address: Not Given

Client Reference: RT-17-60015
Job Number: 17-57432
Date Sampled: Not Given
Date Received: 15/08/2017
Date Tested: 24/08/2017
Sampled By: Not Given

Test results

Laboratory Reference	Hole No.	Sample				Specimen		Description	Rock Type and Test condition	Test Type see ISRM			Dimensions				Force P kN	Equivalent diameter, De mm	Point Load Strength Index		Remarks (including water content if measured)
		Reference	Depth Top [m]	Depth Base [m]	Type	Reference	Depth [m]			Type (D, A, I, B)	Direction (L, P or U)	Failure Valid (Y/N)	Lne mm	W mm	Dps mm	Dps' mm			Is MPa	Is(50) MPa	
799589	BH1	Not Given	11.00	Not Given	B	1	Not Given	Orangish brown SANDSTONE	Not Given	D	U	YES	40.2	71.8	71.0	69.0	0.1	70.4	0.02	0.03	
799589	BH1	Not Given	11.00	Not Given	B	2	Not Given	Orangish brown SANDSTONE	Not Given	A	U	YES	-	71.8	42.0	40.0	0.2	60.5	0.05	0.05	
799590	BH1	Not Given	12.60	Not Given	B	1	Not Given	Orangish brown SANDSTONE	Not Given	D	U	YES	36.9	71.4	71.0	69.0	0.5	70.2	0.10	0.11	
799590	BH1	Not Given	12.60	Not Given	B	2	Not Given	Orangish brown SANDSTONE	Not Given	A	U	YES	-	71.4	39.0	37.0	0.4	58.0	0.12	0.13	
799591	BH1	Not Given	13.90	Not Given	B	1	Not Given	Orangish brown SANDSTONE	Not Given	D	U	YES	39.6	72.0	70.0	69.0	0.1	70.5	0.01	0.01	
799591	BH1	Not Given	13.90	Not Given	B	2	Not Given	Orangish brown SANDSTONE	Not Given	A	U	YES	-	72.0	50.0	48.0	0.1	66.3	0.03	0.04	
799592	BH1	Not Given	15.50	Not Given	B	1	Not Given	Orangish brown SANDSTONE	Not Given	D	U	YES	36.6	71.6	71.0	69.0	0.3	70.3	0.06	0.07	
799592	BH1	Not Given	15.50	Not Given	B	2	Not Given	Orangish brown SANDSTONE	Not Given	A	U	YES	-	71.6	52.0	50.0	0.4	67.5	0.09	0.11	
799593	BH1	Not Given	17.00	Not Given	B	1	Not Given	Orangish brown SANDSTONE	Not Given	D	U	YES	39.1	70.3	70.0	68.0	0.1	69.1	0.02	0.02	
799593	BH1	Not Given	17.00	Not Given	B	2	Not Given	Orangish brown SANDSTONE	Not Given	A	U	YES	-	70.3	37.0	35.0	0.1	56.0	0.03	0.03	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
L - parallel to planes of weakness
P - perpendicular to planes of weakness
U - unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 9)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P



Detailed legend for test and dimensions, based on ISRM, is shown above.

Size factor, $F = (De/50)^{0.45}$ for all tests.

Comments:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section
Date Reported: 29/08/2017

Piotrowski

Signed:

Mark Beastall
Geotechnical Commercial
Manager

M. Beastall

for and on behalf of i2 Analytical Ltd

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TEST CERTIFICATE

Point Load Strength Index Tests Summary of Results

Tested in Accordance with ISRM : 2007, pages 125-132

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



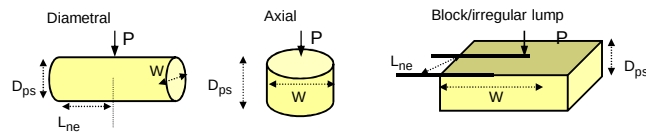
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Client Address: Tralee Close
Kirkleatham Business Park
Redcar, Cleveland
TS10 5SG
Contact: Beverley Grace
Site Name: Chandos Hall
Site Address: Not Given

Client Reference: RT-17-60015
Job Number: 17-57432
Date Sampled: Not Given
Date Received: 15/08/2017
Date Tested: 24/08/2017
Sampled By: Not Given

Test results

Laboratory Reference	Hole No.	Sample				Specimen		Description	Rock Type and Test condition	Test Type see ISRM			Dimensions				Force P kN	Equivalent diameter, De mm	Point Load Strength Index		Remarks (including water content if measured)
		Reference	Depth Top [m]	Depth Base [m]	Type	Reference	Depth [m]			Type (D, A, I, B)	Direction (L, P or U)	Failure Valid (Y/N)	Lne mm	W mm	Dps mm	Dps' mm			Is MPa	Is(50) MPa	
799594	BH1	Not Given	18.70	Not Given	B	1	Not Given	Orangish brown SANDSTONE	Not Given	D	U	YES	37.9	71.0	70.0	69.0	0.1	70.0	0.02	0.02	
799594	BH1	Not Given	18.70	Not Given	B	2	Not Given	Orangish brown SANDSTONE	Not Given	A	U	YES	-	71.0	42.0	39.0	0.7	59.4	0.21	0.23	
799595	BH2	Not Given	10.00	Not Given	B	1	Not Given	Orangish brown SANDSTONE	Not Given	D	U	YES	52.5	71.7	72.0	70.0	0.3	70.8	0.06	0.07	
799595	BH2	Not Given	10.00	Not Given	B	2	Not Given	Orangish brown SANDSTONE	Not Given	A	U	YES	-	71.7	51.0	49.0	0.5	66.9	0.11	0.12	
799596	BH2	Not Given	12.80	Not Given	B	1	Not Given	Orangish brown SANDSTONE	Not Given	D	U	YES	49.5	71.0	71.0	68.0	0.4	69.5	0.09	0.11	
799596	BH2	Not Given	12.80	Not Given	B	2	Not Given	Orangish brown SANDSTONE	Not Given	A	U	YES	-	71.0	54.0	50.0	0.5	67.2	0.12	0.14	
799597	BH2	Not Given	14.50	Not Given	B	1	Not Given	Orangish brown SANDSTONE	Not Given	D	U	YES	39.5	71.2	71.0	69.0	0.3	70.1	0.06	0.07	
799597	BH2	Not Given	14.50	Not Given	B	2	Not Given	Orangish brown SANDSTONE	Not Given	A	U	YES	-	71.2	35.0	33.0	0.4	54.7	0.14	0.15	
799598	BH2	Not Given	16.00	Not Given	B	1	Not Given	Orangish brown SANDSTONE	Not Given	D	U	YES	69.6	67.1	68.0	66.0	0.4	66.6	0.10	0.11	
799598	BH2	Not Given	16.00	Not Given	B	2	Not Given	Orangish brown SANDSTONE	Not Given	A	U	YES	-	67.1	59.0	57.0	0.5	69.8	0.10	0.11	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
L - parallel to planes of weakness
P - perpendicular to planes of weakness
U - unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 9)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P



Detailed legend for test and dimensions, based on ISRM, is shown above.

Size factor, $F = (De/50)^{0.45}$ for all tests.

Comments:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section
Date Reported: 29/08/2017

Signed:

Mark Beastall
Geotechnical Commercial
Manager

for and on behalf of i2 Analytical Ltd

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TEST CERTIFICATE

Point Load Strength Index Tests Summary of Results

Tested in Accordance with ISRM : 2007, pages 125-132

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



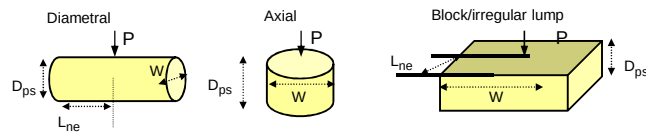
Client: Geocore Site Investigations
Client Address: Tralee Close
Kirkleatham Business Park
Redcar, Cleveland
TS10 5SG
Contact: Beverley Grace
Site Name: Chandos Hall
Site Address: Not Given

Client Reference: RT-17-60015
Job Number: 17-57432
Date Sampled: Not Given
Date Received: 15/08/2017
Date Tested: 24/08/2017
Sampled By: Not Given

Test results

Laboratory Reference	Hole No.	Sample				Specimen		Description	Rock Type and Test condition	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P kN	Equivalent diameter, D _e mm	Point Load Strength Index		Remarks (including water content if measured)
		Reference	Depth Top [m]	Depth Base [m]	Type	Reference	Depth [m]			Type (D, A, I, B)	Direction (L, P or U)		Lne mm	W mm	Dps mm	Dps' mm			Is MPa	Is(50) MPa	
799599	BH2	Not Given	17.50	Not Given	B	1	Not Given	Orangish brown SANDSTONE	Not Given	D	U	YES	61.3	70.5	70.0	68.0	0.2	69.2	0.05	0.06	
799599	BH2	Not Given	17.50	Not Given	B	2	Not Given	Orangish brown SANDSTONE	Not Given	A	U	YES	-	70.5	47.0	46.0	0.2	64.3	0.04	0.04	
799600	BH2	Not Given	19.30	Not Given	B	1	Not Given	Orangish brown SANDSTONE	Not Given	D	U	YES	38.1	69.1	70.0	69.0	0.1	69.0	0.01	0.01	
799600	BH2	Not Given	19.30	Not Given	B	2	Not Given	Orangish brown SANDSTONE	Not Given	A	U	YES	-	69.1	56.0	53.0	0.2	68.3	0.05	0.05	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
L - parallel to planes of weakness
P - perpendicular to planes of weakness
U - unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 9)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P



Detailed legend for test and dimensions, based on ISRM, is shown above.

Size factor, $F = (De/50)^{0.45}$ for all tests.

Comments:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section
Date Reported: 29/08/2017

Piotrowski

Signed:

Mark Beastall
Geotechnical Commercial
Manager

M. Beastall

for and on behalf of i2 Analytical Ltd

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**Jessica Bailey**

Curtins
Merchant Exchange
17-19 Whitworth Street West
Manchester
M1 5WG

e: jessica.bailey@curtins.com

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

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

Analytical Report Number : 18-73908

Project / Site name:	Chandos	Samples received on:	23/01/2018
Your job number:	B065374	Samples instructed on:	23/01/2018
Your order number:	EBMA1048	Analysis completed by:	05/02/2018
Report Issue Number:	1	Report issued on:	06/02/2018
Samples Analysed:	5 soil samples		

Signed:

Jordan Hill
Reporting Manager
For & on behalf of i2 Analytical Ltd.

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

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

Standard sample disposal times, unless otherwise agreed with the laboratory, are :	soils	- 4 weeks from reporting
	leachates	- 2 weeks from reporting
	waters	- 2 weeks from reporting
	asbestos	- 6 months from reporting

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Analytical Report Number: 18-73908

Project / Site name: Chandos

Your Order No: EBMA1048

Lab Sample Number				895436	895437	895438	895439	895440
Sample Reference				BH03	BH03	WS11	WS09	WS10
Sample Number				D2	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				2.20	5.00-5.50	3.50-3.70	4.50-4.70	2.80-3.00
Date Sampled				19/01/2018	19/01/2018	20/01/2018	20/01/2018	20/01/2018
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	12	13	12	15	11
Total mass of sample received	kg	0.001	NONE	1.4	0.59	0.74	0.22	0.61

General Inorganics

pH - Automated	pH Units	N/A	MCERTS	8.5	7.6	8.3	8.5	8.5
Water Soluble SO ₄ 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.083	0.044	0.14	0.10	0.077



Analytical Report Number : 18-73908

Project / Site name: Chandos

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

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

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
895436	BH03	D2	2.20	Brown clay and sand with gravel.
895437	BH03	None Supplied	5.00-5.50	Brown clay and sand with gravel.
895438	WS11	None Supplied	3.50-3.70	Brown clay.
895439	WS09	None Supplied	4.50-4.70	Brown clay.
895440	WS10	None Supplied	2.80-3.00	Brown clay with gravel.



Analytical Report Number : 18-73908

Project / Site name: Chandos

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

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 2, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests, 2:1 water:soil extraction, analysis by ICP-OES.	L038-PL	D	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.

For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.

Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.



TEST CERTIFICATE

Determination of Liquid and Plastic Limits

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



Tested in Accordance with BS1377-2: 1990: Clause 4.3 & 5: Definitive Method

Client: CURTINS
Client Address: 2 The Wharf
Bridge Street
Birmingham
B1 2JS
Contact: Rob Swinnerton
Site Name: Chandos
Site Address: Not Given

Client Reference: B065374
Job Number: 18-73808
Date Sampled: 19/01/2018
Date Received: 23/01/2018
Date Tested: 30/01/2018
Sampled By: Not Given

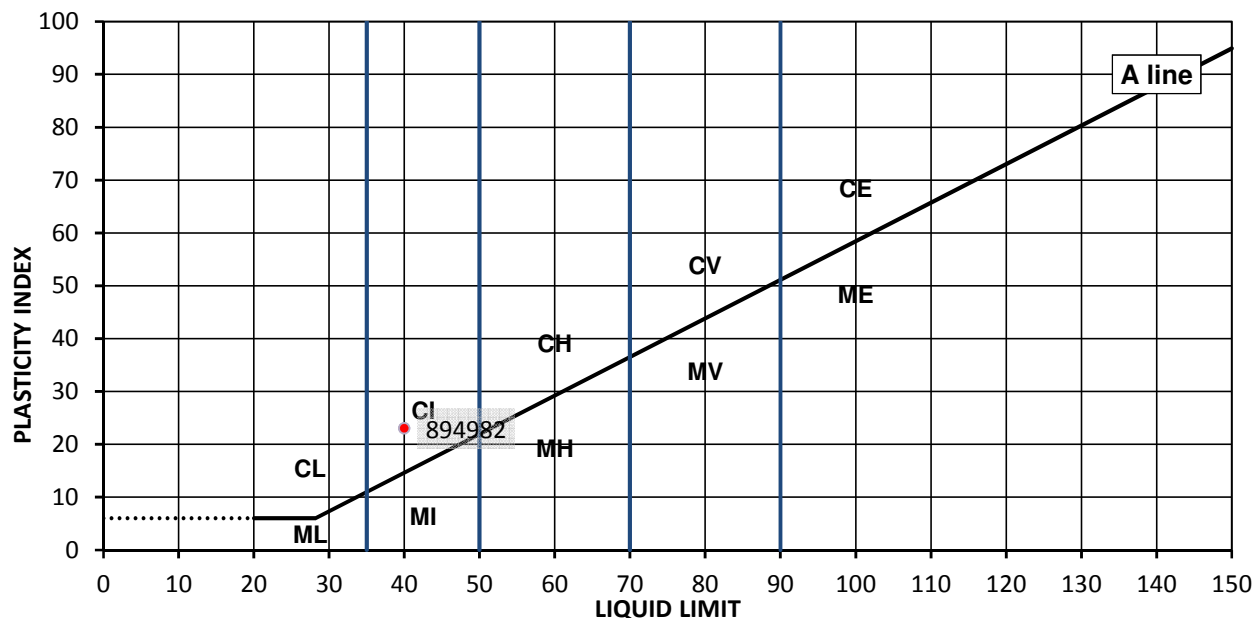
TEST RESULTS

Laboratory Reference: 894982
Sample Reference: Not Given

Description: Dark brown slightly gravelly sandy CLAY
Location: BH03
Sample Preparation: Tested after washing to remove >425um

Sample Type: B
Depth Top [m]: 4.50
Depth Base [m]: 4.70

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
17	40	17	23	88



Legend, based on BS 5930:2015 Code of practice for site investigations

	Plasticity	Liquid Limit
C	Clay	below 35
M	Silt	35 to 50
	L	Low
	I	Medium
	H	High
	V	Very high
	E	Extremely high
Organic	O	append to classification for organic material (eg CHO)

Remarks

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section

Signed:

Darren Berrill
Geotechnical General
Manager

Date Reported: 06/02/2018

for and on behalf of i2 Analytical Ltd

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TEST CERTIFICATE

Determination of Liquid and Plastic Limits

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



Tested in Accordance with BS1377-2: 1990: Clause 4.3 & 5: Definitive Method

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Client Address: 2 The Wharf
Bridge Street
Birmingham
B1 2JS
Contact: Rob Swinnerton
Site Name: Chandos
Site Address: Not Given

Client Reference: B065374
Job Number: 18-73808
Date Sampled: 20/01/2018
Date Received: 23/01/2018
Date Tested: 30/01/2018
Sampled By: Not Given

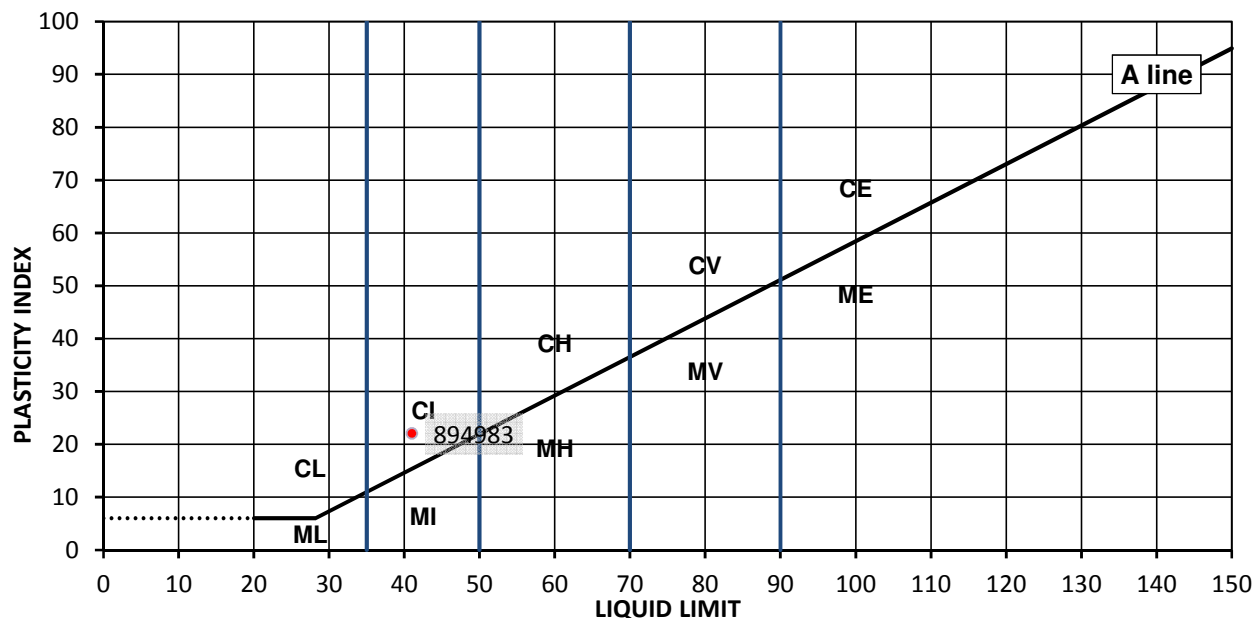
TEST RESULTS

Laboratory Reference: 894983
Sample Reference: Not Given

Description: Dark brown slightly gravelly sandy CLAY
Location: WS11
Sample Preparation: Tested after washing to remove >425um

Sample Type: B
Depth Top [m]: 3.50
Depth Base [m]: 3.70

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
16	41	19	22	92



Legend, based on BS 5930:2015 Code of practice for site investigations

	Plasticity	Liquid Limit
C	Clay	below 35
M	Silt	35 to 50
	L	Low
	I	Medium
	H	High
	V	Very high
	E	Extremely high
Organic	O	append to classification for organic material (eg CHO)

Remarks

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section

Signed:

Darren Berrill
Geotechnical General
Manager

Date Reported: 06/02/2018

for and on behalf of i2 Analytical Ltd

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The analysis was carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland."



TEST CERTIFICATE

Determination of Liquid and Plastic Limits

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



Tested in Accordance with BS1377-2: 1990: Clause 4.3 & 5: Definitive Method

Client: CURTINS
Client Address: 2 The Wharf
Bridge Street
Birmingham
B1 2JS
Contact: Rob Swinnerton
Site Name: Chandos
Site Address: Not Given

Client Reference: B065374
Job Number: 18-73808
Date Sampled: 20/01/2018
Date Received: 23/01/2018
Date Tested: 30/01/2018
Sampled By: Not Given

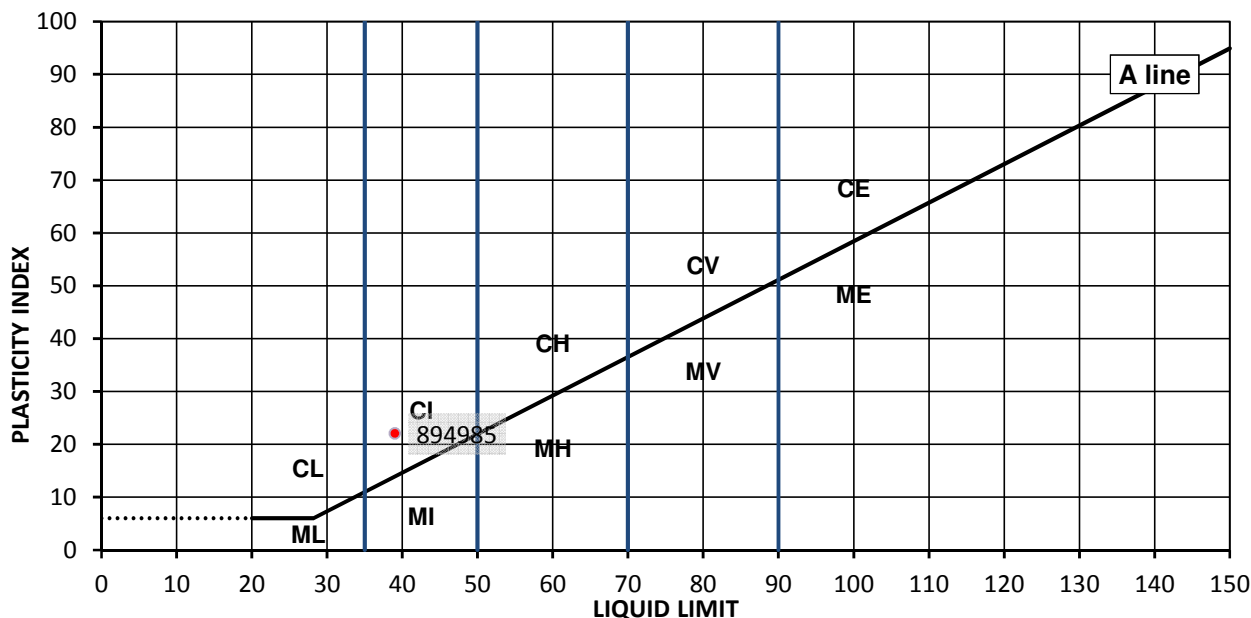
TEST RESULTS

Laboratory Reference: 894985
Sample Reference: Not Given

Description: Dark brown slightly gravelly sandy CLAY
Location: WS10
Sample Preparation: Tested after washing to remove >425um

Sample Type: B
Depth Top [m]: 2.80
Depth Base [m]: 3.00

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
14	39	17	22	89



Legend, based on BS 5930:2015 Code of practice for site investigations

	Plasticity	Liquid Limit
C	Clay	below 35
M	Silt	35 to 50
	L	Low
	I	Medium
	H	High
	V	Very high
	E	Extremely high
Organic	O	append to classification for organic material (eg CHO)

Remarks

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section

Signed:

Darren Berrill
Geotechnical General
Manager

Date Reported: 06/02/2018

for and on behalf of i2 Analytical Ltd

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TEST CERTIFICATE

Summary of Classification Test Results

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



Client: CURTINS
Client Address: 2 The Wharf
Bridge Street
Birmingham
B1 2JS
Contact: Rob Swinnerton
Site Name: Chandos
Site Address: Not Given

Client Reference: B065374
Job Number: 18-73808
Date Sampled: 19/01 - 20/01/2018
Date Received: 23/01/2018
Date Tested: 30/01/2018
Sampled By: Not Given

Test results

Laboratory Reference	Hole No.	Sample				Soil Description	Density		M/C	Atterberg				PD
		Reference	Top depth [m]	Base depth [m]	Type		bulk	dry		% Passing 425um	LL	PL	PI	
							Mg/m3	Mg/m3		%	%	%	%	%
894982	BH03	Not Given	4.50	4.70	B	Dark brown slightly gravelly sandy CLAY			17	88	40	17	23	
894984	WS09	Not Given	4.50	4.70	B	Dark brown slightly gravelly sandy CLAY			16					
894985	WS10	Not Given	2.80	3.00	B	Dark brown slightly gravelly sandy CLAY			14	89	39	17	22	
894983	WS11	Not Given	3.50	3.70	B	Dark brown slightly gravelly sandy CLAY			16	92	41	19	22	

Comments:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section

Date Reported: 06/02/2018

Signed:

Darren Berrill
Geotechnical General Manager

for and on behalf of i2 Analytical Ltd

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LABORATORY REPORT



4043

Contract Number: PSL18/0467

Report Date: 01 February 2018
Client's Reference: 60577
Client Name: Geocore Site Investigations Ltd
Tralee Close
Kirkleatham Business Park
Redcar
Cleveland
TS10 5SG

For the attention of: Bev Grace

Contract Title: Manchester
Date Received: 30/1/2018
Date Commenced: 30/1/2018
Date Completed: 01/2/2018

Notes: Opinions and Interpretations are outside the UKAS Accreditation

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced other than in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

R Gunson
(Director)

A Watkins
(Director)

R Berriman
(Quality Manager)

L Knight
(Senior Technician)


S Eyre
(Senior Technician)

A Fry
(Senior Technician)

5 – 7 Hexthorpe Road, Hexthorpe,
Doncaster DN4 0AR
tel: +44 (0)844 815 6641
fax: +44 (0)844 815 6642
e-mail: rgunson@prosoils.co.uk
awatkins@prosoils.co.uk

Page 1 of

DETERMINATION OF UNCONFINED COMPRESSIVE STRENGTH

ISRM Suggested Methods, pp 111 –116, 1981.

[illegible]

Manchester

Contract No:

PSL18/0467

Client Ref:

60577

SUMMARY OF POINT LOAD TEST RESULTS

ISRM Suggested Methods : 2007

[illegible]

***Note** All testing carried out on samples at as received water content

Par = parallel, Perp = perpendicular, U = Random

A = Axial, D = Diametral, I = Irregular



Manchester

Contract No:

PSL18/0467

Client Ref:

60577

SUMMARY OF POINT LOAD TEST RESULTS

ISRM Suggested Methods : 2007

[illegible]

***Note** All testing carried out on samples at as received water content

Par = parallel, Perp = perpendicular, U = Random



Manchester

Contract No:

PSL18/0467

Client Ref:

60577



TEST CERTIFICATE

Liquid and Plastic Limits

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



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

Client: CURTINS
Client Address: 17-19 Whitworth Street West, Manchester,
M1 5WG
Contact: Matthew Holroyd
Site Name: Chandos 54
Site Address: Not Given

Client Reference: B065374
Job Number: 19-43458
Date Sampled: 28/05/2019
Date Received: 29/05/2019
Date Tested: 03/06/2019
Sampled By: Not Given

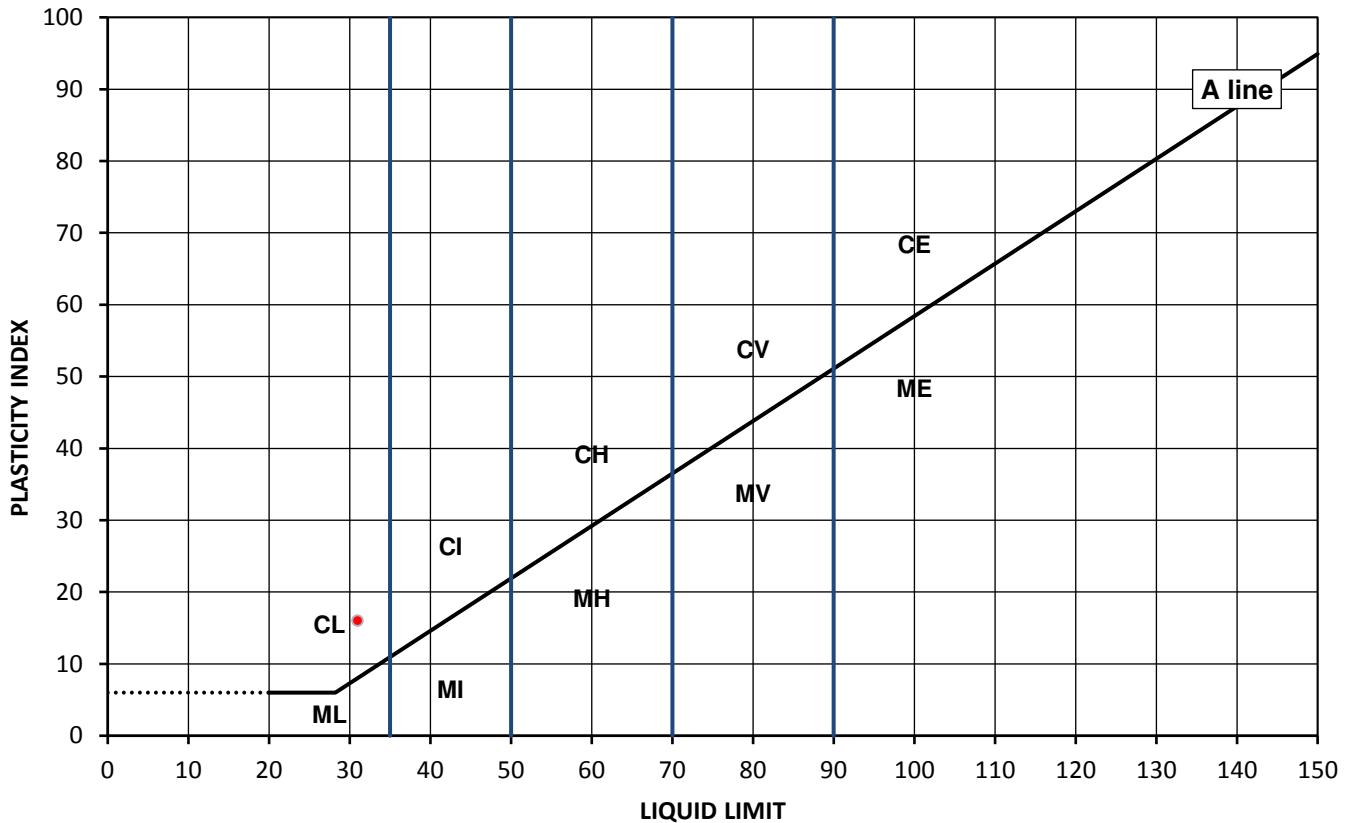
Test Results:

Laboratory Reference: 1233730
Hole No.: BH401
Sample Reference: D2
Soil Description: Brown slightly gravelly very sandy CLAY

Depth Top [m]: 4.20
Depth Base [m]: Not Given
Sample Type: D

Sample Preparation: Tested after >425um removed by hand

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
15	31	15	16	95



Legend, based on BS 5930:2015 Code of practice for site investigations

C	Clay	Plasticity	Liquid Limit
M	Silt	L	Low
		I	Medium
		H	High
		V	Very high
		E	Extremely high
	Organic	O	append to classification for organic material (eg CHO)

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

Remarks:

Approved: Dariusz Piotrowski
PL Geotechnical Laboratory Manager
Date Reported: 11/06/2019

Signed: Darren Berrill
Geotechnical General Manager
for and on behalf of i2 Analytical Ltd GF 236.5

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



SUMMARY REPORT

Summary of Classification Test Results

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



Tested in Accordance with:

MC by BS 1377-2: 1990: Clause 3.2; WC by BS EN 17892-1: 2014; Atterberg
by BS 1377-2: 1990: Clause 4.3, Clause 4.4 and 5; PD by BS 1377-2: 1990:
Clause 8.2

Client Reference: B065374
Job Number: 19-43458
Date Sampled: 28/05 - 29/05/2019
Date Received: 29/05/2019
Date Tested: 03/06/2019
Sampled By: Not Given

Client: CURTINS
Client Address: 17-19 Whitworth Street West, Manchester,
M1 5WG
Contact: Matthew Holroyd
Site Name: Chandos 54
Site Address: Not Given

Test results

Laboratory Reference	Hole No.	Sample				Description	Remarks	MC	WC	Atterberg				Density			Total Porosity#		
		Reference	Depth Top m	Depth Base m	Type					% Passing 425um	LL	PL	PI	bulk Mg/m3	dry Mg/m3	PD Mg/m3			
1233729	BH401	D1	1.80	Not Given	D	Brown slightly gravelly CLAY		14											
1233730	BH401	D2	4.20	Not Given	D	Brown slightly gravelly very sandy CLAY	Atterberg 4 Point	15		95	31	15	16						
1233732	WS401	D1	3.00	3.45	D	Brown CLAY		13											

Note: # Non accredited; NP - Non plastic

Comments:

Approved: Dariusz Piotrowski
PL Geotechnical Laboratory Manager
Date Reported: 11/06/2019

Signed: Darren Berrill
Geotechnical General Manager
for and on behalf of i2 Analytical Ltd GF 238.7

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The analysis was carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland."



TEST CERTIFICATE

Particle Size Distribution

Tested in Accordance with: BS 1377-2: 1990

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



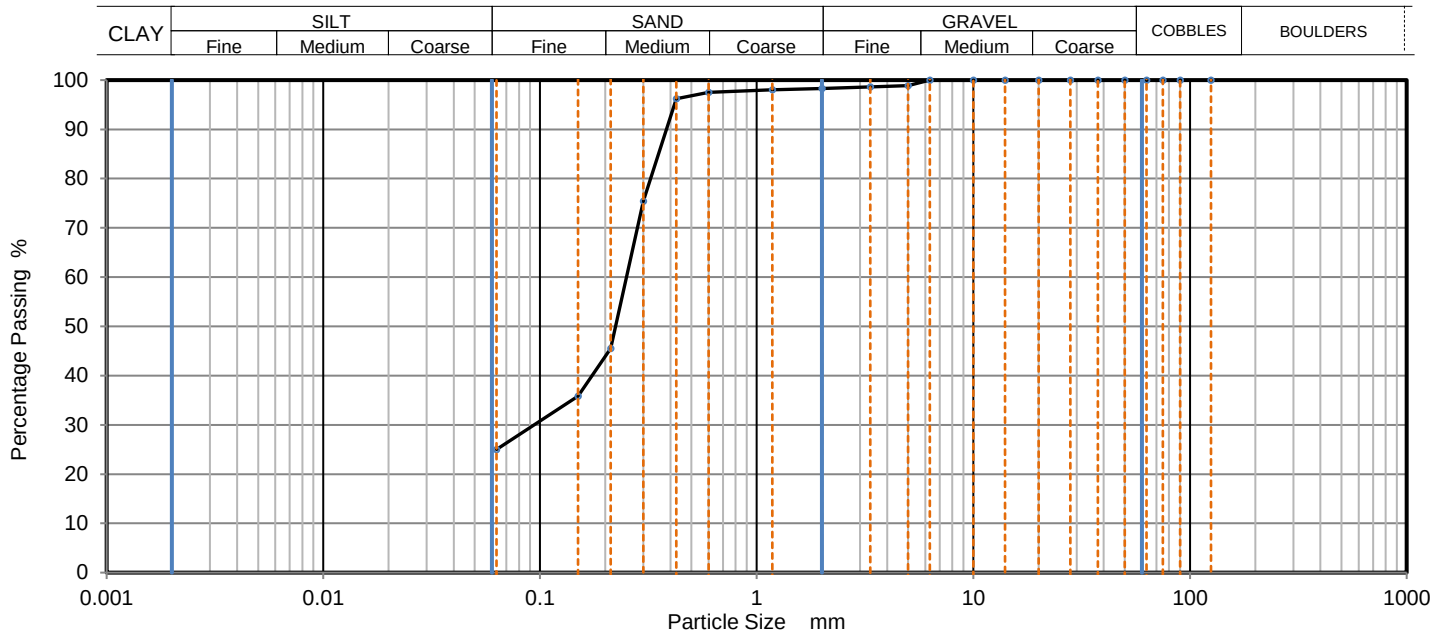
Client: CURTINS
Client Address: 17-19 Whitworth Street West, Manchester,
M1 5WG
Contact: Matthew Holroyd
Site Name: Chandos 54
Site Address: Not Given

Client Reference: B065374
Job Number: 19-43458
Date Sampled: 28/05/2019
Date Received: 29/05/2019
Date Tested: 04/06/2019
Sampled By: Not Given

Test Results:

Laboratory Reference: 1233731
Hole No.: BH401
Sample Reference: B1
Sample Description: Brown slightly gravelly clayey SAND

Depth Top [m]: 5.50
Depth Base [m]: 6.00
Sample Type: B



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	99		
3.35	99		
2	98		
1.18	98		
0.6	98		
0.425	96		
0.3	75		
0.212	46		
0.15	36		
0.063	26		

Dry Mass of sample [g]: 560

Sample Proportions	% dry mass
Very coarse	0.00
Gravel	1.70
Sand	72.70
Fines <0.063mm	25.60

Grading Analysis		
D100	mm	6.3
D60	mm	0.251
D30	mm	0.0914
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

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

Remarks:

Approved: Dariusz Piotrowski
PL Geotechnical Laboratory Manager
Date Reported: 11/06/2019

Signed: Darren Berrill
Geotechnical General Manager
for and on behalf of i2 Analytical Ltd GF 100.11



Matthew Holroyd

Curtins
17-19 Whitworth Street West
Manchester
M1 5WG

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

t: 01923 225404

f: 01923 237404

e: reception@i2analytical.com

e: matthew.holroyd@curtins.com

Analytical Report Number : 19-43459

Project / Site name:	Chandos 54	Samples received on:	29/05/2019
Your job number:	B065374	Samples instructed on:	29/05/2019
Your order number:		Analysis completed by:	12/06/2019
Report Issue Number:	1	Report issued on:	12/06/2019
Samples Analysed:	4 soil samples		

Signed: Karolina Marek

Karolina Marek
Technical Reviewer (Reporting Team)
For & on behalf of i2 Analytical Ltd.

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

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

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

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

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

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

Iss No 19-43459-1 Chandos 54 B065374

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The results included within the report are representative of the samples submitted for analysis.

Page 1 of 4



Analytical Report Number: 19-43459

Project / Site name: Chandos 54

Lab Sample Number				1233733	1233734	1233735	1233736	
Sample Reference				BH401	BH401	BH401	WS401	
Sample Number				D1	D2	B1	D1	
Depth (m)				1.80	4.20	5.50-6.00	3.00-3.45	
Date Sampled				28/05/2019	28/05/2019	28/05/2019	29/05/2019	
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	
Moisture Content	%	N/A	NONE	11	8.2	14	9.5	
Total mass of sample received	kg	0.001	NONE	0.19	0.16	0.89	0.18	

General Inorganics

pH - Automated	pH Units	N/A	MCERTS	8.0	8.6	8.6	8.4	
Water Soluble SO ₄ 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.093	0.064	0.073	0.067	



Analytical Report Number : 19-43459

Project / Site name: Chandos 54

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

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

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1233733	BH401	D1	1.80	Brown clay.
1233734	BH401	D2	4.20	Brown clay.
1233735	BH401	B1	5.50-6.00	Brown sand.
1233736	WS401	D1	3.00-3.45	Brown clay.



Analytical Report Number : 19-43459

Project / Site name: Chandos 54

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

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 2, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests, 2:1 water:soil extraction, analysis by ICP-OES.	L038-PL	D	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.

For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.

Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.



TEST CERTIFICATE

Liquid and Plastic Limits

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



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

Client: CURTINS
Client Address: 17-19 Whitworth Street West, Manchester,
M1 5WG
Contact: Matthew Holroyd
Site Name: Chandos 54
Site Address: Not Given

Client Reference: B065374
Job Number: 19-43949
Date Sampled: 29/05/2019
Date Received: 31/05/2019
Date Tested: 06/06/2019
Sampled By: Not Given

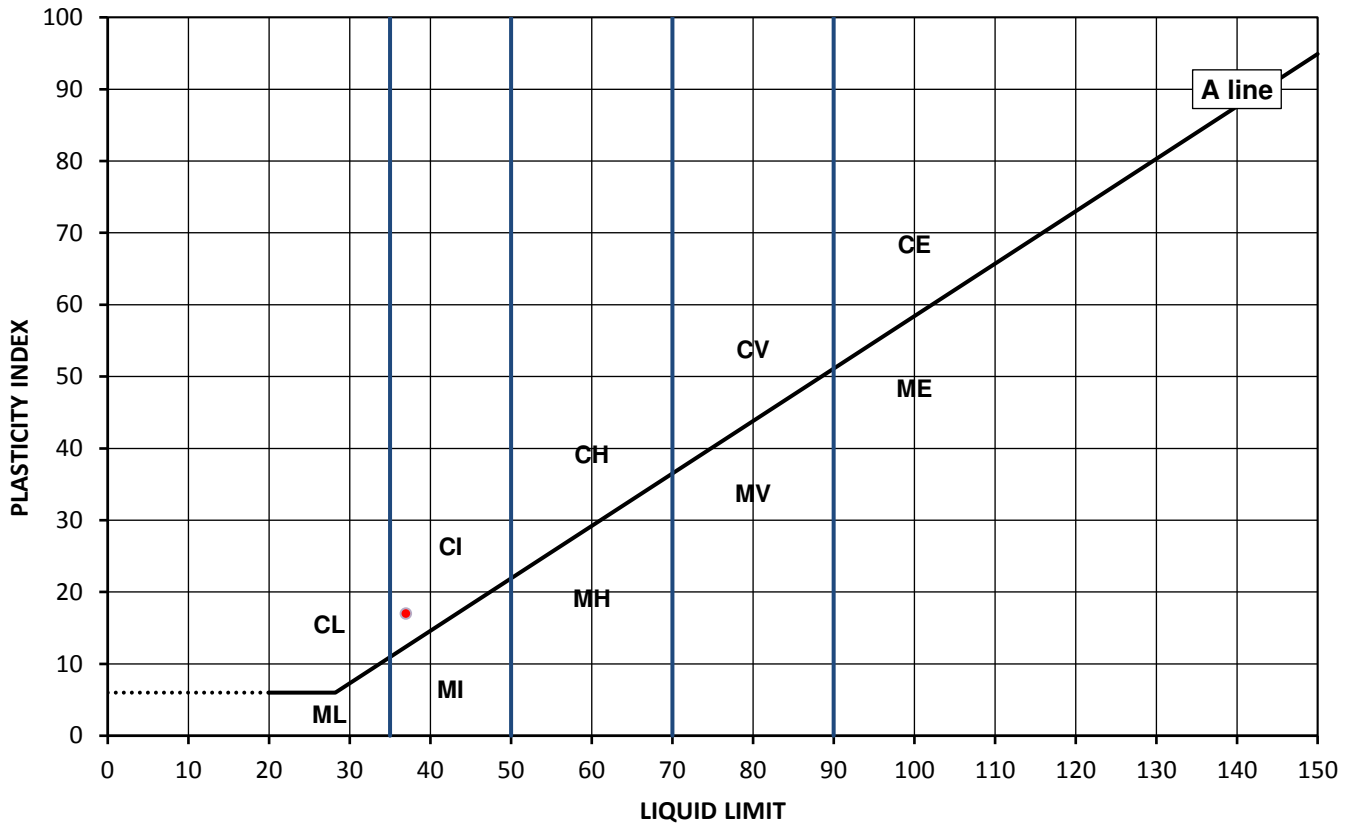
Test Results:

Laboratory Reference: 1236326
Hole No.: WS5403
Sample Reference: Not Given
Soil Description: Brown slightly gravelly sandy CLAY

Depth Top [m]: 3.60
Depth Base [m]: Not Given
Sample Type: D

Sample Preparation: Tested after washing to remove >425um

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
13	37	20	17	94



Legend, based on BS 5930:2015 Code of practice for site investigations

C	Clay	Plasticity	Liquid Limit
M	Silt	L	Low
		I	Medium
		H	High
		V	Very high
		E	Extremely high
	Organic	O	append to classification for organic material (eg CHO)

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

Remarks:

Approved: Dariusz Piotrowski
PL Geotechnical Laboratory Manager
Date Reported: 14/06/2019

Signed: Darren Berrill
Geotechnical General Manager
for and on behalf of i2 Analytical Ltd GF 236.5

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



TEST CERTIFICATE

Liquid and Plastic Limits

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



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

Client: CURTINS
Client Address: 17-19 Whitworth Street West, Manchester,
M1 5WG
Contact: Matthew Holroyd
Site Name: Chandos 54
Site Address: Not Given

Client Reference: B065374
Job Number: 19-43949
Date Sampled: 29/05/2019
Date Received: 31/05/2019
Date Tested: 06/06/2019
Sampled By: Not Given

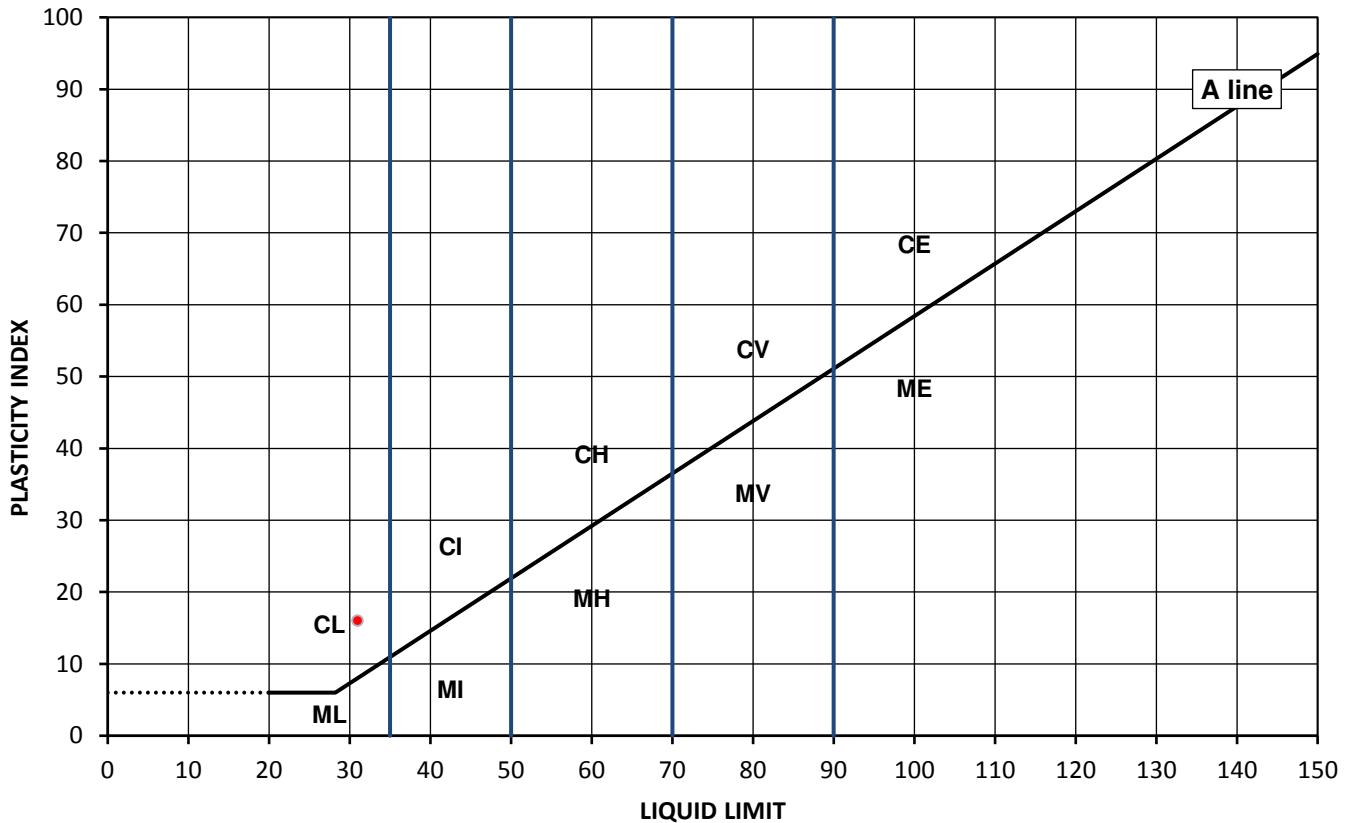
Test Results:

Laboratory Reference: 1236328
Hole No.: BH402B
Sample Reference: Not Given
Soil Description: Brown very sandy CLAY

Depth Top [m]: 5.00
Depth Base [m]: 5.40
Sample Type: D

Sample Preparation: Tested in natural condition

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
14	31	15	16	100



Legend, based on BS 5930:2015 Code of practice for site investigations

C	Clay	Plasticity	Liquid Limit
M	Silt	L	Low
		I	Medium
		H	High
		V	Very high
		E	Extremely high
	Organic	O	append to classification for organic material (eg CHO)

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

Remarks:

Approved: Dariusz Piotrowski
PL Geotechnical Laboratory Manager
Date Reported: 14/06/2019

Signed: Darren Berrill
Geotechnical General Manager
for and on behalf of i2 Analytical Ltd GF 236.5

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SUMMARY REPORT

Summary of Classification Test Results

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



Tested in Accordance with:

MC by BS 1377-2: 1990: Clause 3.2; WC by BS EN 17892-1: 2014; Atterberg
by BS 1377-2: 1990: Clause 4.3, Clause 4.4 and 5; PD by BS 1377-2: 1990:
Clause 8.2

Client Reference: B065374
Job Number: 19-43949
Date Sampled: 29/05/2019
Date Received: 31/05/2019
Date Tested: 06/06/2019
Sampled By: Not Given

Client: CURTINS
Client Address: 17-19 Whitworth Street West, Manchester,
M1 5WG
Contact: Matthew Holroyd
Site Name: Chandos 54
Site Address: Not Given

Test results

Laboratory Reference	Hole No.	Sample				Description	Remarks	MC	WC	Atterberg				Density			Total Porosity#		
		Reference	Depth Top	Depth Base	Type					% Passing 425um	LL	PL	PI	bulk	dry	PD			
			m	m															
1236328	BH402B	Not Given	5.00	5.40	D	Brown very sandy CLAY	Atterberg 4 Point	14		100	31	15	16						
1236327	BH403	Not Given	3.00	Not Given	D	Brown CLAY		16											
1236326	WS5403	Not Given	3.60	Not Given	D	Brown slightly gravelly sandy CLAY	Atterberg 4 Point	13		94	37	20	17						

Note: # Non accredited; NP - Non plastic

Comments:

Approved: Dariusz Piotrowski
PL Geotechnical Laboratory Manager
Date Reported: 14/06/2019

Signed: Darren Berrill
Geotechnical General Manager
for and on behalf of i2 Analytical Ltd GF 238.7

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TEST CERTIFICATE

Particle Size Distribution

Tested in Accordance with: BS 1377-2: 1990

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



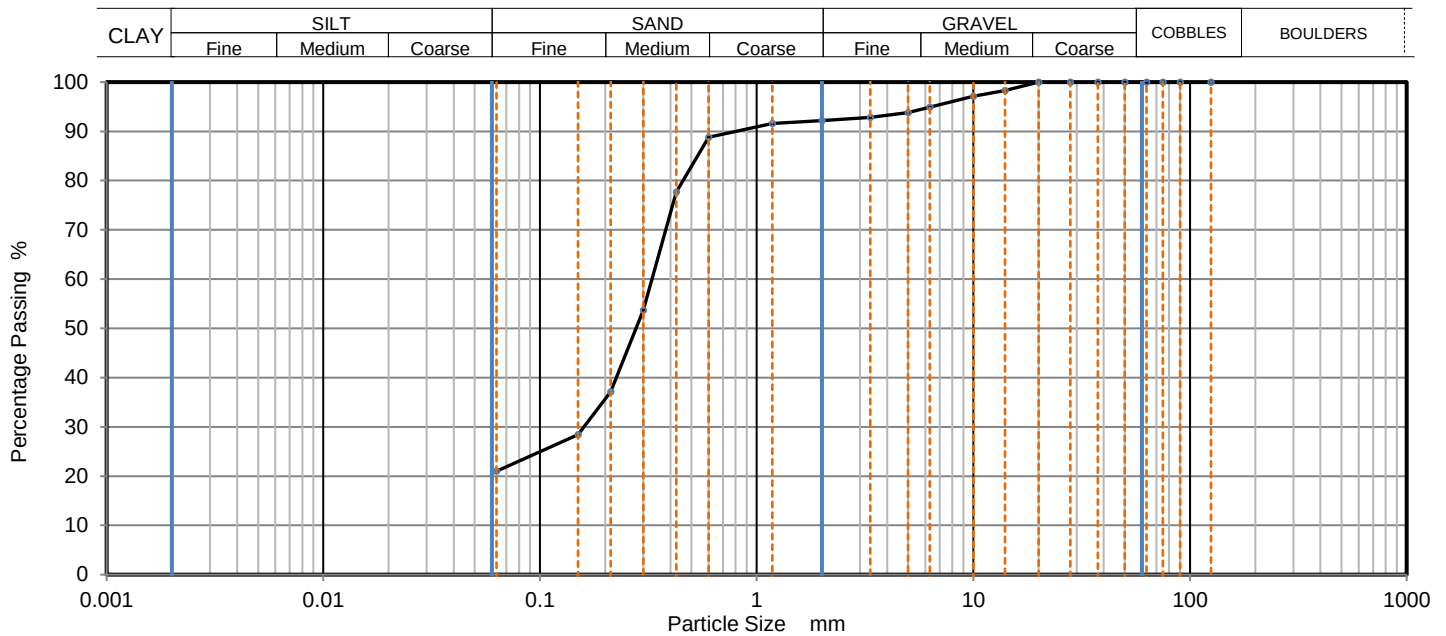
Client: CURTINS
Client Address: 17-19 Whitworth Street West, Manchester,
M1 5WG
Contact: Matthew Holroyd
Site Name: Chandos 54
Site Address: Not Given

Client Reference: B065374
Job Number: 19-43949
Date Sampled: 29/05/2019
Date Received: 31/05/2019
Date Tested: 06/06/2019
Sampled By: Not Given

Test Results:

Laboratory Reference: 1236324
Hole No.: BH402B
Sample Reference: Not Given
Sample Description: Brown slightly gravelly clayey SAND

Depth Top [m]: 6.50
Depth Base [m]: 7.50
Sample Type: B



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	98		
10	97		
6.3	95		
5	94		
3.35	93		
2	92		
1.18	92		
0.6	89		
0.425	78		
0.3	54		
0.212	37		
0.15	28		
0.063	21		

Dry Mass of sample [g]: 914

Sample Proportions	% dry mass
Very coarse	0.00
Gravel	7.80
Sand	71.10
Fines <0.063mm	21.10

Grading Analysis		
D100	mm	20
D60	mm	0.329
D30	mm	0.16
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

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

Remarks:

Approved: Dariusz Piotrowski
PL Geotechnical Laboratory Manager
Date Reported: 14/06/2019

Signed: Darren Berrill
Geotechnical General Manager

for and on behalf of i2 Analytical Ltd GF 100.11

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This report may not be reproduced other than in full without the prior written approval of the issuing laboratory.
The results included within the report are representative of the samples submitted for analysis.
The analysis was carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland.*



TEST CERTIFICATE

Particle Size Distribution

Tested in Accordance with: BS 1377-2: 1990

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



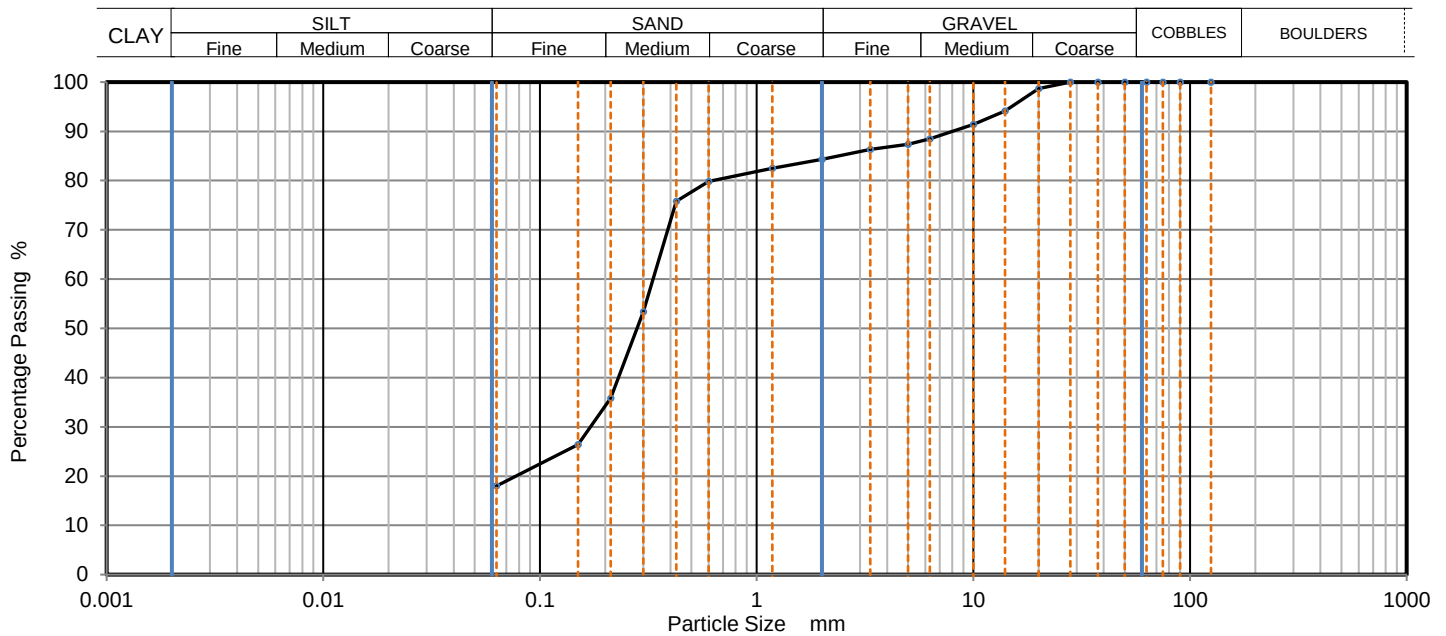
Client: CURTINS
Client Address: 17-19 Whitworth Street West, Manchester,
M1 5WG
Contact: Matthew Holroyd
Site Name: Chandos 54
Site Address: Not Given

Client Reference: B065374
Job Number: 19-43949
Date Sampled: 30/05/2019
Date Received: 31/05/2019
Date Tested: 06/06/2019
Sampled By: Not Given

Test Results:

Laboratory Reference: 1236325
Hole No.: BH403
Sample Reference: Not Given
Sample Description: Brown gravelly clayey SAND

Depth Top [m]: 7.00
Depth Base [m]: 7.50
Sample Type: B



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	99		
14	94		
10	91		
6.3	89		
5	87		
3.35	86		
2	84		
1.18	83		
0.6	80		
0.425	76		
0.3	53		
0.212	36		
0.15	26		
0.063	19		

Dry Mass of sample [g]: 1988

Sample Proportions	% dry mass
Very coarse	0.00
Gravel	15.70
Sand	65.70
Fines <0.063mm	18.50

Grading Analysis		
D100	mm	28
D60	mm	0.333
D30	mm	0.171
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

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

Remarks:

Approved: Dariusz Piotrowski
PL Geotechnical Laboratory Manager
Date Reported: 14/06/2019

Signed: Darren Berrill
Geotechnical General Manager
for and on behalf of i2 Analytical Ltd GF 100.11



TEST CERTIFICATE

Unconsolidated Undrained Triaxial Compression

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



Tested in Accordance with: BS 1377-7: 1990: Clause 9

Client: CURTINS
Client Address: 17-19 Whitworth Street West, Manchester,
M1 5WG
Contact: Matthew Holroyd
Site Name: Chandos 54
Site Address: Not Given

Client Reference: B065374
Job Number: 19-43949
Date Sampled: 29/05/2019
Date Received: 31/05/2019
Date Tested: 06/06/2019
Sampled By: Not Given

Test Results:

Laboratory Reference: 1236323
Hole No.: BH402B
Sample Reference: Not Given
Sample Description: Brown gravelly CLAY

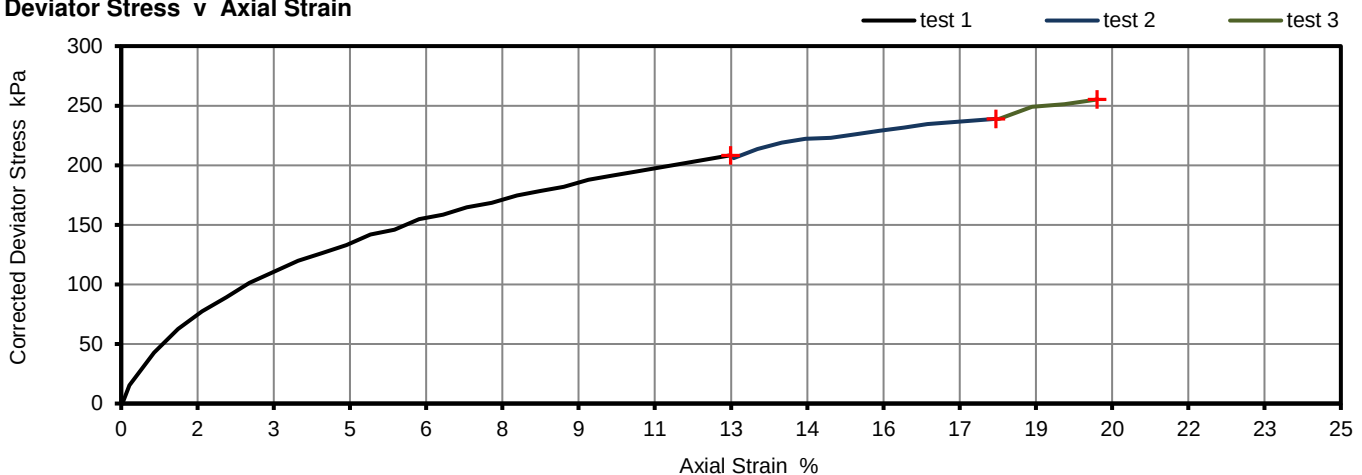
Depth Top [m]: 4.00
Depth Base [m]: 4.45
Sample Type: U

Length	135.10	mm
Diameter	70.80	mm
Bulk Density	2.12	Mg/m ³
Moisture Content	14	%
Dry Density	1.86	Mg/m ³
Membrane thickness	0.16	mm

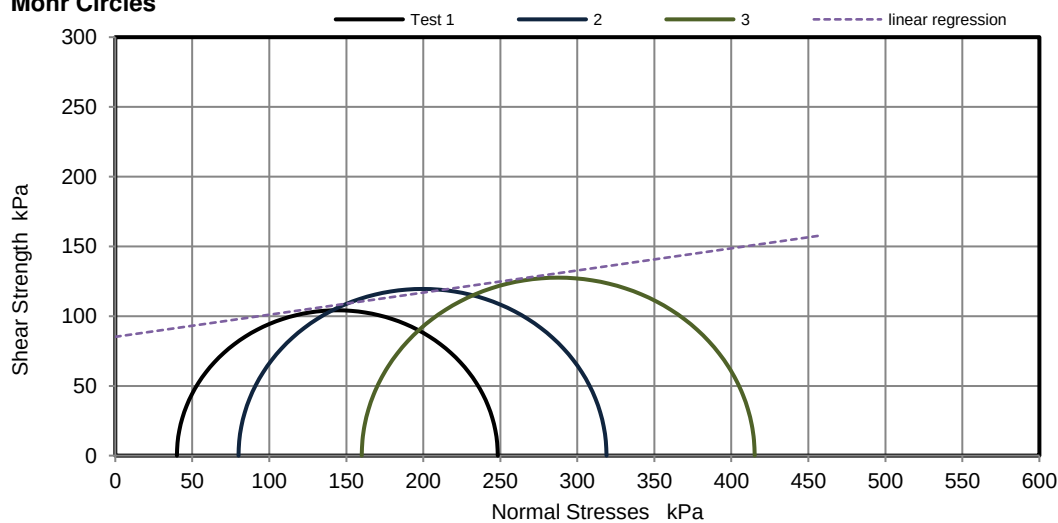
Rate of Strain
Stage Number
Cell Pressure
Axial Strain at failure
Deviator Stress, ($\sigma_1 - \sigma_3$) f
Shear strength, cu
Mode of failure
Membrane Correction

2.00			%/min
1	2	3	
40	80	160	kPa
12.5	17.9	20.0	%
208	239	255	kPa
104	119	128	kPa
Compound			
0.59	0.79	0.87	kPa

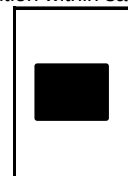
Deviator Stress v Axial Strain



Mohr Circles



Position within sample



Linear Regression
 ϕ_u 9.0 °
cu 85 kPa

Note: Mohr circles and their interpretation is not covered by BS1377. These are provided for information only.

Remarks: Correction values: 40kPa=20N, 80kPa=30N, 160kPa=80N.

Approved: Dariusz Piotrowski
PL Geotechnical Laboratory Manager
Date Reported: 14/06/2019

Signed: Darren Berrill
Geotechnical General Manager

for and on behalf of i2 Analytical Ltd GF 186.7

*Opinions and interpretations expressed herein are outside of the scope of the UKAS Accreditation.
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The results included within the report are representative of the samples submitted for analysis.
The analysis was carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland.*



Matthew Holroyd

Curtins
17-19 Whitworth Street West
Manchester
M1 5WG

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

t: 01923 225404

f: 01923 237404

e: reception@i2analytical.com

e: matthew.holroyd@curtins.com

Analytical Report Number : 19-43964

Project / Site name:	Chandos 54	Samples received on:	31/05/2019
Your job number:	B065374	Samples instructed on:	31/05/2019
Your order number:	EBMA1881	Analysis completed by:	12/06/2019
Report Issue Number:	1	Report issued on:	12/06/2019
Samples Analysed:	9 soil samples		

Signed: Karolina Marek

Karolina Marek
Technical Reviewer (Reporting Team)
For & on behalf of i2 Analytical Ltd.

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

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

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

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

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

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

Iss No 19-43964-1 Chandos 54 B065374

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The results included within the report are representative of the samples submitted for analysis.

Page 1 of 5



Analytical Report Number: 19-43964

Project / Site name: Chandos 54

Your Order No: EBMA1881

Lab Sample Number				1236395	1236396	1236397	1236398	1236399
Sample Reference				BH402B	BH403	BH403	WS403	WS404
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				6.50-7.50	7.00-7.50	8.00-9.00	3.60	5.00-5.40
Date Sampled				29/05/2019	30/05/2019	29/05/2019	29/05/2019	29/05/2019
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	7.4	9.4	7.9	10	9.4
Total mass of sample received	kg	0.001	NONE	1.8	0.68	0.76	0.23	0.53

General Inorganics

pH - Automated	pH Units	N/A	MCERTS	8.8	8.6	8.5	8.5	8.5
Water Soluble SO ₄ 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.019	0.021	0.017	0.053	0.057



Analytical Report Number: 19-43964

Project / Site name: Chandos 54

Your Order No: EBMA1881

Lab Sample Number				1236400	1236401	1236402	1236403	
Sample Reference				BH403	WS402	BH402B	BH402B	
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	
Depth (m)				3.00	2.80	5.00-5.40	12.50	
Date Sampled				29/05/2019	29/05/2019	29/05/2019	31/05/2019	
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	
Moisture Content	%	N/A	NONE	11	11	11	17	
Total mass of sample received	kg	0.001	NONE	0.14	0.66	0.25	0.52	

General Inorganics

pH - Automated	pH Units	N/A	MCERTS	8.4	8.6	8.6	9.0	
Water Soluble SO ₄ 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.042	0.13	0.068	0.010	



Analytical Report Number : 19-43964

Project / Site name: Chandos 54

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

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

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1236395	BH402B	None Supplied	6.50-7.50	Brown clay and sand.
1236396	BH403	None Supplied	7.00-7.50	Brown sand.
1236397	BH403	None Supplied	8.00-9.00	Brown sand.
1236398	WS403	None Supplied	3.60	Brown clay.
1236399	WS404	None Supplied	5.00-5.40	Brown clay.
1236400	BH403	None Supplied	3.00	Brown clay.
1236401	WS402	None Supplied	2.80	Brown clay.
1236402	BH402B	None Supplied	5.00-5.40	Brown clay.
1236403	BH402B	None Supplied	12.50	Brown sand.



Analytical Report Number : 19-43964

Project / Site name: Chandos 54

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

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 2, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests, 2:1 water:soil extraction, analysis by ICP-OES.	L038-PL	D	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.

For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.

Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.



LABORATORY REPORT



4043

Contract Number: PSL19/3693

Report Date: 25 June 2019
Client's Reference: RT/19/63456
Client Name: Geocore Site Investigations Ltd
Tralee Close
Kirkleatham Business Park
Redcar
Cleveland
TS10 5SG

For the attention of: Ed Lodge/Bev Grace

Contract Title: Echo Street, Manchester
Date Received: 19/6/2019
Date Commenced: 19/6/2019
Date Completed: 25/6/2019

Notes: Opinions and Interpretations are outside the UKAS Accreditation

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced other than in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

R Gunson
(Director)

A Watkins
(Director)

R Berriman
(Quality Manager)

L Knight
(Senior Technician)


S Eyre
(Senior Technician)

R Cowles
(Senior Technician)

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Page 1 of

DETERMINATION OF UNCONFINED COMPRESSIVE STRENGTH

ISRM Suggested Methods, pp 111 –116, 1981.

[illegible]

Echo Street, Manchester

Contract No:

PSL19/3693

Client Ref:

RT/19/63456

SUMMARY OF POINT LOAD TEST RESULTS

ISRM Suggested Methods : 2007

[illegible]

***Note** All testing carried out on samples at as received water content

Par = parallel, Perp = perpendicular, U = Random

A = Axial, D = Diametral, I = Irregular



Echo Street, Manchester

Contract No:

PSL19/3693

Client Ref:

RT/19/63456

SUMMARY OF POINT LOAD TEST RESULTS

ISRM Suggested Methods : 2007

[illegible]

***Note** All testing carried out on samples at as received water content

Par = parallel, Perp = perpendicular, U = Random



Echo Street, Manchester

Contract No:

PSL19/3693

Client Ref:

RT/19/63456

Appendix E Ground Gas and Groundwater Monitoring Results

- Visit 1 – 6.
- Groundwater level monitoring visits 1 & 2 (Stage 4)

Curtins Consulting

Merchant Exchange, 17-19 Whitworth Street West, Manchester, M1 5WG

Tel: 0161 236 2394

Fax: 0161 228 7902



GAS MONITORING LOG SHEET

Project:	Chandos Hall	Date:	26/01/2018
Job Number:	B065374.001	Visit:	1
Client:	IQ Student Accommodation	Weather:	Clear
Barometric State:	Rising	Ground Conditions:	Damp

Borehole Reference	Barometric Pressure mb	Flow l/hr		Methane %		Carbon Dioxide %		Oxygen %	Hydrogen Sulphide ppm	Carbon Monoxide ppm	Water Level m bgl	Borehole Base m bgl	Note
		Max	SS	Max	SS	Max	SS						
WS01	1016	0.0	0.0	0.0	0.0	0.9	0.9	18.7	0	0	3.00	3.00	
WS02A	1015	0.0	0.0	0.0	0.0	2.4	2.4	14.4	0	0	Dry	4.00	
WS03	1016	-1.0	0.0	0.0	0.0	0.4	0.4	11.2	0	0	Dry	3.00	
WS07	1015	-0.6	-0.6	0.0	0.0	0.4	0.5	19.7	0	10	1.21	2.60	
WS08	1014	0.0	0.0	0.0	0.0	0.8	0.8	18.4	0	36	1.81	2.50	
WS09	1014	0.0	0.0	0.0	0.0	0.0	0.0	20.4	0	1	0.40	3.40	
WS10	1014	0.0	0.0	0.0	0.0	0.6	0.6	19.8	0	1	1.10	1.40	
WS11	1015	-3.0	-2.1	0.0	0.0	0.5	0.5	17.5	0	3	Dry	2.13	
BH03	1014	0.0	0.0	0.0	0.0	0.0	0.0	15.6	40	750	Dry	10.40	

Notes

Logged by

ST

1% gas volume = 10,000 ppm**Flow rate, methane and carbon dioxide reported as 'maximum' (max) and 'steady state' (SS) readings.****All other gases recorded at 'steady state' unless otherwise stated**

Curtins Consulting

Merchant Exchange, 17-19 Whitworth Street West, Manchester, M1 5WG

Tel: 0161 236 2394

Fax: 0161 228 7902



GAS MONITORING LOG SHEET

Project:	Chandos Hall	Date:	07/02/2018
Job Number:	B065374.001	Visit:	2
Client:	IQ Student Accommodation	Weather:	Clear
Barometric State:	Falling	Ground Conditions:	Dry

Borehole Reference	Barometric Pressure mb	Flow l/hr		Methane %		Carbon Dioxide %		Oxygen %	Hydrogen Sulphide ppm	Carbon Monoxide ppm	Water Level m bgl	Borehole Base m bgl	Note
		Max	SS	Max	SS	Max	SS						
WS01	1013	0.1	0.0	0.0	0.0	0.0	0.0	20.10	0	3	3.00	3.00	
WS02A	1013	0.0	0.0	0.0	0.0	2.2	2.2	15.40	0	1	Dry	3.90	
WS03	1012	0.0	0.0	0.0	0.0	0.2	0.2	12.00	0	1	3.00	3.00	
WS07	1014	0.0	0.0	0.0	0.0	0.2	0.2	20.20	0	3	1.17	2.60	
WS08	1013	-0.2	0.0	0.0	0.0	0.8	0.8	18.80	0	1	1.85	3.50	
WS09	1013	0.0	0.0	0.0	0.0	0.2	0.2	19.2	0	1	0.60	3.40	
WS10	1013	0.0	0.0	0.0	0.0	0.9	0.9	19.5	0	0	1.17	1.50	
WS11	1014	0.0	0.0	0.0	0.0	0.6	0.6	15.2	0	1	2.15	2.15	
BH03	1012	0.1	0.1	0.0	0.0	1.0	1.0	15.8	0	6	Dry	10.30	

Notes

Logged by

ST

1% gas volume = 10,000 ppm**Flow rate, methane and carbon dioxide reported as 'maximum' (max) and 'steady state' (SS) readings.****All other gases recorded at 'steady state' unless otherwise stated**

Curtins Consulting

Merchant Exchange, 17-19 Whitworth Street West, Manchester, M1 5WG

Tel: 0161 236 2394

Fax: 0161 228 7902



GAS MONITORING LOG SHEET

Project:	Chandos Hall	Date:	16/02/2018
Job Number:	B065374.001	Visit:	3
Client:	IQ Student Accommodation	Weather:	Clear
Barometric State:	Falling	Ground Conditions:	Mostly dry

Borehole Reference	Barometric Pressure mb	Flow l/hr		Methane %		Carbon Dioxide %		Oxygen %	Hydrogen Sulphide ppm	Carbon Monoxide ppm	Water Level m bgl	Borehole Base m bgl	Note
		Max	SS	Max	SS	Max	SS						
WS01	1013	0.0	0.0	0.0	0.0	0.7	0.7	19.1	0	0	3.00	3.10	
WS02A	1013	0.0	0.0	0.0	0.0	2.3	2.3	15.2	0	0	Dry	3.90	
WS03	1013	0.0	0.0	0.0	0.0	0.1	0.1	11.7	0	0	2.33	3.00	
WS07	1013	0.0	0.0	0.0	0.0	0.4	0.5	19.0	0	3	1.10	2.60	
WS08	1013	0.0	0.0	0.0	0.0	0.7	0.7	19.7	0	5	1.83	3.50	
WS09	1016	0.0	0.0	0.0	0.0	0.1	0.1	20.6	0	1	0.43	3.40	
WS10	1014	0.0	0.0	0.0	0.0	0.5	0.5	20.2	0	5	1.00	1.40	
WS11	1013	0.0	0.0	0.0	0.0	0.0	0.0	19.0	0	0	Dry	2.15	
BH03	1013	0.0	0.0	0.0	0.0	1.7	1.7	16.0	0	5	Dry	10.30	

Notes

Logged by

ST

1% gas volume = 10,000 ppm**Flow rate, methane and carbon dioxide reported as 'maximum' (max) and 'steady state' (SS) readings.****All other gases recorded at 'steady state' unless otherwise stated**

Curtins Consulting

Merchant Exchange, 17-19 Whitworth Street West, Manchester, M1 5WG

Tel: 0161 236 2394

Fax: 0161 228 7902



GAS MONITORING LOG SHEET

Project:	Chandos Hall	Date:	05/03/2018
Job Number:	B065374.001	Visit:	4
Client:	IQ Student Accommodation	Weather:	Overcast
Barometric State:	Steady	Ground Conditions:	Damp

Borehole Reference	Barometric Pressure mb	Flow l/hr		Methane %		Carbon Dioxide %		Oxygen %	Hydrogen Sulphide ppm	Carbon Monoxide ppm	Water Level m bgl	Borehole Base m bgl	Note
		Max	SS	Max	SS	Max	SS						
WS01	980	0.0	0.0	0.0	0.0	0.6	0.6	19.8	0	0	2.97	3.00	
WS02A	980	0.0	0.0	0.0	0.0	2.3	2.3	14.9	0	0	Dry	3.90	
WS03	980	0.0	0.0	0.0	0.0	0.2	0.2	14.4	0	3	3.00	3.00	
WS07	980	0.1	0.1	0.0	0.0	0.2	0.2	20.1	0	1	1.16	2.50	
WS08	981	0.0	0.0	0.0	0.0	0.5	0.5	20.2	0	0	1.85	2.50	
WS09	982	0.0	0.0	0.0	0.0	0.2	0.1	20.2	0	1	0.50	3.40	
WS10	981	0.0	0.0	0.0	0.0	0.6	0.6	20.1	0	1	1.22	1.40	
WS11	980	6.4	0.0	0.0	0.0	0.7	0.7	10.6	0	0	2.01	2.15	1
BH03	981	0.0	0.0	0.0	0.0	0.6	0.5	19.4	0	0	Dry	10.40	

Notes

1 - Steady state flow rate achieved after 1 minute and 30 seconds.

Logged by

ST

1% gas volume = 10,000 ppm**Flow rate, methane and carbon dioxide reported as 'maximum' (max) and 'steady state' (SS) readings.****All other gases recorded at 'steady state' unless otherwise stated**

Curtins Consulting

Merchant Exchange, 17-19 Whitworth Street West, Manchester, M1 5WG

Tel: 0161 236 2394

Fax: 0161 228 7902



GAS MONITORING LOG SHEET

Project:	Chandos Hall	Date:	14/03/2018
Job Number:	B065374.001	Visit:	5
Client:	IQ Student Accommodation	Weather:	Overcast
Barometric State:	Falling	Ground Conditions:	Damp

Borehole Reference	Barometric Pressure mb	Flow l/hr		Methane %		Carbon Dioxide %		Oxygen %	Hydrogen Sulphide ppm	Carbon Monoxide ppm	Water Level m bgl	Borehole Base m bgl	Note
		Max	SS	Max	SS	Max	SS						
WS01	990	0.0	0.0	0.0	0.0	0.7	0.7	19.2	0	0	2.95	5.00	
WS02A	990	0.0	0.0	0.0	0.0	2.0	2.0	16.1	0	1	Dry	3.90	
WS03	990	0.0	0.0	0.0	0.0	0.7	0.7	12.8	0	3	2.12	3.00	
WS07	990	0.0	0.0	0.0	0.0	0.2	0.2	20.1	0	3	2.00	2.20	
WS08	991	0.0	0.0	0.0	0.0	0.5	0.4	20.0	0	0	1.81	2.50	
WS09	991	0.0	0.0	0.0	0.0	0.0	0.0	16.1	0	1	0.40	3.40	
WS10	991	0.0	0.0	0.0	0.0	0.4	0.4	19.9	0	3	1.10	1.40	
WS11	990	0.0	0.0	0.0	0.0	0.8	0.7	10.6	0	0	2.00	2.20	
BH03	992	0.0	0.0	0.0	0.0	0.5	0.5	19.6	0	0	Dry	10.40	

Notes

Logged by

ST

1% gas volume = 10,000 ppm**Flow rate, methane and carbon dioxide reported as 'maximum' (max) and 'steady state' (SS) readings.****All other gases recorded at 'steady state' unless otherwise stated**

Curtins Consulting

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GAS MONITORING LOG SHEET

Project:	Chandos Hall	Date:	03/04/2018
Job Number:	B065374.001	Visit:	6
Client:	IQ Student Accommodation	Weather:	Light cloud
Barometric State:	Steady	Ground Conditions:	Dry

Borehole Reference	Barometric Pressure mb	Flow l/hr		Methane %		Carbon Dioxide %		Oxygen %	Hydrogen Sulphide ppm	Carbon Monoxide ppm	Water Level m bgl	Borehole Base m bgl	Note
		Max	SS	Max	SS	Max	SS						
WS01	983	0.0	0.0	0.0	0.0	0.0	0.0	20.9	3	1	2.92	3.04	1
WS02A	984	0.0	0.0	0.0	0.0	0.0	0.0	20.9	3	1	Dry	3.90	
WS03	984	0.1	0.0	0.0	0.0	0.0	0.0	20.9	3	1	2.83	2.96	
WS07	-	-	-	-	-	-	-	-	-	-	-	-	
WS08	983	0.0	0.0	0.0	0.0	0.0	0.0	21.1	3	1	1.74	2.50	
WS09	983	0.0	0.0	0.0	0.0	0.0	0.0	20.8	4	1	0.45	3.40	
WS10	982	0.0	0.0	0.0	0.0	0.0	0.0	20.8	3	0	1.10	1.45	
WS11	983	0.0	0.0	0.0	0.0	0.0	0.0	20.8	4	0	1.85	2.15	
BH03	983	0.0	0.0	0.0	0.0	0.0	0.0	20.7	4	0	Dry	10.40	

Notes

1 - Monitoring well could not be accessed.

Logged by

MH

1% gas volume = 10,000 ppm**Flow rate, methane and carbon dioxide reported as 'maximum' (max) and 'steady state' (SS) readings.****All other gases recorded at 'steady state' unless otherwise stated**

Curtins Consulting

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**GROUNDWATER LEVEL MONITORING LOG SHEET****Project:** Chandos Hall**Date:** 21/06/2019**Job Number:** B065374.001**Visit:** 1A**Client:** Chandos Hall**Weather:** Sunny**Barometric State:** Steady**Ground Conditions:** Dry

Borehole Reference	Water Level m bgl	Borehole Base m bgl	Note
BH401	7.42	9.95	
BH402	12.58	18.09	
BH403	12.77	20.24	

Notes**Logged by**

ZH

Curtins Consulting

Merchant Exchange, 17-19 Whitworth Street West, Manchester, M1 5WG

Tel: 0161 236 2394

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**GROUNDWATER LEVEL MONITORING LOG SHEET****Project:** Chandos Hall**Date:** 26/06/2019**Job Number:** B065374.001**Visit:** 2A**Client:** Chandos Hall**Weather:** Sunny**Barometric State:** Steady**Ground Conditions:** Dry

Borehole Reference	Water Level m bgl	Borehole Base m bgl	Note
BH401	7.40	9.80	
BH402	12.55	18.01	
BH403	12.59	20.05	

Notes**Logged by**

PN

Appendix F GAC Screening Thresholds

- Curtins, Soil GAC Thresholds for 6.0%, 2.5% and 1.0% SOM.
- Curtins, Water Tier 1 Thresholds

Adopted Soil Generic Assessment Criteria
Sandy loam with 6% SOM



Contaminants	Residential <u>with</u> home grown produce	Residential <u>without</u> home grown produce	Allotments	Commercial	Public open space near residential housing POS _{resi}	Public park POS _{park}
Metals						
Beryllium	1.7	1.7	35	12	2.2	63
Boron	290	11,000	45	240,000	21,000	46,000
Cadmium	10 ⁽¹³⁾ <u>22</u>	85 ⁽¹³⁾ <u>150</u>	1.8 <u>3.9</u>	230 <u>410</u>	120 <u>220</u>	560 <u>880</u>
Chromium III	910	910	18,000	8,600	1,500	33,000
Chromium VI	6 <u>21</u>	6 <u>21</u>	1.8 <u>170</u>	33 <u>49</u>	7.7 <u>21</u>	220 <u>250</u>
Lead	<u>200</u>	<u>310</u>	<u>80</u>	<u>2,300</u>	<u>630</u>	<u>1,300</u>
Mercury (<i>elemental</i>)	1	1	26	26	16	26 ⁽⁸⁾ [30]
Mercury (<i>inorganic</i>)	170	240	80	3600	120	240
Nickel	130 ⁽¹⁰⁾	180 ⁽¹⁰⁾	53 ⁽¹¹⁾	980 ⁽¹⁰⁾	230	800
Vanadium	410	1200	91	9000	2000	5000
Copper	2400	7100	520	68000	12000	44000
Zinc	3700	40000	620	730000	81000	170000
Semi-Metals and non-metals						
Arsenic	32 ⁽¹²⁾ <u>37</u>	35 ⁽¹²⁾ <u>40</u>	43 ⁽¹²⁾ <u>49</u>	640 ⁽¹²⁾ <u>640</u>	79 <u>79</u>	170 <u>170</u>
Antimony		550		7500	1500	3300
Selenium	350	600	120	13000	1100	1800
Inorganic chemicals						
Cyanide	34	34	34	34	34	34
Organic contaminants						
Aliphatic risk banded hydrocarbons - TPHCWG method						
EC ₅₋₅ - EC ₆	160	160	3900	12000	600000	180000
EC ₅₋₆ - EC ₈	530	530	13000	40000	620000	320000
EC ₅₋₈ - EC ₁₀	150	150	1700	11000	13000	21000
EC ₁₀₋₁₀ - EC ₁₂	760	770	7300	47000	13000	24000
EC ₁₂₋₁₂ - EC ₁₆	4300	4400	13000	90000	13000	26000
EC ₅₋₁₆ - EC ₃₅	110000	110000	270000	1800000	250000	490000
EC ₃₅₋₃₅ - EC ₄₄	110000	110000	270000	1800000	250000	490000
Aromatic risk banded hydrocarbons - TPHCWG method						
EC ₅₋₅ - EC ₇	300	1400	57	86000	56000	92000
EC ₅₋₇ - EC ₈	660	3900	120	180000	56000	100000
EC ₅₋₈ - EC ₁₀	190	270	51	17000	5000	9300
EC ₁₀₋₁₀ - EC ₁₂	380	1200	74	34000	5000	10000
EC ₁₂₋₁₂ - EC ₁₆	660	2500	130	38000	5000	10000
EC ₅₋₁₆ - EC ₂₁	930	1900	260	28000	3800	7800
EC ₂₁₋₂₁ - EC ₃₅	1700	1900	1600	28000	3800	7900
EC ₃₅₋₃₅ - EC ₄₄	1700	1900	1600	28000	3800	7900
Aliph + Arom EC >44-70	1900	1900	3000	28000	3800	7900
Aromatic						
Benzene	0.33 <u>0.87</u>	1.0 <u>3.3</u>	0.07 <u>0.18</u>	95 <u>98</u>	73 <u>140</u>	110 <u>230</u>
Ethyl benzene	350	840	90	2800 ⁽⁸⁾ [66000]	2800 ⁽⁸⁾ [25000]	2800 ⁽⁸⁾ [27000]
Toluene	610	2700	120	4400 ⁽⁸⁾ [190000]	4400 ⁽⁸⁾ [56000]	4400 ⁽⁸⁾ [100000]
Xylene ⁽⁹⁾	230	290	160	2600 ⁽⁸⁾ [32000]	2600 ⁽⁸⁾ [43000]	2600 ⁽⁸⁾ [31000]
Phenol	420	520	280	3200 ⁽¹⁴⁾ (38000)	3200 ⁽¹⁴⁾ (10000)	3200 ⁽¹⁴⁾ (9300)
Polycyclic Aromatic Hydrocarbons (PAH)						
Naphthalene	13	13	24	1100	4900	3000
Acenaphthylene	920	6000	160	100000	15000	30000
Acenaphthene	1100	6000	200	100000	15000	30000
Fluorene	860	4500	160	71000	9900	20000
Phenanthrene	440	1500	90	23000	3100	6300
Anthracene	11000	37000	2200	540000	74000	150000
Fluoranthene	890	1600	290	23000	3100	6400
Pyrene	2000	3800	620	54000	7400	15000
Benz(a)anthracene	13	15	13	180	29	62
Chrysene	27	32	19	350	57	120
Benzo(b)fluoranthene	3.7	4.0	3.9	45	7.2	16.0
Benzo(k)fluoranthene	100	110	130	1200	190	440
Benzo(a)pyrene	3.0 <u>5.0</u>	3.2 <u>5.3</u>	3.5 <u>5.7</u>	36 <u>77</u>	5.7 <u>10</u>	13 <u>21</u>
Indeno(123cd)pyrene	41	46	39	510	82	180
Dibenzo(ah)anthracene	0.3	0.32	0.43	3.6	0.58	1.4
Benzo(ghi)perylene	350	360	640	4000	640	1600
Chlorinated Aliphatic Hydrocarbons						
Vinyl chloride	0.0014	0.0015	0.0018	0.12	3.5	5.4
Trichloroethene (TCE)	0.075	0.08	0.21	5.7	120	120
1,1,1,2 Tetrachlorethane	6.4	8.2	4.4	560	1400	2100
Tetrachlorethane (PCE)	0.90	0.92	3.6	95	1400	1500
1,1,1 Trichlorethane	39	40	240	3000	140000	100000

Notes

- All values above are in mg/kg
- Numbers in bold are SGVs or GAC that are derived based on SGV report input parameters, numbers in italics are SAULs, numbers in bold-italics are based on EIC/AGS/CL:AIRE numbers & input parameters and underlined numbers are C4SLs
- Soil organic matter (SOM) is assumed to be 6% - DEFAULT VALUE
- Soil type is assumed to be sandy loam - DEFAULT SOIL TYPE
- For residential, the building type is conservatively assumed to be a small terrace house where the development includes bungalows change to more conservative bungalow setting in computer model
- For commercial, the building type is conservatively assumed to be a pre 1970s office building, where the proposed development comprises houses, flat with living spaces changes setting in model accordingly
- For classrooms consider increasing the dust loading factor in the 'Soil and Building Data' of the CLEA 1.04 model from 50 to 100µg m⁻³
- Based on vapour saturation limit as suggested by EA / [] model value
- Lowest of o-, m- and p-xylene
- Based on comparison of inhalation exposure with inhalation TDI
- Based on comparison of oral, dermal, and inhalation exposure with the oral TDI
- Based on a comparison of oral and dermal soil exposure with oral Index Dose only
- Averaged over and based on lifetime exposure
- Based on critical concentration for skin irritation in humans arising from contact with phenol in aqueous solution (number in brackets based on health effects following long term exposure for illustration)
- NA: Not applicable

Adopted Soil Generic Assessment Criteria
Sandy loam with 2.5% SOM



Contaminants	Residential <u>with</u> home grown produce	Residential <u>without</u> home grown produce	Allotments	Commercial	Public open space near residential housing POS _{resi}	Public park POS _{park}
Metals						
Beryllium	1.7	1.7	35	12	2.2	63
Boron	290	11,000	45	240,000	21,000	46,000
Cadmium	10⁽¹³⁾ 22	85⁽¹³⁾ 150	1.8 3.9	230 410	120 220	560 880
Chromium III	910	910	18,000	8,600	1,500	33,000
Chromium VI	6 21	6 21	1.8 170	33 49	7.7 21	220 250
Lead	200	310	80	2,300	630	1,300
Mercury (<i>elemental</i>)	1	1	26	26	16	26⁽⁸⁾ [30]
Mercury (<i>inorganic</i>)	170	240	80	3600	120	240
Nickel	130⁽¹⁰⁾	180⁽¹⁰⁾	53⁽¹¹⁾	980⁽¹⁰⁾	230	800
Vanadium	410	1200	91	9000	2000	5000
Copper	2400	7100	520	68000	12000	44000
Zinc	3700	40000	620	730000	81000	170000
Semi-Metals and non-metals						
Arsenic	32⁽¹²⁾ 37	35⁽¹²⁾ 40	43⁽¹²⁾ 49	640⁽¹²⁾ 640	79 79	170 170
Antimony		550		7500	1500	3300
Selenium	350	600	120	13000	1100	1800
Inorganic chemicals						
Cyanide	34	34	34	34	34	34
Organic contaminants						
Aliphatic risk banded hydrocarbons - TPHCWG method						
EC ₅ - EC ₆	78	78	1700	5900	590000	130000
EC ₆ - EC ₈	230	230	5600	17000	610000	220000
EC ₈ - EC ₁₀	65	65	770	4800	13000	18000
EC ₁₀ - EC ₁₂	330	330	4400	23000	13000	23000
EC ₁₂ - EC ₁₆	2400	2400	13000	82000	13000	25000
EC ₁₆ - EC ₃₅	92000	92000	270000	1700000	250000	480000
EC ₃₅ - EC ₄₄	92000	92000	270000	1700000	250000	480000
Aromatic risk banded hydrocarbons - TPHCWG method						
EC ₅ - EC ₇	140	690	27	46000	56000	84000
EC ₇ - EC ₈	290	1800	51	110000	56000	95000
EC ₈ - EC ₁₀	83	110	21	8100	5000	8500
EC ₁₀ - EC ₁₂	180	590	31	28000	5000	9700
EC ₁₂ - EC ₁₆	330	2300	57	37000	5100	10000
EC ₁₆ - EC ₂₁	540	1900	110	28000	3800	7700
EC ₂₁ - EC ₃₅	1500	1900	820	28000	3800	7800
EC ₃₅ - EC ₄₄	1500	1900	820	28000	3800	7800
Aliph + Arom EC >44-70	1800	1900	2100	28000	3800	7800
Aromatic						
Benzene	0.16	0.49	0.035	50	72	100
Ethyl benzene	150	380	39	1200⁽⁸⁾ [35000]	1200⁽⁸⁾ [24000]	1200⁽⁸⁾ [22000]
Toluene	270	1300	51	1900⁽⁸⁾ [110000]	1900⁽⁸⁾ [56000]	1900⁽⁸⁾ [95000]
Xylene ⁽⁹⁾	98	120	70	1200⁽⁸⁾ [14000]	1200⁽⁸⁾ [42000]	1200⁽⁸⁾ [23000]
Phenol	290	420	140	1500⁽¹⁴⁾ (35000)	1500⁽¹⁴⁾ (10000)	1500⁽¹⁴⁾ (8300)
Polycyclic Aromatic Hydrocarbons (PAH)						
Naphthalene	5.6	5.6	10	460	4900	1900
Acenaphthylene	420	4600	69	97000	15000	30000
Acenaphthene	510	4700	85	97000	15000	30000
Fluorene	400	3800	67	68000	9900	20000
Phenanthrene	220	1500	38	22000	3100	6200
Anthracene	5400	35000	950	540000	74000	150000
Fluoranthene	560	1600	130	23000	3100	6300
Pyrene	1200	3800	270	54000	7400	15000
Benz(a)anthracene	11	14	6.5	170	29	56
Chrysene	22	31	9.4	350	57	110
Benzo(b)fluoranthene	3.3	4.0	2.1	44	7.2	15
Benzo(k)fluoranthene	93	110	75	1200	190	410
Benzo(a)pyrene	2.7	3.2	2	35	5.7	12
Indeno(123cd)pyrene	36	46	21	510	82	170
Dibenzo(ah)anthracene	0.28	0.32	0.27	3.6	0.57	1.3
Benzo(ghi)perylene	340	360	470	4000	640	1500
Chlorinated Aliphatic Hydrocarbons						
Vinyl chloride	0.00087	0.001	0.001	0.077	3.5	5
Trichloroethene (TCE)	0.034	0.036	0.091	2.6	120	91
1,1,1,2 Tetrachlorethane	2.8	3.5	1.9	250	1400	1800
Tetrachlorethane (PCE)	0.39	0.4	1.5	42	1400	1100
1,1,1 Trichlorethane	18	18	110	1300	140000	76000

Notes

- All values above are in mg/kg
- Numbers in bold are SGVs or GAC that are derived based on SGV report input parameters, numbers in *italics* are S4ULs, numbers in *bold-italics* are based on EIC/AGS/CL:AIRE numbers & input parameters and underlined numbers are C4SLs
- Soil organic matter (SOM) is assumed to be 2.5% - DEFAULT VALUE
- Soil type is assumed to be sandy loam - DEFAULT SOIL TYPE
- For residential, the building type is conservatively assumed to be a small terrace house where the development includes bungalows change to more conservative bungalow setting in computer model
- For commercial, the building type is conservatively assumed to be a pre 1970s office building, where the proposed development comprises houses, flat with living spaces changes setting in model accordingly
- For classrooms consider increasing the dust loading factor in the 'Soil and Building Data' of the CLEA 1.04 model from 50 to 100µg m⁻³
- Based on vapour saturation limit as suggested by EA / [] model value
- Lowest of o-, m- and p-xylene
- Based on comparison of inhalation exposure with inhalation TDI
- Based on comparison of oral, dermal, and inhalation exposure with the oral TDI
- Based on a comparison of oral and dermal soil exposure with oral Index Dose only
- Averaged over and based on lifetime exposure
- Based on critical concentration for skin irritation in humans arising from contact with phenol in aqueous solution (number in brackets based on health effects following long term exposure for illustration)
- NA: Not applicable

Adopted Soil Generic Assessment Criteria
Sandy loam with 1% SOM



Contaminants	Residential <u>with</u> home grown produce	Residential <u>without</u> home grown produce	Allotments	Commercial	Public open space near residential housing POS _{resi}	Public park POS _{park}
Metals						
Beryllium	1.7	1.7	35	12	2.2	63
Boron	290	11,000	45	240,000	21,000	46,000
Cadmium	10⁽¹³⁾ 22	85⁽¹³⁾ 150	1.8 3.9	230 410	120 220	560 880
Chromium III	910	910	18,000	8,600	1,500	33,000
Chromium VI	6 21	6 21	1.8 170	33 49	7.7 21	220 250
Lead	200	310	80	2,300	630	1,300
Mercury (<i>elemental</i>)	1	1	26	26	16	26⁽⁸⁾ [30]
Mercury (<i>inorganic</i>)	170	240	80	3600	120	240
Nickel	130⁽¹⁰⁾	180⁽¹⁰⁾	53⁽¹¹⁾	980⁽¹⁰⁾	230	800
Vanadium	410	1200	91	9000	2000	5000
Copper	2400	7100	520	68000	12000	44000
Zinc	3700	40000	620	730000	81000	170000
Semi-Metals and non-metals						
Arsenic	32⁽¹²⁾ 37	35⁽¹²⁾ 40	43⁽¹²⁾ 49	640⁽¹²⁾ 640	79 79	170 170
Antimony		550		7500	1500	3300
Selenium	350	600	120	13000	1100	1800
Inorganic chemicals						
Cyanide	34	34	34	34	34	34
Organic contaminants						
Aliphatic risk banded hydrocarbons - TPHCWG method						
EC _{>5} - EC ₆	42	42	730	3200	570000	95000
EC _{>6} - EC ₈	100	100	2300	7800	600000	150000
EC _{>8} - EC ₁₀	27	27	320	2000	13000	14000
EC ₁₀ - EC ₁₂	130	130	2200	9700	13000	21000
EC ₁₂ - EC ₁₆	1100	1100	11000	59000	13000	25000
EC _{>16} - EC ₃₅	65000	65000	260000	1600000	250000	450000
EC _{>35} - EC ₄₄	65000	65000	260000	1600000	250000	450000
Aromatic risk banded hydrocarbons - TPHCWG method						
EC _{>5} - EC ₇	70	370	13	26000	56000	76000
EC _{>7} - EC ₈	130	860	22	56000	56000	87000
EC _{>8} - EC ₁₀	34	47	8.6	3500	5000	7200
EC ₁₀ - EC ₁₂	74	250	13	16000	5000	9200
EC ₁₂ - EC ₁₆	140	1800	23	36000	5100	10000
EC _{>16} - EC ₂₁	260	1900	46	28000	3800	7600
EC _{>21} - EC ₃₅	1100	1900	370	28000	3800	7800
EC _{>35} - EC ₄₄	1100	1900	370	28000	3800	7800
Aliph + Arom EC >44-70	1600	1900	1200	28000	3800	7800
Aromatic						
Benzene	0.08	0.3	0.017	28	72	90
Ethyl benzene	65	170	16	520⁽⁸⁾ [17000]	520⁽⁸⁾ [24000]	520⁽⁸⁾ [17000]
Toluene	120	610	22	860⁽⁸⁾ [59000]	860⁽⁸⁾ [56000]	860⁽⁸⁾ [87000]
Xylene ⁽⁹⁾	41	53	28	480⁽⁸⁾ [69000]	480⁽⁸⁾ [41000]	480⁽⁸⁾ [17000]
Phenol	180	310	66	760⁽¹⁴⁾ (31000)	760⁽¹⁴⁾ (10000)	760⁽¹⁴⁾ (7600)
Polycyclic Aromatic Hydrocarbons (PAH)						
Naphthalene	2.3	2.3	4.1	190	4900	1200
Acenaphthylene	170	2900	28	83000	15000	29000
Acenaphthene	210	3000	34	84000	15000	29000
Fluorene	170	2800	27	63000	9900	20000
Phenanthrene	95	1300	15	22000	3100	6200
Anthracene	2400	31000	380	520000	74000	150000
Fluoranthene	280	1500	52	23000	3100	6300
Pyrene	620	3700	110	54000	7400	15000
Benz(a)anthracene	7.2	11	2.9	170	29	49
Chrysene	15	30	4.1	350	57	93
Benzo(b)fluoranthene	2.6	3.9	0.99	44	7.1	13
Benzo(k)fluoranthene	77	110	37	1200	190	370
Benzo(a)pyrene	2.2	3.2	0.97	35	5.7	11
Indeno(123cd)pyrene	27	45	9.5	500	82	150
Dibenzo(ah)anthracene	0.24	0.31	0.14	3.5	0.57	1.1
Benzo(ghi)perylene	320	360	290	3900	640	1400
Chlorinated Aliphatic Hydrocarbons						
Vinyl chloride	0.00064	0.00077	0.00055	0.059	3.5	4.8
Trichloroethene (TCE)	0.016	0.017	0.041	1.2	120	70
1,1,1,2 Tetrachlorethane	1.2	1.5	0.79	110	1400	1500
Tetrachlorethane (PCE)	0.18	0.18	0.65	19	1400	810
1,1,1 Trichlorethane	8.8	9	48	660	140000	57000

Notes

- All values above are in mg/kg
- Numbers in bold are SGVs or GAC that are derived based on SGV report input parameters, numbers in italics are SAULs, numbers in bold-italics are based on EIC/AGS/CL:AIRE numbers & input parameters and underlined numbers are C4SLs
- Soil organic matter (SOM) is assumed to be 1% - DEFAULT VALUE
- Soil type is assumed to be sandy loam - DEFAULT SOIL TYPE
- For residential, the building type is conservatively assumed to be a small terrace house where the development includes bungalows change to more conservative bungalow setting in computer model
- For commercial, the building type is conservatively assumed to be a pre 1970s office building, where the proposed development comprises houses, flat with living spaces changes setting in model accordingly
- For classrooms consider increasing the dust loading factor in the 'Soil and Building Data' of the CLEA 1.04 model from 50 to 100µg m⁻³
- Based on vapour saturation limit as suggested by EA / [] model value
- Lowest of o-, m- and p-xylene
- Based on comparison of inhalation exposure with inhalation TDI
- Based on comparison of oral, dermal, and inhalation exposure with the oral TDI
- Based on a comparison of oral and dermal soil exposure with oral Index Dose only
- Averaged over and based on lifetime exposure
- Based on critical concentration for skin irritation in humans arising from contact with phenol in aqueous solution (number in brackets based on health effects following long term exposure for illustration)
- NA: Not applicable

Tier 1 Thresholds

Water Contaminants: Initial Assessment of Risk



Introduction

The Generic Assessment Criteria (GAC) employed as Tier 1 Controlled Water Screening criteria are given in Tables 1 and 2. The more conservative available Drinking Water Standards (DWS) and Environmental Quality Standards (EQS) (Freshwater and Saltwater), applicable in England and Wales have been included in the tables.

The list of determinands is non-industry specific and it should be recognised that additional site specific determinands may need to be taken into account. The applicability of these criteria, with regard to the developed Conceptual Site Model, is discussed within the relevant section of the preceding report. Further details on individual GAC can be obtained in the referenced source legislation.

Generic Assessment Criteria

Table 1 – Inorganic Contaminant Controlled Waters Generic Assessment Criteria

Contaminant	Units	Hardness Banding (mg/l CaCO ₃)	EQS (Freshwater)	EQS (Saltwater)	EU DWS	WHO
Arsenic	µg/l	-	50	25	10	10
Boron	µg/l	-	2000	7000	1000	0.3
Cadmium	µg/l	<40	0.08	0.2	5	3
		40- <50	0.08			
		50- <100	0.09			
		100- <200	0.15			
		>200	0.25			
Chromium III	µg/l	-	4.7	-	50	50
Chromium VI	µg/l	-	3.4	0.6		
Copper	µg/l	-	1 bioavailable ⁱ	3.76 Where DOC ⁱⁱ ≤ 1mg	2000	2000
				3.76 + (2.677 x ((DOC/2)- 0.5)) Where DOC ⁱⁱ >1mg/l		
Cyanide (Free)	µg/l	-	1	1		
Cyanide (Total)	µg/l	-	1	1	50	70
Iron	µg/l	-	1000	1000	200	300
Lead	µg/l		1.2	1.3	10	10
Mercury	µg/l	-	0.07 ⁱⁱⁱ	0.07 ⁱⁱⁱ	1	1
Nickel	µg/l	-	4 bioavailable ⁱ	8.6	20	70

Tier 1 Thresholds

Water Contaminants: Initial Assessment of Risk



Contaminant	Units	Hardness Banding (mg/l CaCO ₃)	EQS (Freshwater)	EQS (Saltwater)	EU DWS	WHO
Selenium	µg/l	-	-	-	10	10
Sulphate	mg/l	-	400	-	250	-
Sulphide	µg/l	-	0.25	-	-	-
Zinc	µg/l	-	10.9 bioavailable ⁱⁱ + ABC ^v	6.8 dissolved ^{iv} + ABC	5000	3000

i - fraction likely to have toxic effect as determined using the UKTAG Metal Bioavailability Assessment Tool

ii - concentration of dissolved organic carbon in mg/l of the receiving water (as identified in the Conceptual Site Model)

iii - in absence on Annual Average the Maximum Allowable Concentration Used

iv - total dissolved as reported

v - Average Background Concentration (ABC) as listed in Part 2 Table 2 in Ref. 1.

Table 2 – Organic Contaminant Controlled Waters Generic Assessment Criteria

Contaminant	Units	EQS (Freshwater)	EQS (Saltwater)	EU DWS	WHO
Organics					
Phenol (total)	µg/l	7.7	7.7	0.5	-
MTBE	µg/l	-	-	-	15
Total Petroleum Hydrocarbons (TPH)					
Aliphatic C5-C6	µg/l	-	-	-	15000
Aliphatic C6-C8	µg/l	-	-	-	15000
Aliphatic C8-C10	µg/l	-	-	-	300
Aliphatic C10-C12	µg/l	-	-	-	300
Aliphatic C12-C16	µg/l	-	-	-	300
Aliphatic C16-C21	µg/l	-	-	-	300
Aliphatic C21-C35	µg/l	-	-	-	300
Aromatic C6-C7 (benzene)	µg/l	10	8	1	10
Aromatic C7-C8 (toluene)	µg/l	74	74	-	700
Aromatic C8-C10 (ethylbenzene)	µg/l	20	20	-	300
Aromatic C10-C12	µg/l	-	-	-	100
Aromatic C12-C16	µg/l	-	-	-	100
Aromatic C16-C21	µg/l	-	-	-	90
Aromatic C21-C35	µg/l	-	-	-	90
Total Hydrocarbons (Dissolved / Emulsion)	µg/l	-	-	10 (revoked)	300

Tier 1 Thresholds

Water Contaminants: Initial Assessment of Risk



Contaminant	Units	EQS (Freshwater)	EQS (Saltwater)	EU DWS	WHO
BTEX Compounds					
Benzene	µg/l	10	8	1	10
Toluene	µg/l	74	74	-	700
Ethyl-benzene	µg/l	20	20	-	300
Xylene (o+p+m)	µg/l	30	30	-	-
Polycyclic Aromatic Hydrocarbons (PAH)					
Anthracene	µg/l	0.1	0.1	-	-
Benzo(a)pyrene	µg/l	0.00017	0.00017	0.01	0.01
Napthalene	µg/l	2	2	-	-
PAHs Sum of four- benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, indeno(1,2,3- c,d)pyrene	µg/l	-	-	0.1	-

References

- 1 The Water Framework Directive, (Standards and Classification) Directions (England and Wales) [2015]
- 2 Council Directive 76/464/EEC, Council Directive on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community (Dangerous Substances Directive) [1976]
- 3 Council Directive 98/83/EC on the quality of water intended for human consumption [1998]
- 4 World Health Organisation (WHO), Guidelines for Drinking Water Quality. Third edition [2004]

Appendix G Risk Assessment Methodology

The site-specific risk assessment, presented in this report, follows the principle of establishing whether there is a viable linkage between a contaminant source to a potential receptor, via an exposure pathway.

The risk assessment corresponds with the total site area and incorporates both descriptive (qualitative) and, where available, numerical (quantitative) lines of evidence.

Risk assessment is the process of collating known information on a hazard or set of hazards to estimate actual or potential risk to receptors. The receptor may be humans, a water resource, a sensitive local ecosystem or future construction materials. Receptors can be connected to the source by one or several exposure pathways such as direct contact for example. Risks are generally managed by isolating the receptor or intercepting the exposure pathway or by isolating or removing the hazard.

Without the three essential components of a source, pathway and receptor there can be no risk. Therefore, the presence of contaminant source on a site does not necessarily mean there is a risk.

The risk assessment considers the likelihood of an event taking place (accounting for the presence of the source and receptor and the viability of the exposure pathway) in conjunction with the severity of the potential consequence (accounting for the potential severity of the hazard and the sensitivity of the receptor).

In the risk assessment, the consequence of the hazard has been classified as severe or medium or mild or minor and the probability (likelihood) of the circumstances occurring classified as high likelihood or likely or low likelihood or unlikely.

The consequences and probabilities are subsequently cross-correlated to give a qualitative estimation of the risk using Department of the Environment risk classifications as detailed in the table below and as referenced in CIRIA C552.

		Consequence			
		Severe	Medium	Mild	Minor
Probability (Likelihood)	High Likelihood	Very High Risk	High Risk	Moderate Risk	Moderate/Low Risk
	Likely	High Risk	Moderate Risk	Moderate/Low Risk	Low Risk
	Low Likelihood	Moderate Risk	Moderate/Low Risk	Low Risk	Very Low Risk
	Unlikely	Moderate/Low Risk	Low Risk	Very Low Risk	Very Low Risk

Phase 2 Site Investigation

In accordance with DoE guidance, the following categorisation of **consequence** has been developed.

Classification	Definition	Examples
Severe	Short-term (acute) risk to human health likely to result in "significant harm" as defined by the Environment Protection Act 1990, Part IIA. Short-term risk of pollution of sensitive water resource. Catastrophic damage to buildings/property. A short-term risk to an ecosystem or organisation forming part of such ecosystem.	High concentrations of cyanide on the surface of an informal recreation area. Major spillage of contaminants from site into controlled water. Explosion, causing building collapse (can also equate to a short-term human health risk if buildings are occupied).
Medium	Chronic damage to Human Health. Pollution of sensitive water resources. A significant change in an ecosystem or organism forming part of such ecosystem.	Concentration of a contaminant from site exceeds the generic or site-specific assessment criteria. Leaching of contaminants from a site to a Principal or Secondary A aquifer. Death of a species within a designated nature reserve. Lesser toxic and asphyxiate effects
Mild	Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services. Damage to sensitive buildings/structures/services or the environment.	Pollution of non-classified groundwater (inc. Secondary B aquifers). Damage to building rendering it unsafe to occupy (e.g. foundation damage resulting in instability).
Minor	Harm, although not necessarily significant harm, which may result in a financial loss or expenditure to resolve. Non-permanent health effects to human health (easily prevented by means such as personal protective clothing, etc). Easily repairable effects of damage to buildings, structures and services.	The presence of contaminants at such concentrations that protective equipment is required during site works. The loss of plants in a landscaping scheme. Discoloration of concrete.

Phase 2 Site Investigation

In accordance with DoE guidance, the following categorisation of **probability** has been developed.

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

In accordance with DoE guidance, the following categorisation of **risk** has been developed.

Classification	Definition
Very High Risk	There is a <i>high probability</i> that <i>severe harm</i> could arise to a designated receptor from an identified hazard at the site without appropriate further action.
High Risk	<i>Harm is likely to arise</i> to a designated receptor from an identified hazard at the site without appropriate further action.
Moderate Risk	<i>It is possible</i> that without appropriate further action <i>harm could arise</i> to a designated receptor. It is relatively <i>unlikely</i> that any such harm would be <i>severe</i> , and if any harm were to occur it is <i>more likely</i> that such harm would be <i>relatively mild</i> .
Low Risk	<i>It is possible</i> that <i>harm could arise</i> to a designated receptor from an identified hazard. It is <i>likely</i> that, at worst, if any harm was realised any effects would be <i>mild</i> .
Very Low Risk	The presence of an identified hazard does not give rise to the potential to cause harm to a designated receptor.

The term 'risk' in this instance refers to the risk that the source, pathway, receptor linkage for a given source of contamination is complete. It does not refer to immediate risk to individuals or features present on the site from potential contaminants and is intended to be used as a tool to assess the necessity of further investigation.

Appendix H Detailed UXO Risk Assessment

- 1st Line Defence (2017) Detailed Unexploded Ordnance Risk Assessment, Chandos Hall (report np. DA4989-00).

1ST LINE DEFENCE

UXO SOLUTIONS



Detailed Unexploded Ordnance (UXO) Risk Assessment

Project Name	Chandos Hall
Client	Curtins
Site Address	Chandos Hall, Granby Row, Manchester, M1 3QJ
Report Reference	DA4989-00
Date	14 th July 2017
Originator	CB



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Executive Summary

Site Location and Description

The site is located in the county borough of Manchester in Lancashire, north-west England. It is bordered by Granby Row to the north, Echo Street to the east, a section of railway and Altrincham Road to the south and Granby Row/Cobourgh Street to the west. The site is located approximately 210m south-west of Manchester Piccadilly station and approximately 870m south-east of Manchester city centre.

The site is currently occupied by a high-rise apartment building and a single level building of an unknown purpose, possibly a day care centre, which is accompanied by a small section of open greenspace in the form of a playground.

The site is approximately centred on the OS grid reference: **SJ 8466597703**.

Proposed Works

The proposed works are understood to involve an intrusive ground investigation (drilling and excavating) for the pile design of a proposed multi storey student accommodation block.

Geology and Bomb Penetration Depth

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 **Low Risk** from UXO across the majority of the site area, with a **Medium Risk** in the north-west of the site. This assessment is based on the following factors:

- The County Borough of Manchester was subject to a **Moderate** density of bombing with 27.1 bombs recorded per 1,000 acres. Manchester bomb plot and damage mapping indicates the presence of bombing incidents in the surrounding area of the proposed site, but none within the site boundary. However, the mapping only covers raids in 1940 so does not record any bombs which fell from 1941 to 1944. Furthermore, no written bomb incident records are available for Manchester. It is understood from the local archive that they were destroyed during/post-war. It has therefore not been possible to ascertain with certainty whether or not the site was bombed.
- At the start of the war, the site was almost entirely occupied by structures of a residential and commercial nature. Across the majority of the site, it is considered that ground cover should have been such that evidence of UXBs should have been noted and reported. However, an area of clearance is noted in the north-eastern corner of the site. It is thought possible that this was as a result of a bomb strike/fire damage. If rubble and debris was present in this area, there is a risk that evidence of UXO could easily have been overlooked. UXBs falling into 'bomb sites' was one of the most common scenarios for this going unnoticed and unrecorded.
- The proposed site was a housing and commercial entity. Should the site have suffered no damage throughout the war, it is anticipated that access levels would have been regular and frequent, and that post-raid checks for evidence of UXO would have been undertaken. Of concern is the north-eastern corner of the site where an area of cleared housing is noted post-war. It is not likely that access was reduced across the entirety of the site. However it cannot be discounted that potential bomb damage occurred in the north-eastern corner therefore lowering access levels and meaning UXO could have potentially fallen unnoticed.

**UXO Risk Assessment**

- It is a distinct possibility that damage may have occurred on site due to the area of cleared housing in the north-eastern corner in post-war photography. If rubble and debris were present in this area, there is a risk that evidence of UXO could easily have been unnoticed. The rest of the site appears to have survived the war intact.
- Given that the majority of the site appears to have survived the war, shows no signs of damage and likely accessed frequently, this part of the site has been given a **Low Risk**. The area within the north-west of the site is shown as cleared on post-war aerial photography. Given the poor quality of the record set for Manchester, it has not proved possible to prove that this clearance was not due to bombing. Thus, this area, with a small buffer to account for the 'J-curve' effect, has been given a **Medium Risk**.

Recommended Risk Mitigation Measures

The following risk mitigation measures are recommended to support the proposed works at the Chandos Hall site:

All Works

- Site Specific Unexploded Ordnance 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 and Site Specific Unexploded Ordnance Awareness Briefings to all personnel conducting intrusive works

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



Low Risk Areas:

- Site Specific Unexploded Ordnance Awareness Briefings to all personnel conducting intrusive works

Medium Risk Areas:

- Unexploded Ordnance (UXO) Specialist presence on site to support open intrusive works
- Intrusive Magnetometer Survey of any borehole or pile locations/clusters down to an assessed maximum bomb penetration depth

Glossary

Abbreviation	Definition
AA	Anti-Aircraft
AAA	Anti-Aircraft Ammunition
AFS	Auxiliary Fire Service
AP	Anti-Personnel
ARP	Air Raid Precautions
AWAS	Air Warfare Analysis Section
EOC	Explosive Ordnance Clearance
EOD	Explosive Ordnance Disposal
FP	Fire Pot
GM	G Mine (Parachute mine)
HAA	Heavy Anti Air
HE	High Explosive
IB	Incendiary Bomb
LAA	Light Anti Air
LCC	London County Council
LRRB	Long Range Rocket Bomb (V-2)
LSA	Land Service Ammunition
MOL	Molotov (Incendiary Bomb)
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
SD1000	1000kg high explosive bomb
SD2	2kg incendiary
SIP	Self-Igniting Phosphorous
U/C	Unclassified bomb
UP	Unrotated Projectile (rocket)
USAAF	United States Army Air Force
UX	Unexploded
UXAA	Unexploded Anti Air
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
V1	Vengeance Weapon 1
V2	Vengeance Weapon 2
WAAF	Women's Auxiliary Air Force
X	Exploded

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1st Line Defence Limited

Detailed Unexploded Ordnance (UXO) Risk Assessment

Site: Chandos Hall, Manchester
Client: Curtins

1. Introduction

1.1. Background

1st Line Defence has been commissioned by Curtins to produce a Detailed Unexploded Ordnance (UXO) Risk Assessment for the proposed works at Chandos Hall.

Buried UXO can present a significant risk to construction works and development projects. The discovery of a suspected 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 deposited as a result of military training and exercises.
2. Munitions lost, burnt, buried or otherwise discarded either deliberately, accidentally, or ineffectively.
3. Munitions resulting from wartime activities including German bombing in WWI and WWII, long range shelling, and defensive activities.

This report will assess the collective factors that may contribute to the risk of UXO contamination. If a potential risk is identified, 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 enable the client to understand the basis for the assessed risk level and any recommendations.

This report follows 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 Chandos Hall. Every reasonable effort has been made to ensure that all available historical information has been accessed and checked. Where possible, evidence has been included in the report to enable the client to understand the basis of the risk assessment.

The report will 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 risk that the site was contaminated with UXO.
2. The risk that UXO remains on the site.
3. The risk that UXO may be encountered during the proposed works.
4. The risk 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 air-delivered bombing and 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

To produce a thorough assessment of UXO risk, military records and archive material held in the public domain have been accessed. The following sources have been consulted for this report:

- The National Archives, Kew, and Greater Manchester County Record Office, Manchester.
- Historical mapping datasets.
- Historic England National Monuments Record.
- Relevant information supplied by Curtins.
- Available material from 33 Engineer Regiment (EOD) Archive.
- 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.

2.4. General Considerations of Historical Research

This desktop assessment is based largely upon analysis of historical evidence. Every reasonable effort has been made to locate significant and pertinent information, and the sources consulted have been presented in this report. 1st Line Defence cannot be held accountable for any changes to the assessed level of risk 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 at the time of the report's production.

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 many sources and types of information have been consulted, analysed and presented. The same methodology is applied to each report during the risk assessment process. 1st Line Defence cannot be held responsible for inaccuracies or gaps in the available historical information.

3. Background to Bombing Records

During WWII bombing records were gathered by the police, Air Raid Precaution (ARP) wardens and military personnel. Records were maintained in the form of local and regional written records, maps depicting the locations of individual strikes, and maps indicating the levels of damage sustained by structures. Records typically noted when, where and what types of bombs had fallen during an air raid. Records of bomb strikes were made either through direct observation or by post-raid surveys. The immediate priority was frequently focussed on assisting casualties and minimising damage. As a result some records were incomplete and contradictory.

The quality, detail and nature of record keeping could vary considerably between boroughs and towns. No two areas were collated or recorded data in the same way. Some areas maintained bomb and damage mapping, some provided grid references of strikes, and some are too vague in detail to be able to ascertain exactly where bombs fell. Many records were even damaged or destroyed in subsequent bombing 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. Furthermore, records of attacks on military or strategic targets were often maintained separately from the general records and have not always survived.

4. Background to Allied Records

During WWII considerable areas of land were requisitioned by the army for the purpose of defence, training, and the construction of airfields and facilities for munitions production. Records relating to military features vary and some areas may remain censored. Within urban environments datasets will be consulted detailing the location of munitions works and air and land defences. In rural locations it may be possible to obtain plans of airfields and military establishments, as well as training logs, personal memoirs, and operational plans.

5. UK Regulatory Environment

5.1. 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.

5.2. 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.

5.3. 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.

5.4. 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.

6. Role of Commercial UXO Contractors and The Authorities

6.1. Commercial UXO Contractors

In the event that a risk of UXO contamination is detected at the proposed site, the support of a UXO specialist may be recommended. A UXO specialist may be able to avoid unnecessary call-outs to the authorities through the disposal or removal of low risk items. In addition a specialist will assist in the swift recognition of high risk items, and will thereafter co-ordinate with the local authority with the objective of causing minimal levels of disruption to site operations, whilst putting in place safe and appropriate measures.

For more information on the role of commercial UXO specialists, see *CIRIA C681*.

6.2. 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 (JSEOD) to arrange for investigation and/or disposal. 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 JSEOD's judgement of the nature of the UXO risk, the location, people and assets at risk, as well as the availability of resources. They may respond immediately or it can take 1-2 days and often longer for the authorities to respond and deal with a UXB.

Depending on the on-site risk assessment the item of ordnance may be removed from the site and/or destroyed by a controlled explosion. The latter process is lengthy and may necessitate the establishment of addition cordons and evacuations.

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 JSEOD 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.

7. The Site

7.1. Site Location

The site is located in the county borough of Manchester in Lancashire, north-west England. It is bordered by Granby Row to the north, Echo Street to the east, a section of railway and Altrincham Road to the south and Granby Row/Cobourg Street to the west. The site is located approximately 210m south-west of Manchester Piccadilly station and approximately 870m south-east of Manchester city centre.

The site is approximately centred on the OS grid reference: **SJ 8466597703**.

Site location maps are presented in **Annex A**.

7.2. Site Description

The site is currently occupied by a high-rise apartment building and a single level building of an unknown purpose, possibly a day care centre, which is accompanied by a small section of open greenspace in the form of a playground.

A recent aerial photograph and site plan are presented in **Annex B** and **Annex C** respectively.

8. Scope of the Proposed Works

8.1. General

The proposed works are understood to involve an intrusive ground investigation (drilling and excavating) for the pile design of a proposed multi storey student accommodation block.

9. Ground Conditions

9.1. General Geology

The British Geological Survey (BGS) map shows the bedrock geology of the site to be underlain by the Chester Pebble Beds Formation – sandstone, of the Early Triassic Epoch. The superficial deposits are comprised of Till, Devansian – Diamicton.

9.2. Site Specific Geology

Site specific geotechnical data was not available at the time of the production of this report.

10. Site History

10.1. Ordnance Survey Historical Maps

Historical maps were obtained for this report and are presented in **Annex D**. These maps provide an indication of the composition of the site pre and post- WWII. See below for a summary of the site history on various mapping editions.

Pre-WWI		
Date	Scale	Description
1908	1:2,500	This map indicates the presence of several residential properties within the site boundary. A road intersects the western half of the site. There are some small areas of open ground, assumed to be hard standing in nature.

Pre-WWII		
Date	Scale	Description
1922	1:2,500	This map shows no significant change since the previous edition. The site remains occupied by residential properties.

Post-WWII		
Date	Scale	Description
1948	1:1,250	There is no significant change since the previous map edition across the majority of the site area. There is an area of clearance to the north-west of the site on the opposite side of Granby Row, and a row of missing houses in the north-eastern corner of the site.
1965	1:2,500	This map edition shows the site to have been cleared of the residential properties and is now occupied by a 'depot' and a structure of an unknown purpose. The road intersecting the site is now gone.

10.2. Goad Fire Insurance Mapping

Available pre and post-WWII fire insurance plans for the site were obtained by 1st Line Defence. These are comprehensive street plans detailing the structure and uses of individual buildings. The plans were originally designed to assist the fire insurance industry. See **Annex E** for the mapping with the site boundary outlined accordingly.

WWII Period	
Date	Description
1942	This plan shows the majority of the buildings within the site footprint to be made of brick, stone or concrete. There is one wooden structure to the south. Some skylights are visible to the south-east. The majority of the buildings are marked as having been commercial units.

Post-WWII	
Date	Description
1962	This plans shows the majority of the buildings from the previous edition to have been demolished, save for the buildings on the far east of the site. A single structure labelled as 'College of Technology', built from brick, stone or concrete, has been erected in place of the former buildings.

10.3. Historical Aerial Photographs of the Site

Historical aerial photographs have been consulted from the Aerofilms collection available from Britain From Above. 1st Line Defence have inquired about obtaining historical air photographs of the site area from the Aerofilms collection. Unfortunately no relevant records could be found.

11. Aerial Bombing Introduction

11.1. General

During WWI and WWII, many towns and cities across the UK were 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 bombing techniques often resulted in neighbouring areas to specific targets being bombed.

In addition to raids which concentrated on specific targets, indiscriminate bombing of large areas also took place – notably the London ‘Blitz’, but also affecting 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 report will concern air delivered weapons dropped during WWII, although WWI bombing will also be considered.

11.2. Generic Types of WWII German Air-delivered Ordnance

An understanding of the type and characteristics of the ordnance used by the Luftwaffe during WWII allows an informed assessment of the hazards posed by any unexploded items that may remain in situ on a site. A brief summary of these characteristics is given in the table below. Examples of German air delivered ordnance are presented in **Annex F**.

Generic Types of WWII German Air Delivered Ordnance				
Type	Description	Size/Weight	Frequency	Likelihood of detecting Unexploded
High Explosive (HE) Bombs	A HE bomb typically has a strong metal casing, which provides a ‘thick skin’ that is designed to fragment on detonation. HE bombs possess a sufficient mass and velocity to enable penetration of the ground if they failed to explode. In addition the shape and fins are aerodynamic to keep the tip end of the bomb facing downward.	Most bombs were 50kg, 250kg or 500kg, although larger bombs of up to 1,800kg were also used. About half the weight of HE bombs comprised of explosive TNT or Amatol.	In terms of weight of ordnance dropped, HE bombs were the most frequent weapon deployed by the Luftwaffe during WWII.	Although efforts were made to identify the presence of unexploded ordnance following a 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 50kg bomb. UXBs therefore present the greatest risk to present-day intrusive works.
Aerial or Parachute Mines (PM)	Luftmines (LMA-500kg and LMB-1000kg) were magnetic sea mines which were thin walled, cylindrical in shape with a hemispherical nose, deployed by parachute. For use on land, the mines were armed with a clockwork bomb fuze which caused the bomb to explode after impact. When operating as designed they caused considerable damage due to the high weight of explosive and their detonation at or near the surface.	PMs either weighed 500kg or 1000kg (approximately 2/3 of the overall weight was explosives) depending on the type of mine. Their length ranged from 1.73-2.64m.	PMs were deployed less frequently than HE and Incendiary bombs due to their size, cost and the difficulty of their 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.
1kg Incendiary Bombs (IB)	1kg IB devices had a magnesium shell and were filled with thermite; both components were designed to burn after igniting on impact. They were jettisoned from air-dropped containers.	1kg in weight and approximately 14 inches long.	In terms of the number of weapons dropped, small IBs were the most numerous. Millions of these weapons	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

	Some variants had explosive heads presenting an increased risk if encountered during works.		were dropped throughout the war.	vegetated ground, or bomb rubble, they could have gone unnoticed.
Large Incendiary Bombs (IB)	Large IBs had various flammable fill materials (including oil and white phosphorus), and a small explosive charge. They were designed to explode and burn close to the surface. Although they were often the same shape as HE bombs, they were thin-skinned and did not generally penetrate the surface.	Large IBs Weighed up to 350kg.	Large IBs were not as common as the 1kg IBs, although they were more frequently deployed than the Parachute Mines and Anti-Personnel 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.
Anti-personnel (AP) Bomblets	The SD2 'Butterfly Bomb' had an 8cm long, thin, cylindrical shaped, cast iron outer shell which hinged open when the bomblet deployed. A 15cm long steel cable was attached via a spindle to an aluminium fuze. They were generally lethal to anyone within a radius of 10 metres (33 ft) and could inflict serious shrapnel injuries.	The size and weight ranged depending on the type used. The SD2 weighed 2kg and contained 225 grams of TNT.	AP Bomblets 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.

11.3. Failure Rate of German Air-Delivered Ordnance

It has been estimated that 10% of the German HE bombs dropped during WWII failed to explode as designed. There are a number of reasons why an air-delivered weapon might fail to function as designed:

- Malfunction of the fuze or gain mechanism (manufacturing fault, sabotage by forced labour or faulty installation).
- Many German bombs were fitted with a clockwork mechanism that could jam on impact.
- Failure of the bomber aircraft to arm the bombs due to human error or an equipment defect.
- Jettisoning of the bomb before it was armed or from a very low altitude. This was most likely if the bomber was under attack or crashing.

From 1940 to 1945 bomb disposal teams dealt with a total of 50,000 explosive items of 50kg, over, 7,000 anti-aircraft projectiles and 300,000 beach mines. Unexploded ordnance is still regularly encountered across the UK, especially in London; see press articles in **Annex H**.

11.4. V-Weapons

From mid-1944, Hitler's 'V-weapon' campaign began. 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-west England were generally too far to be considered for V-weapon strikes by the Luftwaffe.

The risk from V-weapons in Manchester is therefore considered negligible and will not be further addressed in this report.

12. UXB Ground Penetration

12.1. General

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.

12.2. The J-Curve Effect

J-curve is the term used to describe the characteristic curve commonly followed by an air-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 up to 15m.

12.3. WWII UXB 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. 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 1000kg bomb 12.8m. Theoretical calculations suggested that significantly greater penetration depths were probable.

12.4. 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 Pebble Beds 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 of site specific borehole geotechnical information. An assessment can be made once such information becomes available or by an UXO Specialist on-site.

13. **Initiation of Unexploded Ordnance**

13.1. **General**

Unexploded ordnance does not spontaneously explode. All high explosive filling requires significant energy to create the conditions for detonation to occur. In the case of unexploded German bombs discovered within the construction site environment, there are a number of potential initiation mechanisms.

13.2. **UXB Initiation Mechanisms**

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.

Annex H details UXB incidents where intrusive works have caused UXBs to detonate, resulting in death or injury and damage to plant.

13.3. **Effects 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.

14. The Risk from German Air Delivered UXBs

14.1. 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**.

Manchester escaped WWI bombing, with the only Zeppelin attack getting close to Manchester occurring on 25th September 1916. Damage was caused to buildings in the villages of Holcombe and Greenmount, north of Bury, and there were a number of civilian deaths in Bolton. There was one further, unsuccessful Zeppelin foray on Northwest England in April 1918 which reached the Widnes and Wigan area but not Manchester. Zeppelins more often than not did not have great navigational skills; one 1915 attack, claimed to have been on the port of Liverpool, in fact dropped its bombs on the very inland Black Country.

WWI bombs were generally smaller than those used in WWII and were dropped from a lower altitude. 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.

14.2. 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 a moderate density of bombing as represented by bomb density data figures and maps. Manchester was not as targeted as other major northern British cities such as Liverpool and Coventry, but was still subject to numerous major raids. These raids tended to focus on Salford and Stretford, where the majority of Manchester industrial and dockland areas were found. The site was located approximately 4km south-east of Salford.

Manchester and Salford were mapped by the Luftwaffe when preparing for air raids. The mapping is presented in **Annex J**. The map obtained by 1st Line Defence covers Clayton, east Manchester, and highlights targets such as the gas works along Ashton New Road amongst others. Other specific Luftwaffe targets in the city included areas such as Spinningfields, Castlefield, and Ordsall, which lay west of the site. The targets in these areas were predominantly contained on the railway, which proved vital to the war efforts.

Manchester London Road station, or Manchester Piccadilly as it is known today, was marked as a target by the Luftwaffe. WWII bomb accuracy was inconsistent, meaning bombs often missed their targets causing destruction elsewhere. 'Tip and run' raids were frequent, whereby German pilots would empty their aircraft of any remaining bombs before returning to base. It is likely that the Luftwaffe would have used Manchester canal as a source of navigation, of which the nearest point to the site is approximately 1.3km north, and therefore it is probable that the area in general would have endured heavy bombing.

Records of bombing incidents in the civilian areas of Manchester were collected by the Air Raid Precautions warden and collated by the Civil Defence Office. Some other organisations, such as the London Port Authority and railways, 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.

14.3. Second World War Bombing Statistics

The following table summarises the quantity of German bombs (excluding 1kg incendiaries and anti-personnel bombs) falling on the County Borough of Manchester between 1940 and 1945.

Record of German Ordnance Dropped on the County Borough of Manchester		
Area Acreage		27,321
Weapons	High Explosive Bombs (all types)	712
	Parachute Mines	18
	Oil Bombs	7
	Phosphorus Bombs	0
	Fire Pot	0
	Pilotless Aircraft (V-1)	1
	Long Range Rockets (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 designed to inflict damage and injury and should therefore not be dismissed. Therefore, they should not be overlooked in assessing the general risk to personnel and equipment. Anti-personnel bombs were used in much smaller quantities and are rarely found today but are potentially more dangerous.

14.4. Manchester Blitz Air Raid Precautions Bomb Census and Damage Map

A local bomb census map compiled by Manchester City Council showing High Explosive (HE) and Incendiary Bomb strikes on the borough was obtained from Manchester Archives. The section showing the area of the site is described in the table below and presented in **Annex K**.

Manchester Consolidated Bomb Map – Annex K	
Date Range	Comments
Consolidated Bomb Plot Map: 1940 - 1945	This map was compiled post-war and depicts all of the strikes that occurred in Manchester during the 1940 Blitz. No strikes were recorded within the site boundary during these raids. No damage is recorded within the site boundary. The nearest damaged area is approximately 170m west of the site. It should be noted that this bomb mapping only covers the 1940 Manchester Blitz and not any subsequent bombing.

14.5. Quality of Historical Record

The quality of the extant historical record set for Manchester is overall poor, with limited resources available. These limitations hinder the possibility of accurately determining a risk level of UXO being discovered on a site. Whilst more densely bombed areas such as Stretford and Salford have superior record sets, the records for Manchester are lacking in diversity and quality.

No complete written incident records could be found for Manchester. This could be due to them being lost or damaged since the end of WWII. Only one bomb plot map could be found which makes it problematic when attempting to corroborate incidents across several sources. Confirming dates and the extent of damage suffered is likely to be more accurate when done across more than one resource. Furthermore the available record, the Architect's Department map detailed above, has many issues. The mapping only covers a period of the war, 1940-1941, rather than the entirety, meaning that several bombing incidents that occurred in the later war years within the city aren't covered. Moreover, the dates presented next to the strikes are not known to correspond with the incidents. It is therefore incredibly difficult to confirm the exactness or presence of said incidents.

14.6. WWII-Era Aerial Photographs

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 is dated 16th May 1948 and provides a record of the potential composition of the site during the war, as well as its condition immediately following the war (**see Annex M**).

On the whole the site appears to be in good condition, with the majority of the buildings remaining intact. However, an area of clearance is noted in the north-east of the site. The properties are apparent in 1942 GOAD mapping but are gone in the 1948 OS mapping edition. There is no evidence to suggest that bombing occurred on site during the war; however, it is a distinct possibility as the records available to 1st Line Defence were limited at the time of writing as the only bomb map available only covered the Manchester Blitz of 1940. Also, there is an area of lighter coloured earth/structures immediately north-west of the site which may be a sign of bomb damage. However the bomb map available to 1st Line Defence does not indicate any bombing in that particular area.

A view of the wider area is located in **Annex M2**.

14.7. 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.

14.8. Bomb Disposal Tasks

The information service from the Explosive Ordnance Disposal (EOD) Archive Information Office at 33 Engineer Regiment (EOD) 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 Curtins will be advised.

14.9. Evaluation of German Air Delivered UXB Risk

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 levels of bombing density could allow for error in record keeping due to extreme damage caused to the area.</i>	The County Borough of Manchester was subject to a Moderate density of bombing with 27.1 bombs recorded per 1,000 acres. Manchester bomb plot and damage mapping indicates the presence of bombing incidents in the surrounding area of the proposed site, but none within the site boundary. However, the mapping only covers raids in 1940 so does not record any bombs which fell from 1941 to 1944. Furthermore, no written bomb incident records are available for Manchester. It is understood from the local archive that they were destroyed during/post-war. It has therefore not been possible to ascertain with certainty whether or not the site was bombed.
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>	At the start of the war, the site was almost entirely occupied by structures of a residential and commercial nature. Across the majority of the site, it is considered that ground cover should have been such that evidence of UXBs should have been noted and reported. However, an area of clearance is noted in the north-eastern corner of the site. It is thought possible that this was as a result of a bomb strike/fire damage. If rubble and debris was present in this area, there is a risk that evidence of UXO could easily have been overlooked. UXBs falling into 'bomb sites' was one of the most common scenarios for this going unnoticed and unrecorded.
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>	The proposed site was a housing and commercial entity. Should the site have suffered no damage throughout the war, it is anticipated that access levels would have been regular and frequent, and that post-raid checks for evidence of UXO would have been undertaken. Of concern is the north-eastern corner of the site where an area of cleared housing is noted post-war. It is not likely that access was reduced across the entirety of the site. However it cannot be discounted that potential bomb damage occurred in the north-eastern corner therefore lowering access levels and meaning UXO could have potentially fallen unnoticed.
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>	There is a distinct possibility that damage may have occurred on site due to the area of cleared housing in the north-eastern corner in post-war photography. If rubble and debris were present in this area, there is a risk that evidence of UXO could easily been unnoticed. The rest of the site appears to have survived the war intact.

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.

15. The Risk from Allied Ordnance

15.1. General

The potential risk of encountering Allied ordnance on construction sites is particularly elevated in areas previously associated with military activity. This includes munitions deposited by military training exercises, dumped as a result of poor working practices, or deliberately placed to prevent adversary occupation and from other home defence activities. For example, contamination from items of Land Service (LSA) and Small Arms Ammunition (SAA) may result from historic occupation of an area or its use for military training.

Urban areas, such as the location of the site, can be at risk from buried unexploded Anti-Aircraft projectiles fired during WWII – see below.

15.2. Defending Manchester from Aerial Attack

Both passive and active defences were deployed against enemy bombers attacking targets in the Manchester region.

Passive Defences	Active Defences
These included defence tactics: - To hinder the identification of targets, by using lighting blackouts at night and camouflaging strategic installations. - To mislead bomber pilots into attacking decoy sites located away from the city with the use of dummy buildings or lighting to replicate that of the city under attack. - To force attacking aircraft to higher altitudes with the use of barrage balloons.	These relied on a coordinated combination of a number of installations in order to actively engage and oppose attacking aircraft. Some of these installations were: - Fighter aircraft to act as interceptors. - Anti-aircraft gun batteries. - The use of rockets and missiles (later during WWII).

15.3. Anti-Aircraft Artillery (AAA) and Projectiles

At the onset of WWII two types of Anti-Aircraft Artillery (AAA) guns were deployed:

- Heavy Anti-Aircraft Artillery (HAA), using large calibre weapons, such as the 3.7" QF (Quick Firing) gun
- Light Anti-Aircraft Artillery (LAA) using smaller calibre weapons, such as 40mm Bofors gun.

During the early war period there was a severe shortage of AAA available. Older WWI 3" and modified naval 4.5" guns were deployed alongside those available 3.7" weapons.

The maximum ceiling height of fire at that time was around 11,000m for the 3.7" gun and less for other weapons. As the war progressed improved variants of the 3.7" gun were introduced. From 1942, large 5.25" weapons were brought into service. These had significantly improved ceiling heights of fire reaching over 18,000m.

The LAA batteries were intended to engage fast, low flying aircraft and were typically deployed around airfields or strategic installations. These batteries were mobile and could be moved to new positions with relative ease when required. The most numerous of these were the 40mm Bofors gun, which could fire up to 120 x 40mm HE shells per minute to over 1,800m.

The HAA projectiles were high explosive shells, usually fitted with a time delay or a barometric pressure fuze to make them explode at a pre-determined height. If they failed to explode or strike an aircraft they would eventually descend back to earth. Details of the most commonly deployed WWII AAA projectiles are shown below:

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

Although the larger unexploded projectiles could enter beneath the ground surface, they did not have a great penetration ability and are therefore likely to be found close to WWII ground level. Frequently, these shells are sometimes mistakenly identified as small German air-delivered bombs but are differentiated by the copper driving band found in front of the base. If encountered, the high explosive fill and fragmentation hazard of these items of UXO would present a significant risk.

The smaller 40mm projectiles are similar in appearance and effect to SAA and, although still dangerous, present a lower hazard due to its decreased explosive content. They are still dangerous because they were fitted with an impact initiated fuze, which was also a spin-decay self-destruct mechanism.

Numerous unexploded AAA shells were recovered during and following WWII and are still occasionally encountered on sites today.

The closest recorded HAA battery to the site was situated approximately 2.6km north in the vicinity of Cheetham Hill. It should be noted that the positions of mobile LAA gun batteries were generally not well recorded, if at all.

Illustrations of Anti-Aircraft artillery, projectiles and rockets are presented at **Annex N**.

15.4. Evaluation of Allied Ordnance Risk

1st Line Defence has considered the following potential sources of Allied ordnance contamination:

Sources of Contamination	Conclusion
Military Camps	1 st Line Defence could find no evidence of a military camp within the site.
Anti-Aircraft Defences	1 st Line Defence could find no evidence of Anti-Aircraft defences in the site proximity.
Home Guard Activity	Evidence of Home Guard training areas and activities is difficult to obtain. 1 st Line Defence has no evidence of any Home Guard activities on the site.
Defensive Positions	There is no evidence of any defensive structures in the vicinity of the site.
Training or firing ranges	No evidence of these could be found.
Defensive Minefields	No evidence of these could be found.
Ordnance Manufacture	No evidence of ordnance manufacture could be found.
Military Related Airfields	The site was not situated within the vicinity of a military airfield.
Explosive Ordnance Clearance Tasks	1 st Line Defence holds no records of EOC operations on the site.

16. Ordnance Clearance and Post-WWII Ground Works

16.1. General

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.

16.2. UXO Clearance

1st Line Defence has no evidence that any official ordnance clearance operations have taken place on site. Note however that we have not received confirmation of this fact from 33 EOD Regiment.

16.3. Post war Redevelopment

Development has taken place on site post-war. The structures that remained on the western half of the site immediately following the war were demolished sometime before 1962 to make way for a technology college. In later years all structures were demolished and Chandos Hall was built along with another structure.

The development of any hard standing ground would have involved minimal excavation work. Where this development has taken place the risk of encountering shallow buried UXO, especially 1kg incendiaries and anti-aircraft projectiles will have been partly mitigated.

Construction of the structures on site will have most likely required some deeper foundations. The risk from deep-buried unexploded bombs is only considered mitigated at locations where post war piling or deep foundations have taken place.

17. 1st Line Defence Risk Assessment

17.1. 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.

UXO Risk Assessment	
Quality of the Historical Record	The research has evaluated pre- and post-WWII Ordnance Survey maps, GOAD Fire Insurance mapping, WWI maps of air raids, Luftwaffe target imagery, Manchester Blitz bomb mapping, an interactive Manchester bomb map, high resolution post-war RAF aerial photography and comparative bombing statistics. The record sets available are of generally good quality. However, overall the quality of the historical record is poor due to its limited resources.
The Risk that the Site was Contaminated with UXO	1st Line Defence has assessed that there is a Low Risk that items of unexploded German air-delivered ordnance could have fallen unrecorded across the majority of the site area, with a Medium Risk in the north-west of the site. • The County Borough of Manchester was subject to a Moderate density of bombing with 27.1 bombs recorded per 1,000 acres. Manchester bomb plot and damage mapping indicates the presence of bombing incidents in the surrounding area of the proposed site, but none within the site boundary. However, the mapping only covers raids in 1940 so does not record any bombs which fell from 1941 to 1944. Furthermore, no written bomb incident records are available for Manchester. It is understood from the local archive that they were destroyed during/post-war. It has therefore not been possible to ascertain with certainty whether or not the site was bombed. • At the start of the war, the site was almost entirely occupied by structures of a residential and commercial nature. Across the majority of the site, it is considered that ground cover should have been such that evidence of UXBs should have been noted and reported. However, an area of clearance is noted in the north-eastern corner of the site. It is thought possible that this was as a result of a bomb strike/fire damage. If rubble and debris was present in this area, there is a risk that evidence of UXO could easily have been overlooked. UXBs falling into 'bomb sites' was one of the most common scenarios for this going unnoticed and unrecorded. • The proposed site was a housing and commercial entity. Should the site have suffered no damage throughout the war, it is anticipated that access levels would have been regular and frequent, and that post-raid checks for evidence of UXO would have been undertaken. Of concern is the north-eastern corner of the site where an area of cleared housing is noted post-war. It is not likely that access was reduced across the entirety of the site. However it cannot be discounted that potential bomb damage occurred in the north-eastern corner therefore lowering access levels and meaning UXO could have potentially fallen unnoticed. • It is a distinct possibility that damage may have occurred on site due to the area of cleared housing in the north-eastern corner in post-war photography. If rubble



	and debris were present in this area, there is a risk that evidence of UXO could easily been unnoticed. The rest of the site appears to have survived the war intact. Given that the majority of the site appears to have survived the war, shows no signs of damage and likely accessed frequently, this part of the site has been given a Low Risk. The area within the north-west of the site is shown as cleared on post-war aerial photography. Given the poor quality of the record set for Manchester, it has not proved possible to prove that this clearance was not due to bombing. Thus, this area, with a small buffer to account for the 'J-curve' effect, has been given a Medium Risk.
The Risk that UXO Remains on Site	Post-war development has occurred on site – between the 1942 and 1962 GOAD mapping editions the majority of the structures within the site footprint were demolished, leaving only a handful of structures in the western half of the site, with a <i>College of Technology</i> erected in place. More development took place in later years with the college being demolished and Chandos Hall erected in its place, along with another structure constructed in the west of the site. The risk of UXO remaining is considered to have been mitigated at the location of and down to the depth of post-war foundations and excavations.
The Risk that UXO may be Encountered during the Works	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 risk of encountering will depend on the extent of the works, such as the numbers of boreholes/piles (if required) and the volume of the excavations. An air-dropped bomb may come to rest at any depth between just below ground level and its maximum penetration depth. Consequently there is also a chance that such an item could be encountered during shallow excavations (for services or site investigations) into the original WWII ground level.
The Risk that UXO may be Initiated	The risk that UXO could be initiated if encountered will depend on its condition, how it is found, and the energy with which it is struck. Certain construction activities such as piling and percussive drilling pose a greater risk of initiating UXO in comparison to machine excavation, where the force of impact is generally lower and the item more likely to be observed. If a UXB is struck by piling or percussive drilling equipment, the force of the impact can be sufficient to detonate the main high explosive charge irrespective of the condition of the fuze or other components. Violent vibration might also impart enough energy to a chemical detonator for it to function, and there is a potential risk that clockwork fuzes could restart. If piling works are planned at Chandos Hall, there is a potential risk that a UXB, if present, could be initiated. The risk of initiation is assessed to be lower for any shallow intrusive works planned.
The Consequences of Encountering or Initiating Ordnance	The repercussions of the inadvertent detonation of UXO during intrusive ground works are potentially severe, 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. If appropriate risk mitigation measures are put in place, the chances of initiating an item of UXO during ground works is comparatively low. The primary consequence of encounter of UXO will therefore be economic. This would be particularly notable in the case of a high-profile site and sites where it is necessary to evacuate the public from the surrounding area. A site may be closed 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 loss of

	production. Generally, the first action of the police in most cases will be to isolate the locale whilst awaiting military assistance, even if this turns out to have been unnecessary.
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17.2. Assessed Risk Level

Taking into consideration the findings of this study, 1st Line Defence has assessed that there is a **Low-Medium Risk** from unexploded ordnance at the site of proposed works.

Low Risk

This area of the site was occupied by undamaged structures and showed no obvious signs of ground disturbance. It is considered likely that this property and its surrounds would have been accessed throughout WWII and that checks would have been made for evidence of UXO.

Ordnance Type	Risk Level			
	Negligible	Low	Medium	High
German Unexploded Bombs		✓		
German 1kg Incendiary Bombs		✓		
Anti-Aircraft Artillery Projectiles		✓		
Allied Military Land Service Ammunition (Grenades, Mortars etc.)	✓			

Medium Risk

The small area of cleared structures is a cause for concern, as there is no evidence to suggest it was not a bomb strike that caused the clearance. Therefore this area has been given a medium risk due to the potential for conditions to have been such in this area that evidence of a UXB could easily have been overlooked.

Ordnance Type	Risk Level			
	Negligible	Low	Medium	High
German Unexploded Bombs			✓	
German 1kg Incendiary Bombs			✓	
Anti-Aircraft Artillery Projectiles			✓	
Allied Military Land Service Ammunition (Grenades, Mortars etc.)	✓			

18. Proposed Risk Mitigation Methodology

18.1. General

The following risk mitigation measures are recommended to support the proposed works at Chandos Hall:

Type of Work	Recommended Mitigation Measure
All Works	Site Specific Unexploded Ordnance 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 that a suspect item is encountered. 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 in Medium Risk Areas	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 staff that have not already received them 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. UXO Safety and Awareness briefings will be provided to all ground personnel by the UXO Specialist once on site.
Borehole/Piles in Medium Risk Areas	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 proposed 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

14th July 2017

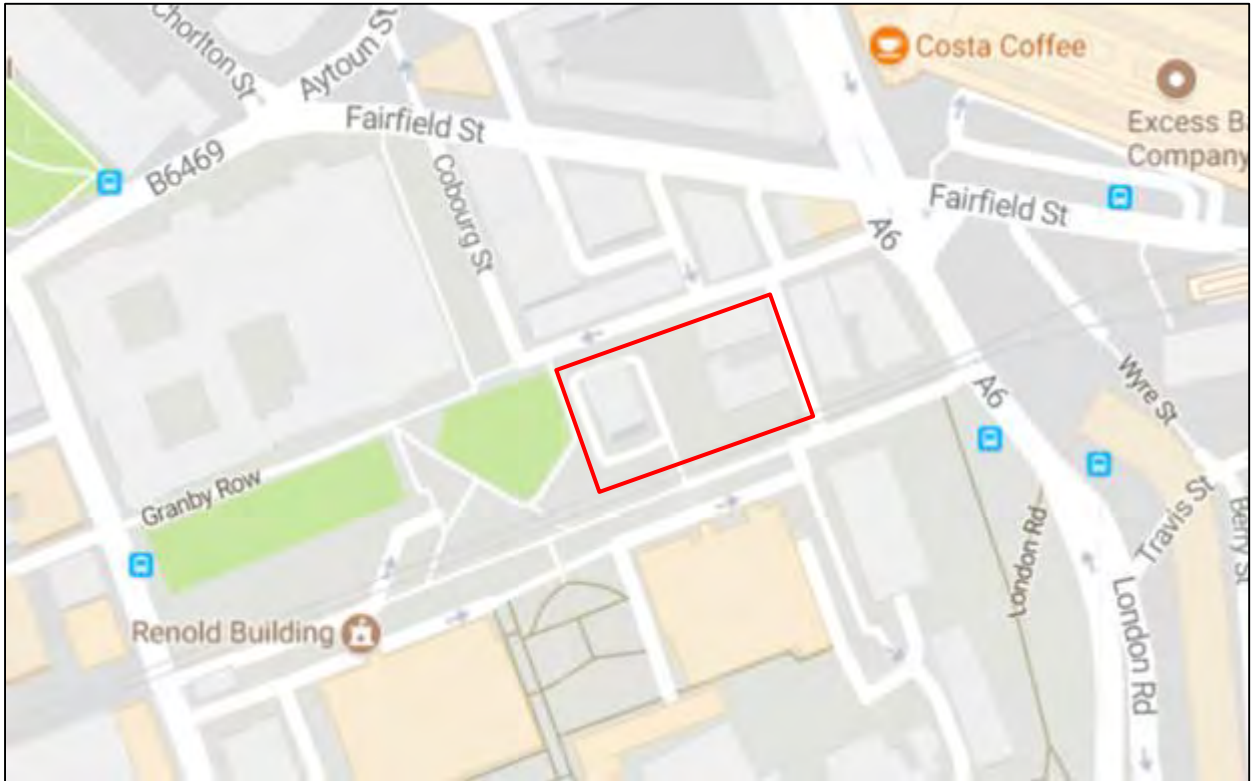
This Report has been produced in compliance with the Construction Industry Research and Information Association (CIRIA) C681 guidelines for the writing of Detailed UXO Risk Assessments.

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Project: **Chandos Hall, Manchester**

Ref: **DA4989-00**

Source: Google Maps

 **Approximate site boundary**





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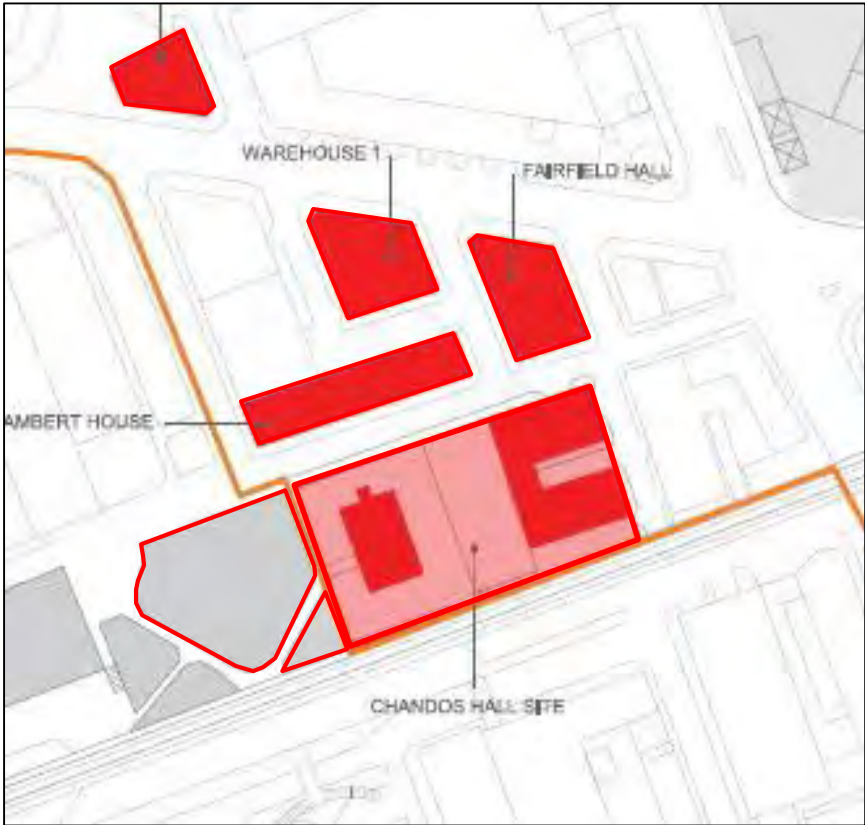
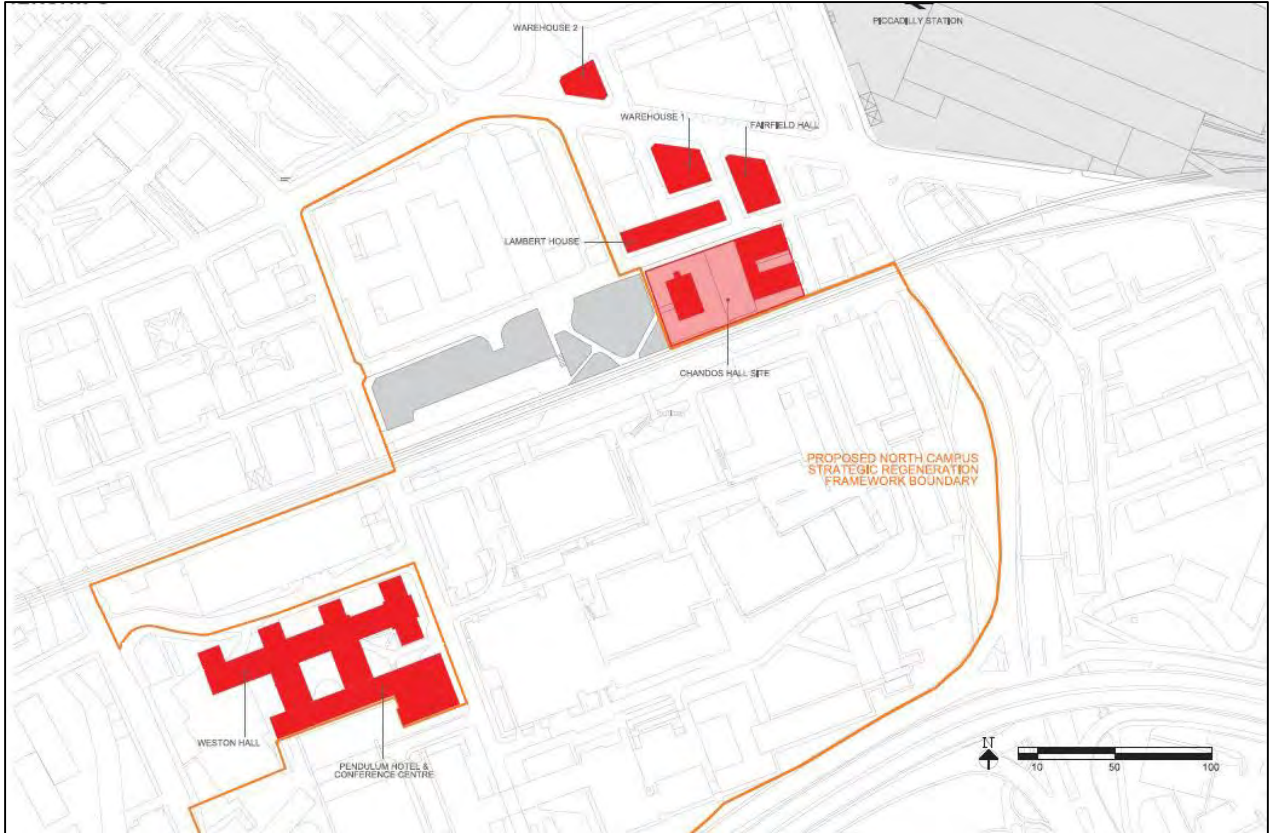
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Source: Google Earth™ Mapping Services

 **Approximate site boundary**





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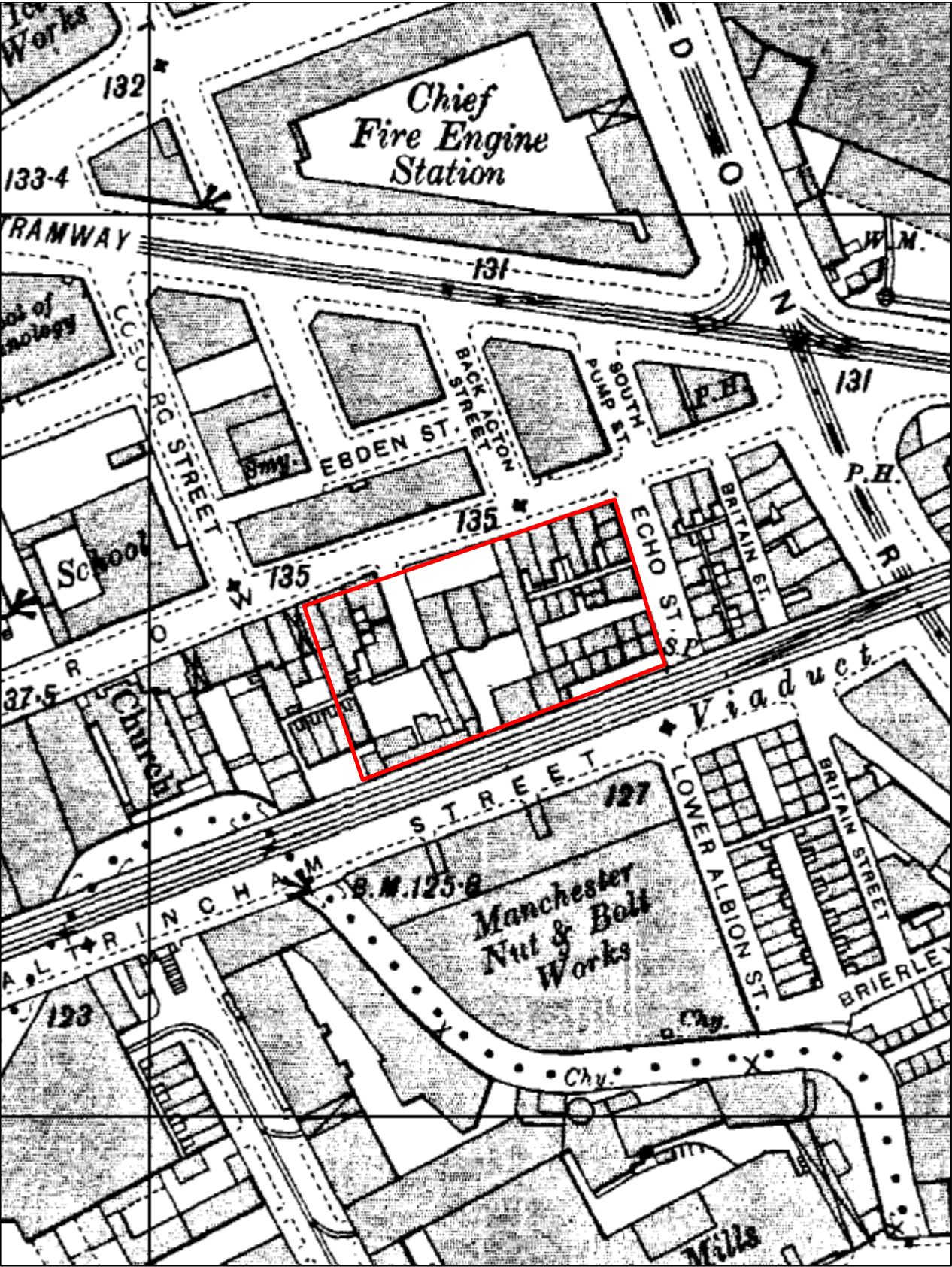
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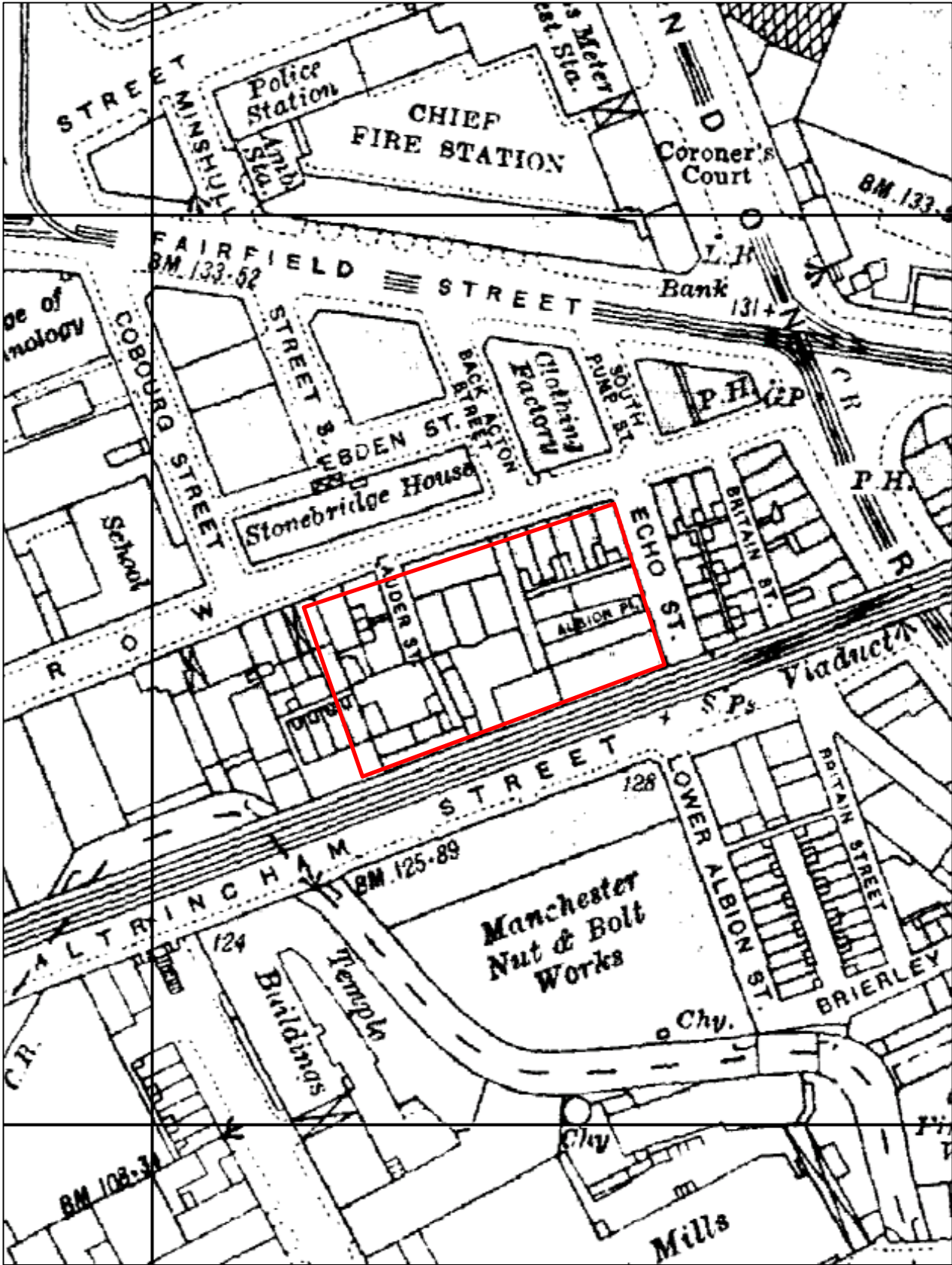
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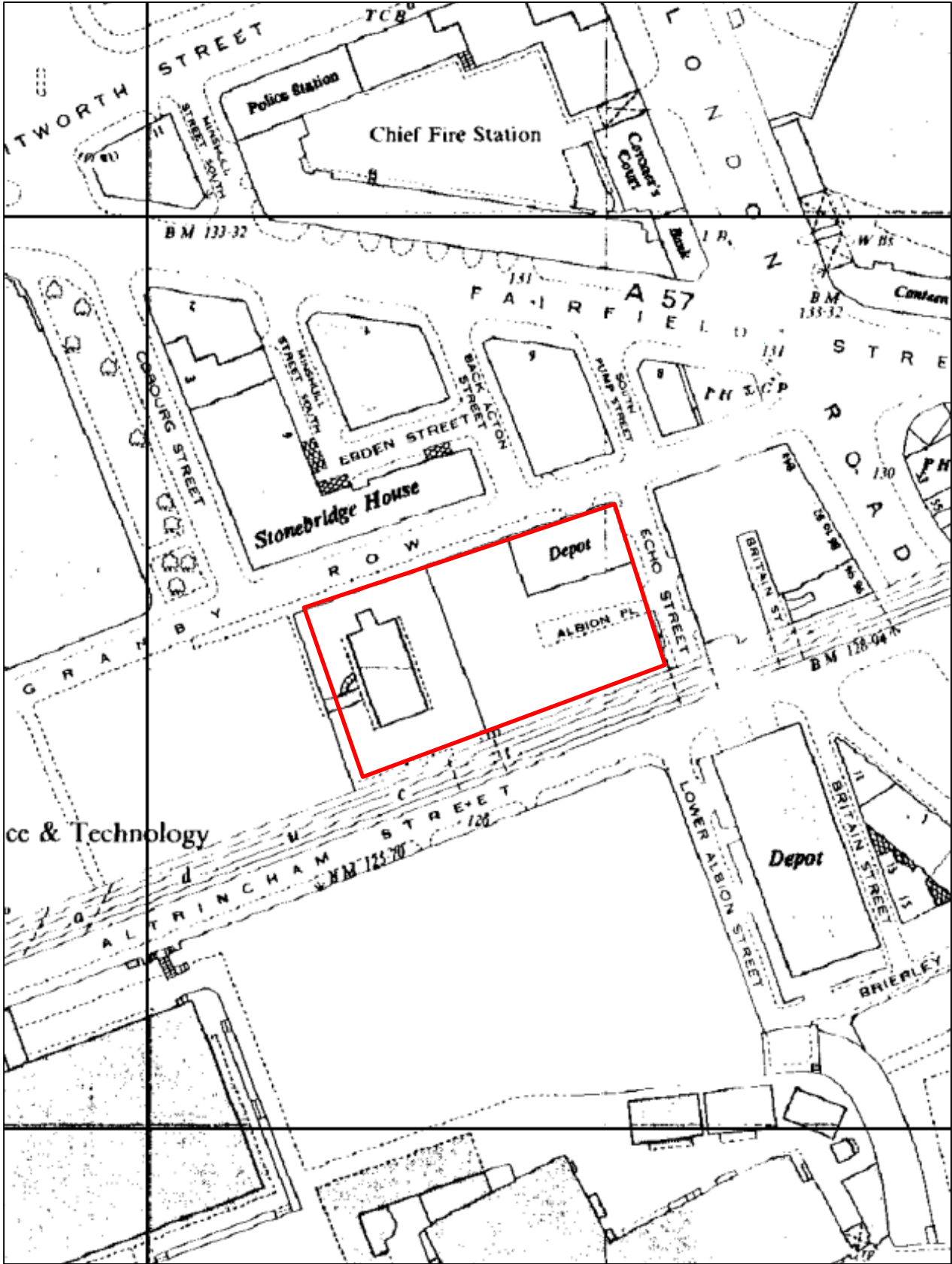
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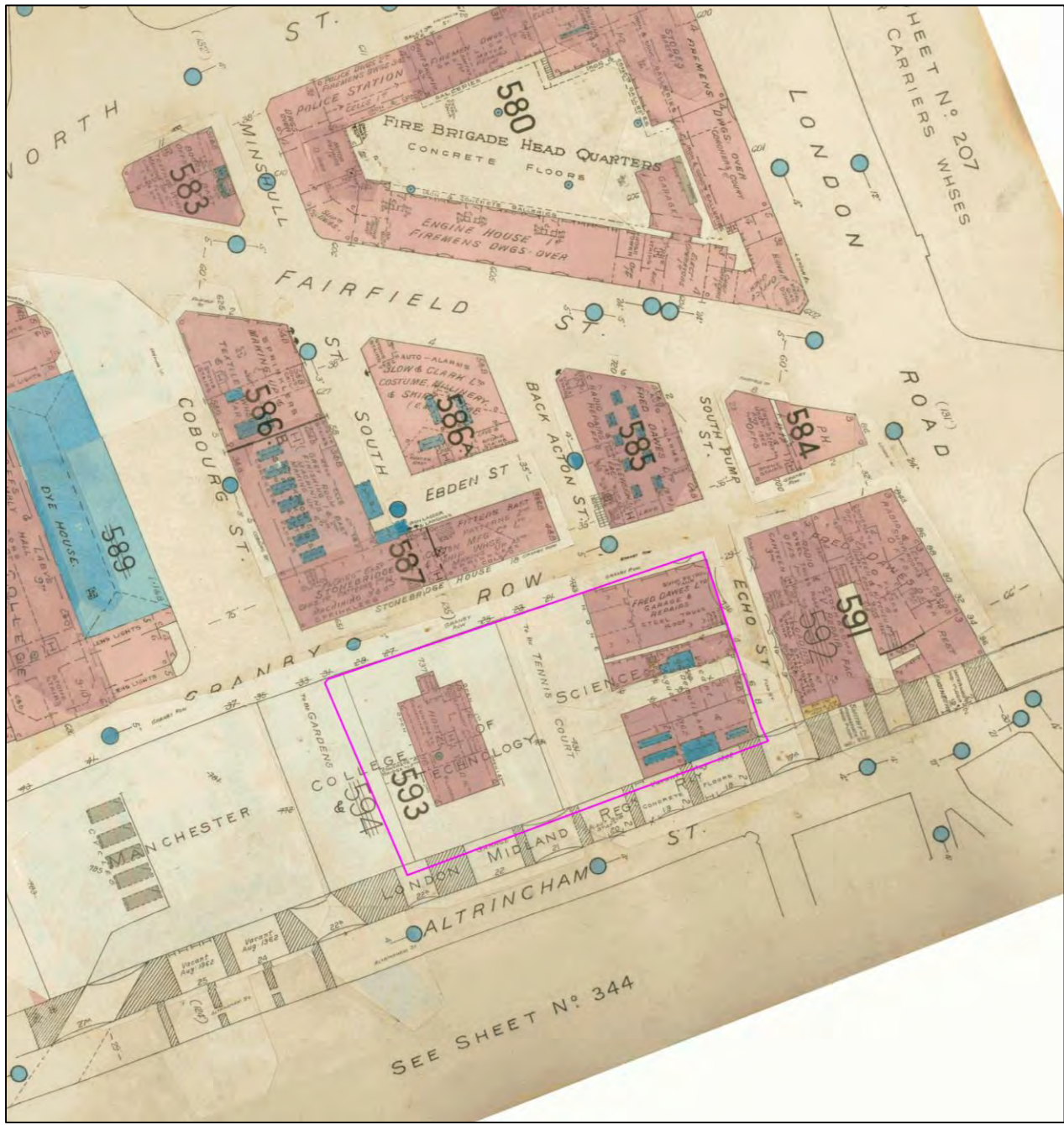
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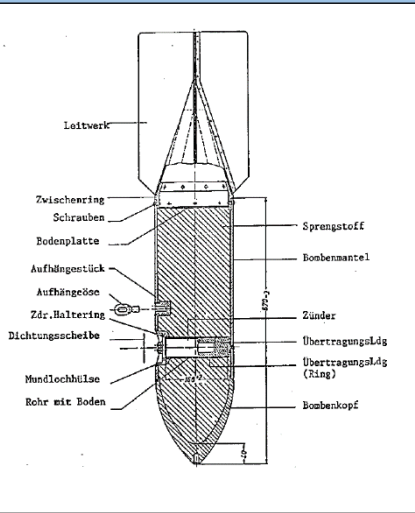
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Examples of German Air-Delivered Ordnance

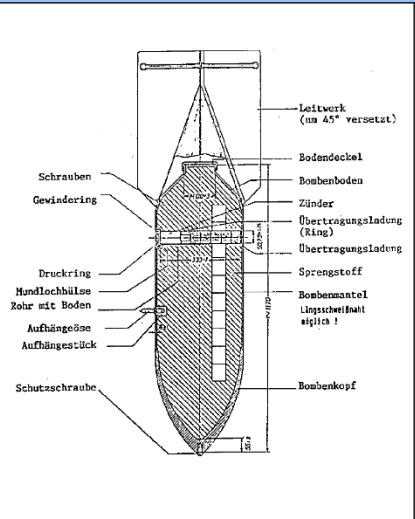
SC 50kg High Explosive Bomb

Bomb Weight	40-54kg (88-119lb)
Explosive Weight	c25kg (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).

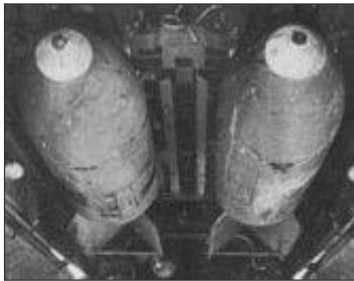
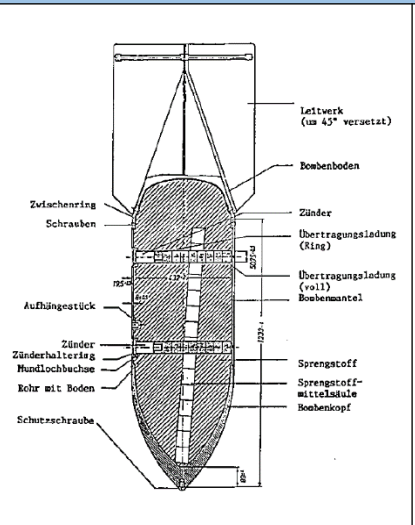


SC250 bomb being loaded onto German bomber



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 Trialene filling have cylindrical paper wrapped pellets 1-15/16 in. in length and diameter forming



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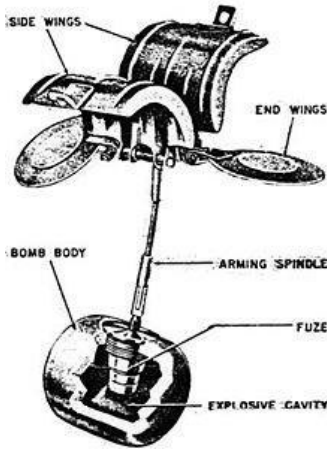
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Examples of German Air-Delivered Ordnance

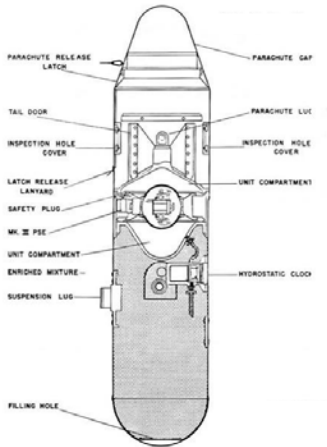
SD2 Anti-Personnel ‘Butterfly Bomb’

Bomb Weight	2kg (4.41lb)
Explosive Weight	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.



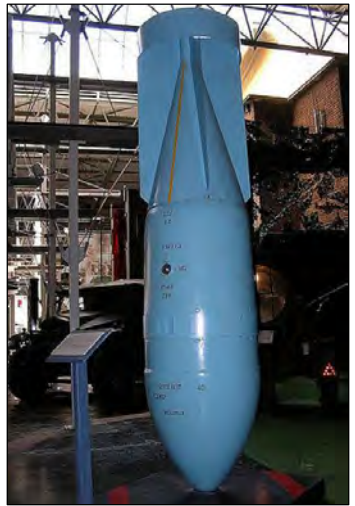
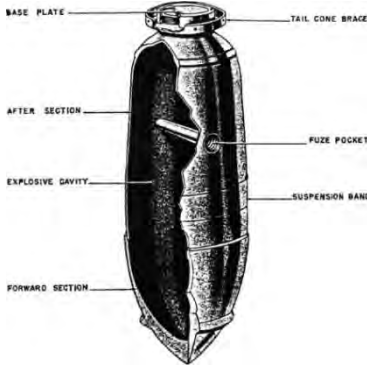
Parachute Mine (Luftmine B / LMB)

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 destroy a whole street of housing in a 100m radius.



SC 1000kg

Bomb Weight	993-1027kg (2,189-2,264lb)
Explosive Weight	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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Project: Chandos Hall, Manchester

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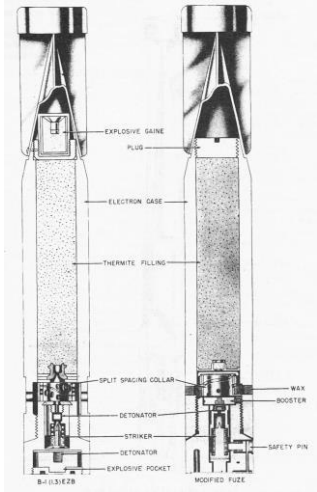
Source: Various sources

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German Incendiary Bombs

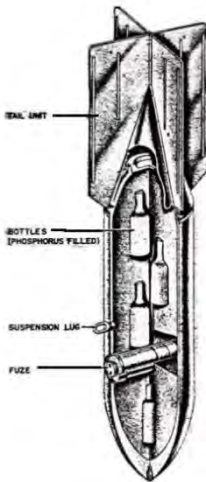
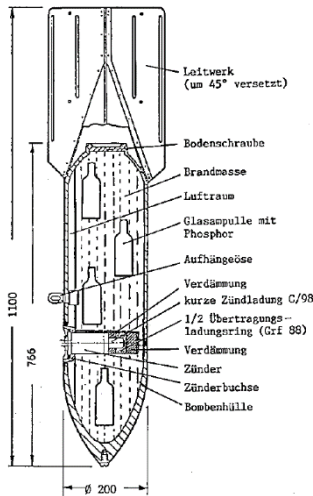
1kg Incendiary Bomb

Bomb Weight	1.0 and 1.3kg (2.2 and 2.9lb)
Explosive Weight	680g (1.3lb) Thermite 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 against 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.



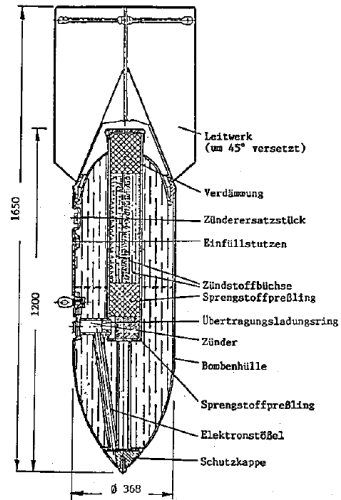
C50 A Incendiary Bomb

Bomb Weight	c41kg (90.4lb)
Explosive Weight	0.03kg (0.066lb)
Incendiary Filling	12kg (25.5lb) liquid filling with phosphor igniters in glass phials. Benzene 85%; Phosphorus 4%; Pure Rubber 10%
Fuze Type	Electrical impact fuze
Bomb Dimensions	1,100 x 280mm (43.2 x 8in)
Use	Against all targets where an incendiary effect is required
Remarks	Early fill was a phosphorous/carbon disulphide incendiary mixture



Flam C-250 Oil Bomb

Bomb Weight	125kg (276lb)
Explosive Weight	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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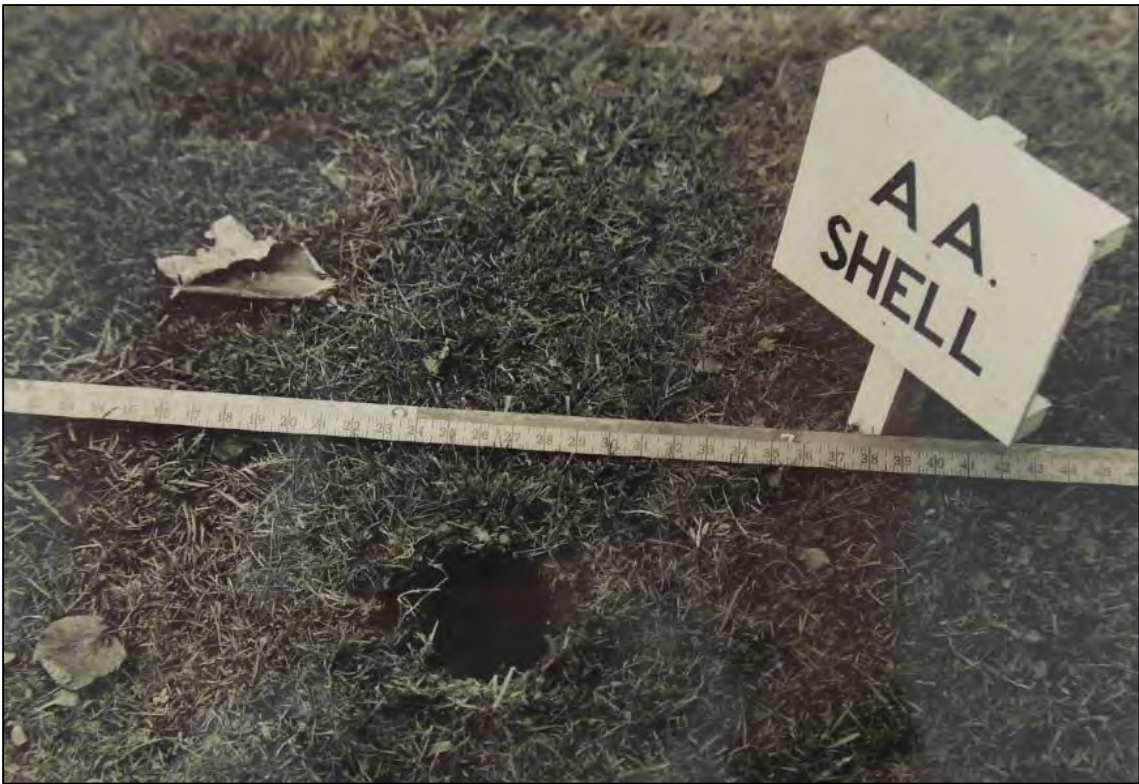
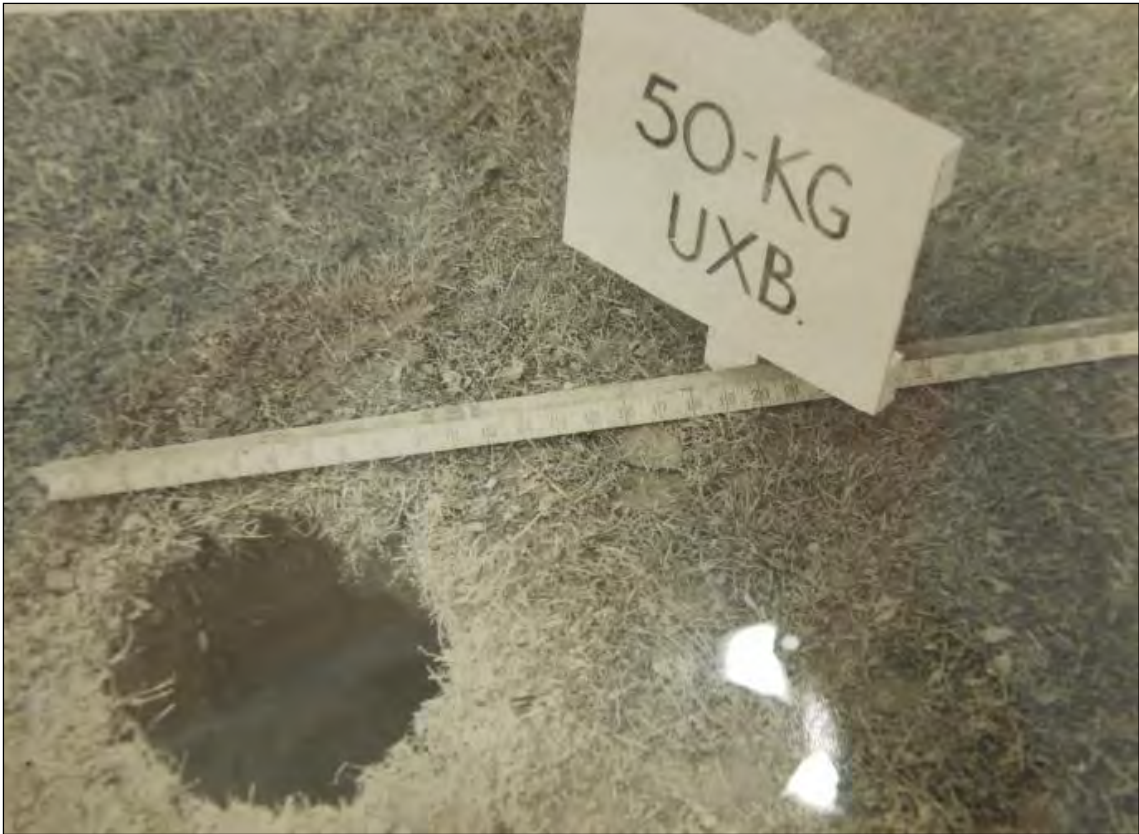
Client: Curtins

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Source: The National Archives

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Examples of Unexpected Detonation of WWII Bombs

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 is expanding their its Ludwigshafen location by expanding several plants and building a TDI plant, which was the site of an explosion on Tuesday (Feb. 26). One person was injured in the blast, which BASF believes was caused when excavation work detonated a bomb.

Early reports had speculated that excavation work had detonated a bomb from World War II. While the age of the bomb has not been confirmed, BASF has said that an explosive device was detonated.

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."

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.

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A cutting machine lies wrecked by the side of the A3 motorway next to a small crater left by the explosion.

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.

The A3 Autobahn linking the cities of Frankfurt and Würzburg has been blocked in both directions.

More than 60 years since the end of World War II, construction workers still frequently unearth unexploded bombs and it is not uncommon for whole city districts to be cordoned off and even evacuated while bomb disposal experts defuse them.

Indeed, just last week, some 22,000 people were evacuated from their homes in Hanover when three World War II bombs were discovered.

Allied pilots rained nearly 2 million tons of explosives on Germany during the war. Landmines, hand grenades, mortar bombs and anti-tank devices from the fighting on German soil at the end of the war are also found, and authorities say it will take decades before the country is cleared of duds.

Between 400 and 600 bombs are discovered a year in the state of North Rhine-Westphalia alone, where the heavily industrialized Ruhr region was a major target for Allied bombers.



WWII bomb injures 17 at Hattingen construction site

Published: 19 Sep 08 16:53 CET

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Seventeen people were injured on Friday when a construction crew unwittingly detonated a buried World War II-era bomb in Hattingen.

- [Liberals grit teeth ahead of May state election](#) (17 Mar 12)
- [Nazi death camp guard Demjanjuk dies](#) (17 Mar 12)
- [Stupid stunt causes bomb scare chaos](#) (16 Mar 12)

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."

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2 June 2010 Last updated at 15:37

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World War II bomb kills three in Germany

Three people have been killed and six injured trying to defuse a World War II bomb in central Germany.

Workers building a sports stadium had earlier unearthed the bomb in the town of Goettingen.

It was not immediately clear why the bomb, reportedly weighing 500kg (1,100lb), had detonated.

Unexploded WWII bombs dropped by Allied planes are frequently found in Germany, though it is unusual for them to explode unexpectedly.

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.



All the victims were involved in an operation to defuse the bomb



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Bermondsey bomb: World War Two device safely removed

🕒 24 March 2015

[London](#)

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The bomb measured about 5ft (1.5m) in length

RUPERT FRERE

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.

250kg HE bomb found in Bermondsey March 2015

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Bethnal Green WW2 bomb: Experts remove unexploded device

🕒 11 August 2015

[London](#)

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The MoD said the German WW2 air delivered bomb could have caused "mass destruction" if it had detonated

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.

250kg HE bomb found in Bethnal Green, Aug 2016

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Bath WW2 bomb scare: Device defused, police say

🕒 13 May 2016

[Somerset](#)

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EPA

The bomb was found on the site of a former school on Thursday

A 500lb World War Two bomb found on the site of a former school in Bath has been defused and made safe.

250kg HE bomb found in Bath, May 2016

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Wembley WW2 live bomb posed 'risk to life'

🕒 22 May 2015

[London](#)

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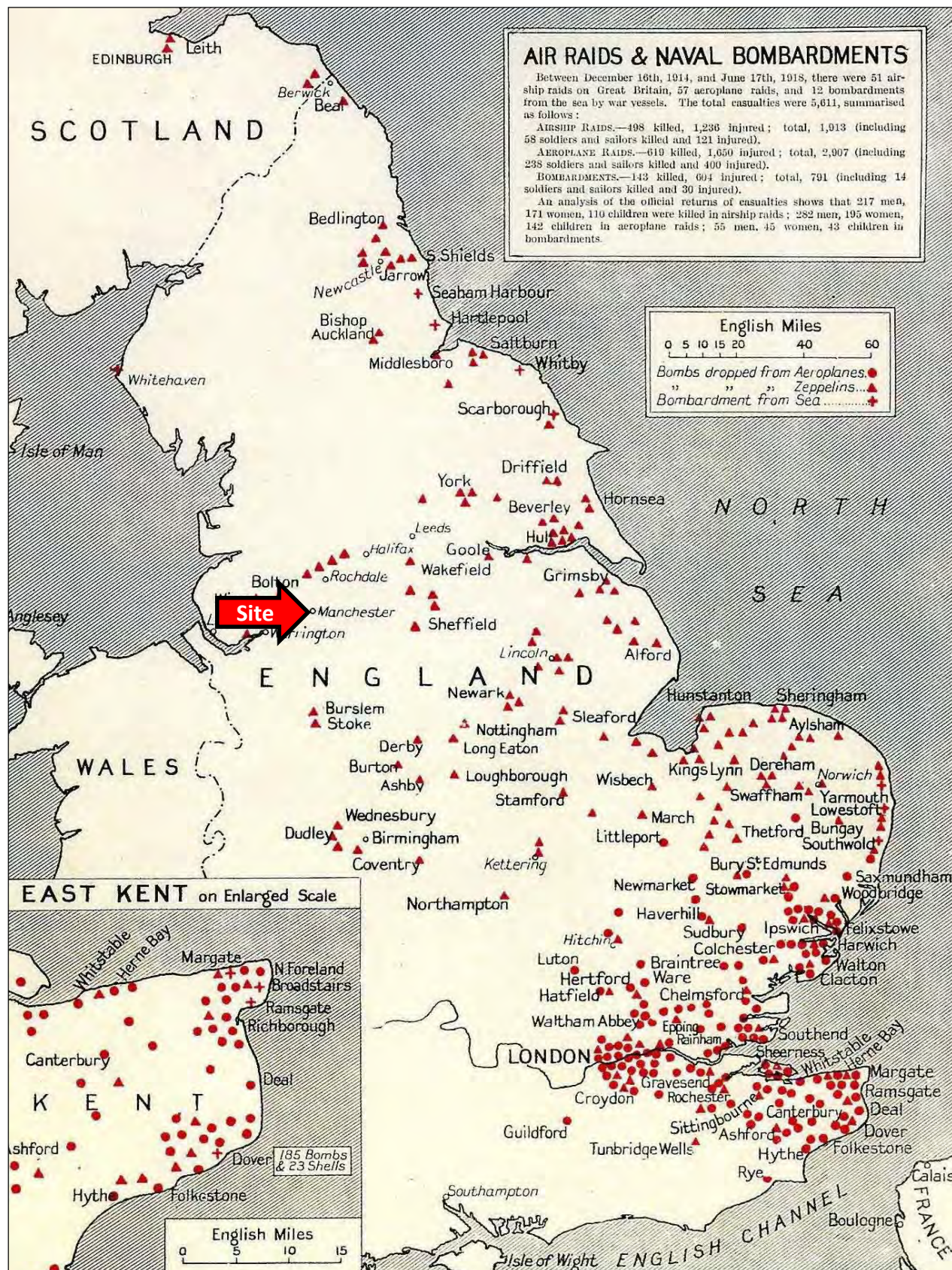
SERGEANT RUPERT FRERE RLC

A blast wall was put up around the bomb to minimise damage if it exploded

An unexploded World War Two bomb uncovered by builders near Wembley Stadium posed "a genuine risk to life", the Army has said.

50kg HE bomb found in Wembley, May 2015

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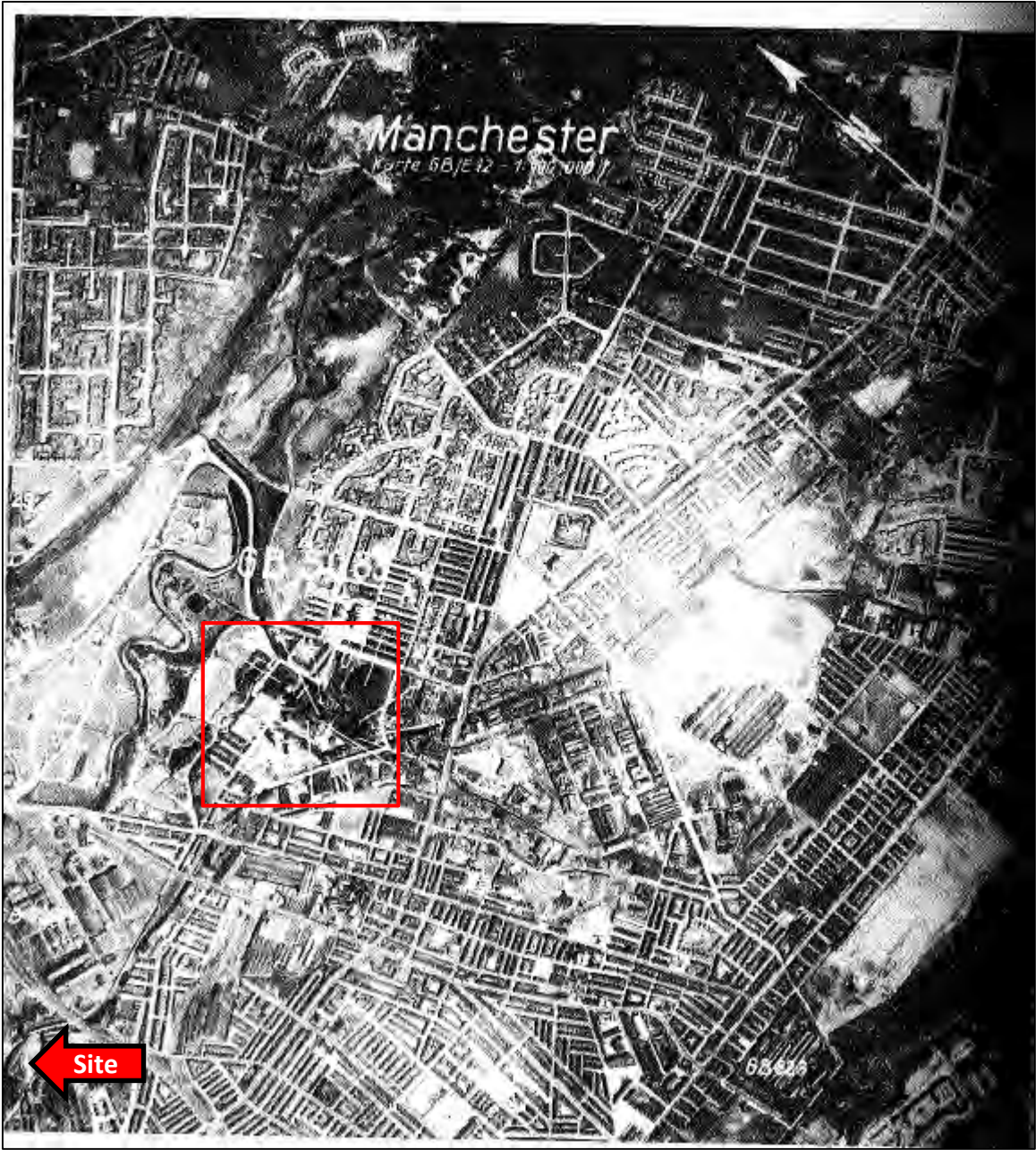
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Source: **J. Morris, German Air Raids on Britain**

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Luftwaffe Photograph, 1st October 1940



Manchester - Clayton
Red boxed area – gas works
GB 823 & GB 5083 – Designated Luftwaffe targets

The site located approximately 2.5km north-east of the arrow.



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Ref: DA4989-00	Source: Nigel J. Clarke, “Adolf Hitler’s Home Counties Holiday Snaps”		



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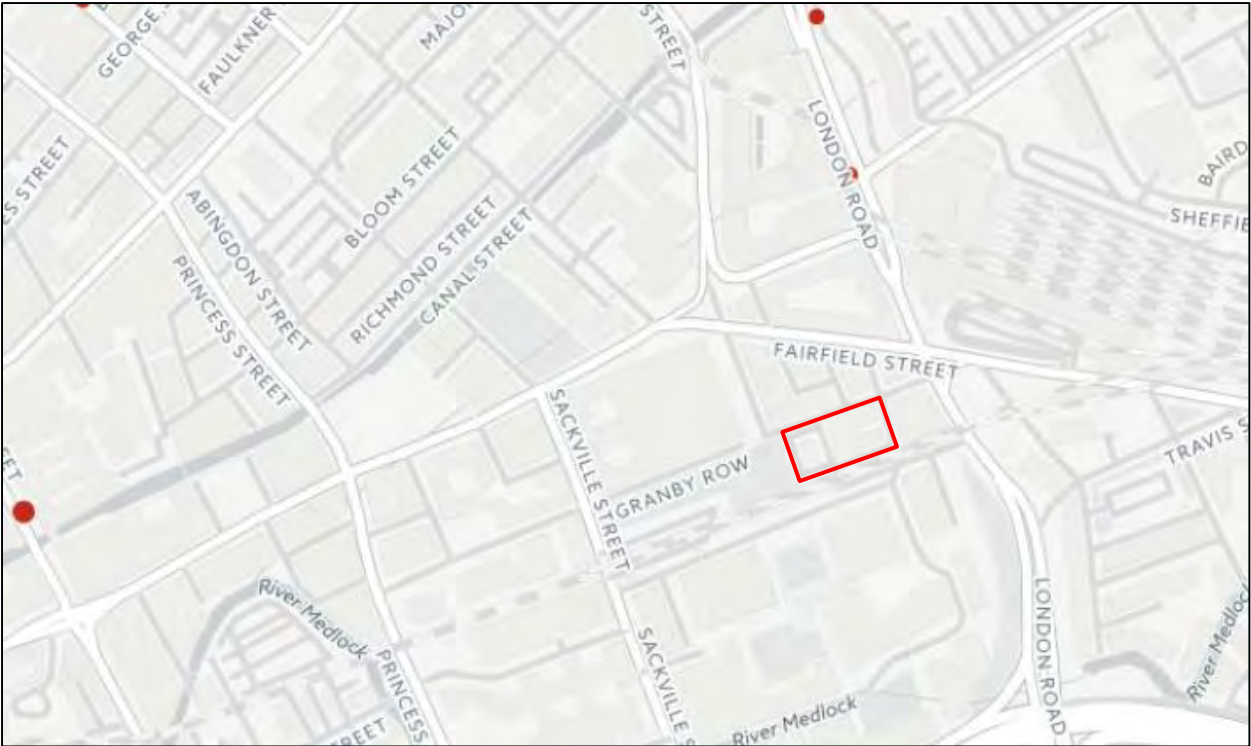
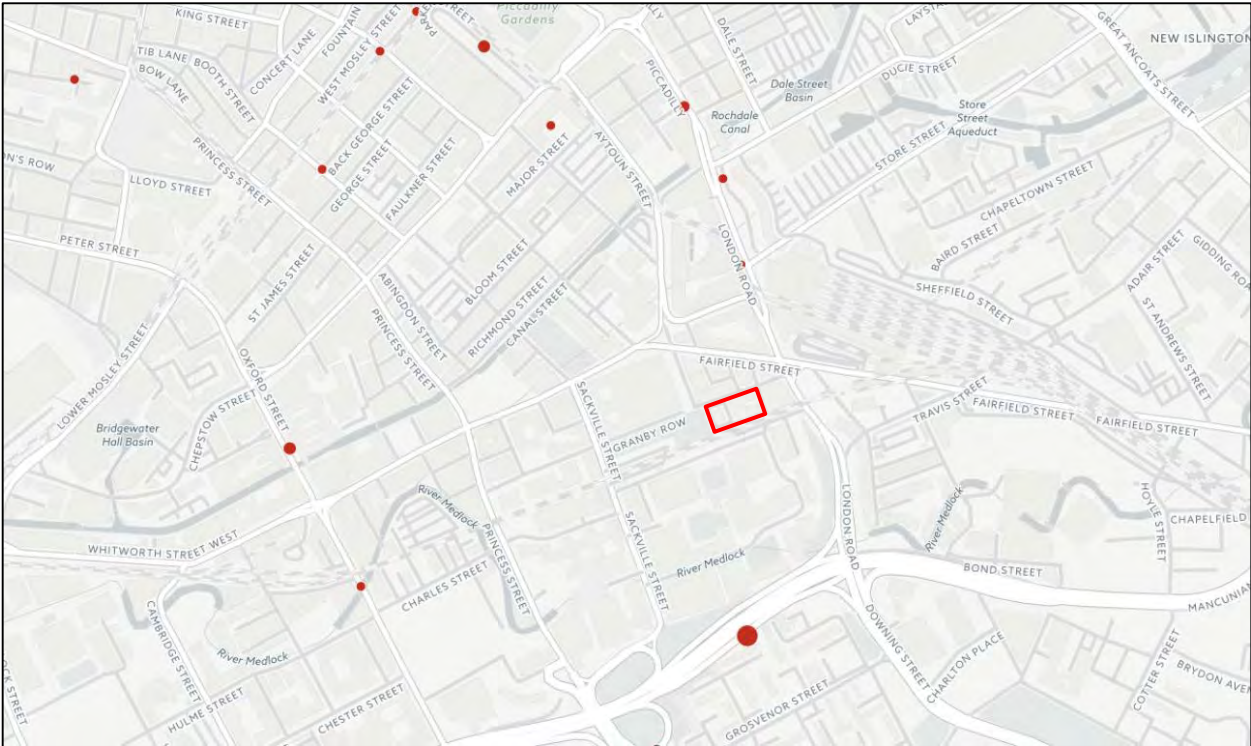
Ref: DA4989-00

Source: The National Archives, Kew

— Approximate site boundary



Night Bombing up to 7th October 1940



-  Recorded HE bomb strike
(colour refers to day of the week)
-  Recorded UXB strike
(colour refers to day of the week)
-  Incendiary bomb shower
-  Oil Bomb



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Source: Manchester Evening News

Approximate site boundary





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 **Approximate site boundary**



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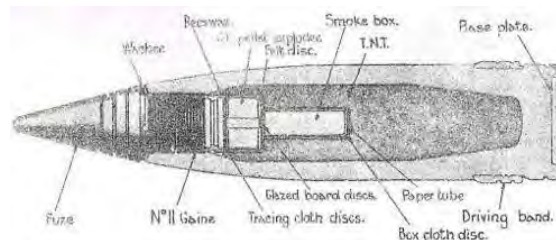
 **Approximate site boundary**



Examples of Anti-Aircraft Projectiles

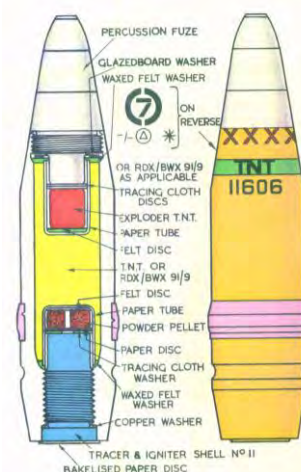
3.7 Inch QF Anti-Aircraft Projectile

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 Mk 1-3 were the standard Heavy Anti-Aircraft guns of the British Army.
Ceiling	30,000ft to 59,000ft



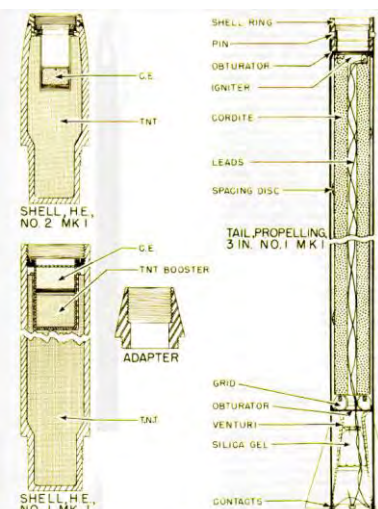
40mm Bofors Projectile

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 fuzeing
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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- Medium Risk
- Low 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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