







Swan House

Stage 2 Pre-Demolition

Ground Investigation

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Client Address: Unit A Icon Building, Firstpoint, Blaby Carr Bank, Doncaster, DN4 5JQ

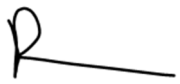
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V02	Updated following additional intrusive works in October 2020	SH	AS	21 March 2021

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Executive Summary

Appointment	In June 2018, Curtins were instructed by Cable Swan Ltd undertake a pre-demolition ground investigation (Stage 1) at the Swan House site, off Cable Street, Manchester, M4 5DF. A second phase of pre-demolition investigation (Stage 2) was instructed in December 2020 by RG Group to mainly inform pile design. The site is centred on NGR SD 84510 98850 and covers an area of approximately 0.25Ha. The aim of the ground investigation is to characterise the geo-environmental and geotechnical conditions prior to the construction of a multistorey structure of thirty one, thirteen and five stories to provide 373no. residential apartments, 12no. service apartments and a ground floor commercial unit with associated car parking.
Current Site Status	The site is currently occupied by a three-storey building with ground level loading bays and a basement thought to extend beneath most of the site. The basement has a surface cover of concrete. The ground floor units comprise a varying thickness of concrete, including raised levels surrounding and extending beyond loading abys in the main warehouse facilities.
Summary of Phase 1	The earliest mapping (1848) shows the site is fully developed, occupied by Cable Street Mill with residential properties in the northwest of the site. During WWII, ruins are noted in the vicinity of the site with building no longer recorded potentially due to bomb strike. In 1948, the site is noted as a warehouse with an extension recorded in western corner in 1951. The site remains unchanged to present day. Based on the site's historical land use, made ground is anticipated. BGS mapping indicates superficial deposits comprised glacial till underlain by bedrock noted as the Chester Pebble Bed Formation. The site is underlain by a Principal Aquifer within the bedrock formation and a Secondary Undifferentiated Aquifer within the superficial deposits. The nearest surface water feature is the River Irk located 304m west of the site. There are no water abstractions points recorded within 500m of the site. Primary potential risks to be investigated during this report, as well as establishing ground conditions for geotechnical design, included; potential for land gas and risks to human health from Made Ground soils.
Unexploded Ordnance	A Preliminary UXO risk assessment undertaken by Curtins to assess risk to ground investigation identified a Medium risk to construction workers from unexploded ordnance in soils underlying the existing building. Consequently, downhole magnetometry was undertaken alongside all exploratory holes during the 2018 and 2021 Pre-Demolition ground investigations. A Detailed UXO Risk Assessment report has since been commissioned on behalf of the client with respect to the proposed construction works on site from a UXO Specialist and a **Low** risk rating is confirmed for the site with respect to unexploded ordnance.
Fieldworks Undertaken	The Stage 1 ground investigations works were undertaken between 10th – 14th September 2018 and comprised seven window sample boreholes; four at ground level and three within the existing basement. Ground gas and groundwater monitoring standpipes were installed within six of the boreholes. Selected soil samples were subject to chemical and geotechnical analysis and six ground gas monitoring visits were undertaken. The Stage 2 ground investigation works were undertaken between 19th – 29th January 2021 and comprised three sonic boreholes. Ground gas and groundwater monitoring standpipes were installed within all the boreholes. Selected soil and rock samples were subject to chemical and geotechnical analysis and four ground gas monitoring visits undertaken.
Encountered Ground Conditions	Made ground deposits were encountered in all ground level exploratory holes, ranging in thickness between 0.25m to 3.00m bgl. Made ground comprised a surface covering of concrete overlying predominantly granular made ground. Concrete was encountered to depths between 0.25m and 1.17m bgl. WS06 and WS07 in the basement recorded concrete underlain directly by natural cohesive glacial till. Made ground was underlain by Glacial Till comprising cohesive material, the base of which was encountered in three boreholes (BH101A, BH102 and BH103) at depths of 10-13m bgl (37.10-40.42m AOD). This stiff clay was underlain by granular Glacial Till material. The granular deposits typically comprised dense to very dense brown slightly gravelly medium to coarse sand to depths of 15-17m bgl (32.95-35.10m AOD). Residual soils (weathered bedrock) were recovered as very dense red brown slightly gravelly medium to coarse sand were encountered to 20-24.20m bgl (26.22-29.95m AOD). The weathered bedrock was underlain by competent sandstone bedrock of the Chester Formation described as weak to medium strong reddish brown fine to coarse sandstone. The base of the sandstone was not encountered, with the boreholes terminated at a maximum depth of 40m bgl (<9.95m AOD). Post investigation groundwater monitoring has shown perched groundwater at depths of 2.70-4.61m bgl (48.40-46.39m AOD) in the made ground and top of the cohesive Glacial Till; groundwater within the granular Glacial

	Till at depths of 14.25-14.33m bgl (35.62-35.70m AOD) and groundwater within the solid bedrock strata at depths of 24.29-24.63m bgl (25.47-25.81m AOD).
Environmental Laboratory Testing and Ground Gas Monitoring Results	With respect to the proposed '*Commercial'* end-use of the ground floor, Tier 1 thresholds for human health have not been exceeded. When compared against Drinking Water Standards (DWS), no significant groundwater contamination has been recorded in the two groundwater samples collected and tested. A maximum carbon dioxide concentration of 5.4% $^{v}/_{v}$ and methane concentration of 2.2% $^{v}/_{v}$ have been recorded in separate boreholes, on single occasions. No other elevated occurrences of carbon dioxide or methane have been recorded above the 5% $^{v}/_{v}$ and 1% $^{v}/_{v}$ respective thresholds over the ten monitoring visits.
Ground Contamination and Ground Gas Assessment	A **Low** risk rating is identified to end-users from direct contact, inhalation and ingestion of contaminants within Made Ground soils on site. A **Low** risk is identified to the underlying Principal Aquifer, with differences in the water quality of the perched water sample and that from the solid strata as anticipated. A **Low** risk is identified to site end-users from ground gas migration and inhalation from soils, corresponding to BS8485 CS1 gas regime requiring no gas protection measures.
Geotechnical Assessment	Due to the likely loads of the proposed development, it is considered that a shallow spread foundation in the superficial deposits are unlikely to be suitable at the site. The ground conditions on site are considered to potentially be amenable to CFA or bored piles into the bedrock. Based on observations on site combined with laboratory tests, it is recommended that consideration be given to a suspended ground floor slab. 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. The following geotechnical consideration should also be considered: • Presence of existing services; • Obstructions and relict foundations; • Variable made ground; • Soft superficial deposits; and • Earthworks. Laboratory test results indicate a Design Sulphate Class for concrete may be taken as DS-2 and ACEC class of AC-2 for the made, decreasing got DS-1 SC-1s in natural geologies.
Recommendations	Based on the findings of the ground investigation, the following recommendations are made: 1) Further ground investigation is recommended in the areas of the development site currently inaccessible; this will be for confirming geotechnical design parameters. 2) The engineering recommendations contained within the report should be reviewed once the final development proposals and site levels are confirmed; 3) It is recommended that construction workers are provided with appropriate PPE and sanitary facilities, with reference to the environmental testing results. 4) With respect to the risk from Unexploded Ordnance, the following steps are recommended: • UXO Risk Management Plan; • Site Specific UXO Awareness Briefings to all personnel conducting intrusive works.

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1.0 Introduction

1.1 Project Background

In December 2020 Curtins were instructed by RG Group to undertake a Pre-Demolition ground investigation, herein after referred to as Stage 2, at the Swan House site, off Cable Street, M4 5DF. The site is centred on National Grid Reference SJ 84510 98850 and covers an area of approximately 0.25Ha.

Curtins undertook a Phase 1 Preliminary Risk Assessment desk study (Ref. 1) for the site in 2018, followed by an initial (shallow) Pre-Demolition investigation, herein after referred to as Stage 1, of the Swan House site in September 2018. Access constraints and tenant/owners' permissions determined that only shallow intrusive investigation namely window sample boreholes, could be undertaken at the time.

The proposed development comprises the demolition of the existing structure on site and construction of a multistorey structure of thirty-one, thirteen and five storeys to provide 373no. residential apartments, 12no. serviced apartments and a ground floor commercial unit with associated car parking.

Proposed development plans are enclosed in *Appendix A.*

1.2 Scope of Services

This aim of the investigation is to characterise the geo-environmental and geotechnical conditions for the proposed construction works.

Specifically, the Phase 2 report is 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) If there is a risk to the end user from soil gases including methane, carbon dioxide, carbon monoxide and hydrogen sulphide; and
d) Likelihood of the proposed works being adversely impacted by potential geo-hazards across the site.

In addition, recommendations on foundation solutions for the proposed structures are provided.

Detailed flood risk assessment, ecology and archaeological studies are outside of the scope of this report.

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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 development site is in Manchester City Centre. It is surrounded by residential and commercial properties and is bound by Cable Street to the northeast; Mason Street to the southeast; Swan Street and properties on Swan Street to the southwest; and Rochdale Road to the northwest.

The site is currently occupied by a three-storey building comprising warehouse and commercial premises on the ground and first floors, with a basement currently used as a storage facility thought to extend beneath most of the site. Topography slopes gently westwards from around 50.6m AOD to 49.1m AOD.

The basement has a surface cover of concrete. The surface cover of the ground floor warehouse units comprises varying thicknesses of concrete, including raised levels surrounding, and extending beyond, loading bays into the main warehouse facilities.

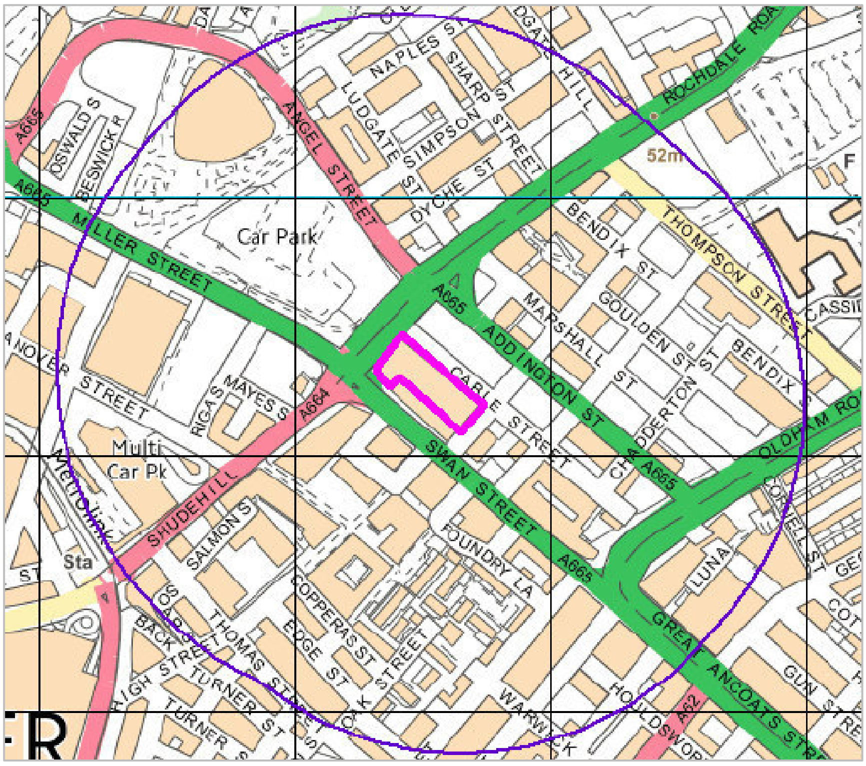


Figure 2.1 *– Site Location Plan, approximate site boundary outlined in pink and 250m buffer in purple. (Landmark Information Group)*

2.2 Previous Site Use

The earliest mapping (1848) shows the site is fully developed, occupied by Cable Street Mill with residential properties in the northwest of the site. During WWII, ruins are noted in the vicinity of the site with building no longer recorded potentially due to bomb strike. In 1948, the site is noted as a warehouse with an extension recorded in western corner in 1951. The site remains unchanged to present day.

2.3 Published Geology

A review of British Geological Survey (BGS) map, 1:50,000 Scale, Solid and Drift Editions, Manchester, Sheet 85, 2011, indicates the following geological sequence:

- Glacial Till; and
- Chester Formation (formerly Chester Pebble Beds) .

There are no BGS faults recorded on site. The nearest BGS recorded available borehole is located 20m northwest, details of which are presented in *Table 2.3* below.

***Table 2.3** – Historical Borehole Record from Surrounding Area*

Borehole Ref.	Location (Easting, Northing)	Details (depth to top of strata/lithology/thickness)
SJ89NW28	20m north west (384457,398885)	0.00m bgl MADE GROUND (1.83m) 1.83m bgl Silty CLAY (3.66) 5.49m bgl CLAY (3.65m) 9.14m bgl Fine SAND (5.34m) 14.48m bgl GRAVEL & SAND (0.46m) 14.94m bgl CLAY (2.05m) 16.99m bgl Red SAND (0.92m) 17.91m bgl Red SANDSTONE (8.00m) ***25.91m bgl borehole termination***

2.3.1 Made Ground Deposits

The BGS maps do not indicate made ground on site, however given the historic land use made ground is anticipated. Given the site setting, it is considered likely that a thickness of made ground is present beneath the site.

2.3.2 Superficial Deposits

Glacial Till deposits comprising sandy, silty clay with gravels and pebbles and laminated sand layers. Local boreholes indicate cohesive superficial deposits to 9.14m bgl underlain by granular soils.

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2.3.3 Bedrock Deposits

Bedrock deposits are present as Chester Formation (formerly Chester Pebble Beds) of *Early Triassic Age,* comprising sandstone. Local boreholes indicate bedrock from approximately 17.91m bgl.

There are no BGS fault lines located beneath the site.

2.3.4 Mining and Quarrying

The site is located within a Coal Mining Reporting Area, however the site is approximately 1km southwest of a coal outcrop and the nearest mine entry is located over 1km to the northeast. The site is not within an area that has been influenced by past or probable shallow coal mine workings.

There are no recorded Mineral Sites within 500m of the site.

It is considered unlikely that relic mining features are present on site and as such, have not been considered further.

2.3.5 Other Pertinent Geological Existing Geological Records

The previous reports identified a low risk to no hazard from the following ground stability hazards on and around the site; running sands, collapsible ground, landslides, shrinking or swelling cl\ay, compressible ground and ground dissolution.

UK Radon Mapping confirms the site is situated in an area where less than 1% of homes are above the radon action level. If 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 geological sequence underlying the site has the following hydrogeological characteristics:

Table 2.4 *– Geological/Hydrogeological Succession*

Geology	Associated Hydrogeological Classification
Made Ground deposits are not indicated to be present	N/A
Glacial Till	Secondary Undifferentiated Aquifer[1]
Chester Formation	Principal Aquifer[2]

Notes:

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1. *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.*
2. *Layers of rock or drift deposits that have high intergranular and/or fracture permeability meaning they usually provide a high level of water storage*

The nearest surface water feature is the River Irk located 304m west of the site flowing from northeast to southwest. The site is not located within a Source Protection Zone (SPZ).

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

2.5 Landfill

There are no licenced or historical landfill sites within 500m of the site.

2.6 Unexploded Ordnance (UXO) Risk Assessment

Risk mapping for UXO's has placed the site in a moderate risk area. Moderate risk areas are those that show a density of bombing hits of 11-50 bombs per 1000 acres and may contain potential WWII targets. Further action may be required to mitigate UXO risk is essential in moderate risk areas.

From the historic mapping, the building currently onsite has been there since before WWII, however it also records ruins surrounding the site and many other buildings disappear during this period.

Analysis of online historical mapping shows fire bomb strikes (80m east, 100m southwest and 120m south) and demolished/damaged buildings and ruins (from 20m southeast, from 50m northwest, 70m northwest, 80m west and northeast and 100m south) surrounding the site, as shown in *Figure 2.6* below.



***Figure 2.6** – Map of bomb damage in Manchester from WWII (red line shows site boundary, red circles show locations of fire bombs, red shading shows locations of demolished buildings).*
Copyright 2016 The University of Manchester.

A Detailed Unexploded Ordnance (UXO) Risk Assessment report for the site was recently obtained on behalf of the Client with reference to the proposed construction works and is included within *Appendix G*. The report concludes a **Low** risk to construction workers from unexploded ordnance within the site's soils.

The following is recommended for all intrusive works:

- UXO Risk Management Plan;
- Site Specific UXO Awareness Briefings to all personnel conducting intrusive works.

2.7 Summary of Phase 1 PCSM

A summary of potential pollutant linkages at the development site identified in the previous Phase 1 reports (Ref. 1) is 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 construction/ demolition onsite; and • Potential contamination associated with historic site use as a Mill.	Direct contact/ ingestion and inhalation	Site End Users	**Moderate**
	Horizontal and vertical migration of contaminants through superficial soils	Groundwater (Principal Aquifer)	**Moderate/ Low**
		Groundwater (Secondary Undifferentiated Aquifer)	
		Surface Water (River Irwell)	**Very Low**
Production of ground generating gases from Made Ground deposits containing organic/ putrescible content.	Vertical and horizontal migration through existing service corridors and the underlying superficial deposits	Site End Users	**Moderate/ Low**

Potential contaminants of concern associated with the sources identified within the Conceptual Site Model in *Section 6.0* of this reporting include but are not limited to: broad range aliphatic and aromatic hydrocarbons present within any fuel oils; polycyclic aromatic hydrocarbons (PAHs); inorganic compounds including heavy metals; and asbestos present in discarded building materials.

Potential contaminants associated with the airborne dust/particulates include but are not limited to: polycyclic aromatic hydrocarbons and inorganic compounds including toxic metals that are also accounted for by potential onsite contaminants of concern.

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The qualitative risk assessment determined the above risks associated with the proposed development of the site warrant further investigation. However, risks to surface waters is Very Low and therefore do not warrant further investigation.

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3.0 Phase 2 Investigation Scope of Works

The Stage 1 Pre-Demolition ground investigations works were undertaken between 10th – 14th September 2018 and comprised four window sample boreholes at ground level and three window samples within the existing basement; and the Stage 2 Pre-Demolition ground investigations works were undertaken between 19th – 29th January 2021.

The scope of the ground investigation was designed in general accordance with current UK guidance including Land Contamination Risk Management (LCRM) (Ref. 2), BS10175:2011+A2:2017 (Ref. 3), BS5930:2015+2020 (Ref. 4) and BSEN1997: Part 2:2007 Eurocode 7 (Ref. 5).

The scope and rationale are summarised in *Table 3.0*.

***Table 3.0** – Scope and Rationale of Fieldwork Undertaken*

	Exploratory Hole Type	Exploratory Hole Reference	Ground Level (m AOD)	Exploratory Hole Depth (m bgl)	Rationale
Stage 1 GI	Window Sample Boreholes continued with Dynamic Probing	WS01 WS02 WS03 WS04 WS05 WS06 WS07	50.90 51.00 51.10 51.10 -[1] -[1] -[1]	5.00 5.00 5.00 3.00 1.17 5.00 5.00	Confirm shallow ground conditions. Collect soil samples for chemical and geotechnical testing. Undertake in-situ testing. Gas and groundwater monitoring in 6 No. boreholes.
Stage 2 GI	Sonic Boreholes	BH101 BH101A BH102 BH103	49.95 50.10 50.42	1.50 40.00 40.00 40.00	Confirm deeper ground conditions Collect soil, rock and water samples for chemical and geotechnical analysis Undertake in-situ testing. Gas and groundwater monitoring in 3 No. boreholes

-[1] window sample boreholes located in the basement do not have estimated ground levels.

All exploratory holes were advanced alongside down-hole magnetometry surveying, undertaken by an unexploded ordnance specialist, 1st Line Defence.

For information regarding the location of the exploratory hole locations, refer to Curtins drawing ref. 077409-CUR-00-XX-DR-GE-80002-P01, contained within *Appendix A*. Ground levels for each of the exploratory holes were estimated from the available survey drawings and added to the exploratory hole logs.

3.1 Soil Logging and Sampling

Exploratory borehole arisings were logged on site by a qualified Engineer. All exploratory holes were logged in accordance with the requirements of BS5930:2020 (Ref. 4) including recording observed visual and olfactory indications of contamination.

Exploratory hole logs are provided in *Appendix B*.

3.2 Monitoring Well Installations

Ground gas and groundwater monitoring slotted 50mm diameter pipes were installed within 6 no. window sample boreholes and within 3 no. sonic 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 aggregate surround was installed in the annulus between the sides of the borehole and the slotted sections of pipe.

The monitoring wells were primarily designed to assess the potential for ground gas and to collect groundwater where possible. The screened sections therefore focused on the more permeable near surface deposits which are likely to be producing ground gas.

The installed response zones are summarised in *Table 3.2* below.

Table 3.2 – *Monitoring Well Response Zones*

	Borehole Ref.	Response Zone(s) m bgl (m AOD)	Strata Description(s)
Stage 1	WS01	1.00 – 4.00 (49.90 – 46.90)	Cohesive glacial till
	WS02	2.00 – 5.00 (49.00 – 46.00)	Cohesive glacial till
	WS03	0.50 – 3.50 (50.60 – 47.60)	Made ground and cohesive glacial till
	WS04	1.00 – 2.00 (50.10 – 49.10)	Made ground
	WS06	1.50 – 2.00	Cohesive glacial till
	WS07	5.00 – 10.00	Cohesive glacial till
Stage 2	BH101A	5.00 – 15.00 (44.95 – 34.95)	Cohesive and granular glacial till
	BH102	22.00 – 32.00 (28.10 – 18.10)	Chester Formation (formerly Chester Pebble Beds) (sandstone)
	BH103	1.00 – 5.00 (49.42 – 45.42)	Made ground and cohesive glacial till

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

3.3 Post-Investigation Monitoring

3.3.1 Ground Gas and Groundwater Monitoring

For the Stage 1 works, six ground gas and groundwater monitoring visits were completed between 25/09/2018 and 31/01/2019 and for the Stage 2 works, four ground gas and groundwater monitoring visits have been completed between 05/02/2021 and 05/03/2021 to assess the groundwater and ground gas conditions as identified in the Preliminary Conceptual Site Model in *Section 2.0.*

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4.0 Laboratory Analysis

Representative soil samples were selected for laboratory geotechnical and chemical testing, based on field observations, to inform the proposed works. Representative groundwater and rock samples were selected for laboratory chemical and geotechnical testing respectively.

Selected environmental soil, water and rock 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 laboratory selected by Curtins for chemical analysis was Envirolab (UKAS and MCERTS accredited) and for geotechnical analysis was Structural Soils (UKAS accredited).

Given the potential site wide source of contamination (Made Ground) the sampling positions were generally located in a non-targeted, systematic array to give adequate and representative coverage of the site's proposed end use and the immediate environmental setting, concentrating in the made ground.

4.1 Environmental Chemistry Analysis

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

***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
	Sulphate (total)	200 mg/kg
	Sulphide	2 mg/kg
	Sulphur (elemental)	20 mg/kg
	Phenols (screen)	1 mg/kg
	PAHs (USEPA 16)	0.1 mg/kg
	TPH (Aro/Ali Split)	0.01 to 0.1 mg/kg
WAC E	Inert, SNRHW + Hazardous Landfills (2 Stage)	

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In the Stage 1 SI, 8no. samples were taken from made ground soils beneath the loading bays in addition to 5no. samples taken from superficial soils directly below made ground. The soil samples were tested for Curtins Suite A.

In the Stage 2 SI, a total of 2no. made ground soil samples were taken on site and tested for Curtins Soils Suite A and Waste Acceptance Criteria (WAC) testing.

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

4.2 Groundwater Analysis

The source material of 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	1 mg/l
	Arsenic, Lead, Nickel, Selenium, Zinc	1 µg/l
	Boron (water soluble), Chromium, Copper, Mercury, Phenols (screen)	0.1 µg/l
	Cadmium	0.5 µg/l
	Cyanide, Sulphide	0.2 mg/l
	Sulphate	10 mg/l
	PAHs (USEPA16)	0.01 µg/l
	TPH (Aro/Ali Split)	10 µg/l

No groundwater samples were obtained from the shallow Stage 1 shallow exploratory hole locations. Groundwater samples were obtained from BH102 and BH103 following the Stage 2 investigation, representing deeper groundwater and shallow (perched) groundwater respectively; and tested for the above suite.

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

4.3 Geotechnical Analysis

Soil samples for testing were prepared in accordance with BS1377: Part 1:2016 (Ref. 6). Rock samples for geotechnical testing were prepared and tested in accordance with ISRM Suggested Methods (Ref.

7). The geotechnical testing undertaken as part of the Stage 1 and Stage 2 investigations are summarised in *Table 4.3*.

***Table 4.3 –** Geotechnical Testing*

	Test Type	Quantity	Standard
Stage 1	Moisture Content	5	BS1377 1990, Part 2 (clause 3.2)
	Atterberg Limit	5	BS1377 1990, Part 2 (clause 4.5, 5.3 & 5.4)
	pH	10	BS1377 1990, Part 3 (clause 9.4 & 9.5)
	Water Soluble Sulphate 2:1 SO_4	10	BS1377 1990, Part 3 (clause 5.3 & 5.5)
Stage 2	Moisture Content	9	BS1377 1990, Part 2 (clause 3.2)
	Atterberg Limit	8	BS1377 1990, Part 2 (clause 4.5, 5.3 & 5.4)
	pH	13	BS1377 1990, Part 3 (clause 9.4 & 9.5)
	Water Soluble Sulphate 2:1 SO_4	13	BS1377 1990, Part 3 (clause 5.3 & 5.5)
	Particle Size Distribution Testing	1	BS1377 1990, Part 2 (clause 9.2)
	Quick Undrained Triaxial Multistage	4	BS1377 1990, Part 7 (clause 9.0)
	Oedometer	2	BS 1377 1990, Part 5
	Point Load Index Test	12	ISRM 1974-206
	Unconfined Compressive Strength	11	ISRM 1974-206

The results of the geotechnical testing are summarised in *Section 6.0* of this report. Copies of the geotechnical testing certificates are presented in *Appendix D*.

4.4 Quality Assurance and Quality Control

Soil and water chemical analysis was conducted by Envirolab, a UKAS and MCERTS accredited laboratory. Geotechnical testing was conducted by Structural Soils, a UKAS accredited laboratory. All samples were delivered in appropriate containers for the suites tested and analysed within the recommended holding times. No deviations were recorded at the time of analysis.

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5.0 Encountered Ground Conditions

The ground conditions across the site, determined during the Stage 1 2018 and Stage 2 2021 ground investigation works, generally comprise concrete overlying granular and cohesive made ground. Cohesive glacial till was recorded beneath the made ground, itself underlain by granular glacial till. Superficial deposits were underlain by the Chester Formation.

5.1 General

A summary of the ground conditions encountered during the ground investigation works is presented in *Table 5.1,* with detailed information presented in the exploratory hole logs included in *Appendix B*.

***Table 5.1 –** Summary of Ground Conditions Encountered*

Strata	Depth to Top of Strata		Depth to Bottom of Strata		Thickness	
	Min m bgl (m AOD)	Max m bgl (m AOD)	Min m bgl (m AOD)	Max m bgl (m AOD)	Min m bgl (m AOD)	Max m bgl (m AOD)
Made Ground	0.00 (49.95)	0.00 (51.10)	0.25 (48.30)	3.00 (50.43)	0.28	1.40
Glacial Till (Cohesive)	0.25 (48.30)	3.00 (50.43)	10.00[1] (37.10)	13.00[1] (40.42)	8.20[1]	12.80[1]
Glacial Till (Granular)[1]	10.00 (37.10)	13.00 (40.42)	15.00 (32.95)	17.00 (35.10)	2.00	6.00
Residual Soils[1]	15.00 (32.95)	17.00 (35.10)	20.00 (26.22)	24.20 (29.95)	3.00	8.20
Chester Formation[1]	20.00 (26.22)	24.20 (29.95)	40.00[2] (<9.95)	-[2]	16.00	-[2]

[1] – Data taken from BH101A, BH102 and BH103
2 – Thickness not proved

5.2 Made Ground

Concrete was encountered in the window samples boreholes in the basement (WS05 – WS07) ranging in thickness from 0.25m to 1.17m.

The window samples (WS01-WS04) undertaken in the loading bays encountered concrete, between 0.13m and 0.31m thick, underlain by a granular made ground and a second layer of concrete between 0.13m and 0.15m.

The sonic boreholes (BH101A-BH103) typically encountered concrete from ground level to depths between 0.40m and 0.60m. The concrete was typically encountered in the following sequence; concrete slab, concrete block, concrete slab and reinforced concrete.

WS04 recorded 0.11m of light brownish grey and black Gravel of concrete and asphalt, below the initial layer of Concrete. The Sand sub-base within WS02 was discoloured (dark greyish-brown) with a slight hydrocarbon odour, possibly indicative of a fuel oil spillage.

In WS02, WS03, WS04, BH101A, BH102 and BH103, made ground soils were recorded underlying the concrete. No made ground soils were encountered underlying the concrete in WS06 and WS07 located within the basement. The base of the concrete in WS05, also located in the basement, was not encountered.

Granular made ground was encountered in WS02-WS04 and BH102-BH103. WS02 recorded black slightly silty fine to medium sand with rare cobbles of brick to 1/05m bgl. WS03 and WS04 recorded brown/black gravelly fine to coarse sand to depths between 1.13m and 1.30m bgl and gravelly typically comprised brick, concrete, clinker and slate. Additional granular layers were recorded in WS04 recorded as light red medium grained sandstone masonry below gravelly Sand, underlain by limestone gravel and gravels of brick, concrete and slate, to a recorded depth of 2.25m bgl.

The granular made ground soils encountered in BH102 and BH103, to depths between 0.45m and 1.00m bgl, comprised reddish brown angular to subangular, fine to coarse gravel of brick.

Cohesive made ground was typically encountered underlying granular made ground in WS02-WS04 and BH101A-BH103. It typically comprised brown/dark brown sandy slightly gravelly clay to depths between 0.65m (BH101A) and 2.80m bgl (WS03). Gravel typically comprised sandstone, brick, concrete and coal.

In WS04, between 2.70m and 3.00m bgl, and BH103, between 1.80m and 2.50m bgl, a soft brown grey clay was encountered. In WS04 rare plant/wood fragments and a slight organic odour was noted. Dynamic probing in WS04 suggests the base of the soft clay was encountered at approximately 4.10m bgl.

5.3 Glacial Till

5.3.1 Cohesive Glacial Till

Superficial deposits comprising glacial till deposits were encountered underlying the made ground in all exploratory holes, except WS04 and WS05, which were terminated in made ground and in concrete, respectively.

In WS06 and WS07, located within the basement, natural clay deposits were encountered directly underlying the concrete floor slab.

The glacial till deposits were generally cohesive to maximum depths between 10m (37.10m AOD) and 13m bgl (40.42m AOD). The deposits are typically described as stiff brown with rare to occasional light brown/grey mottling slightly sandy slightly gravelly clay. Localised firm sandy

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slightly gravelly clay was encountered in WS03 (2.80m – 3.20m bgl), WS06 (3.50m – 3.80m bgl) and WS07 (3.90m and 5.00m bgl). Gravel typically comprises angular to subrounded, fine to medium of sandstone and coal.

5.3.2 Granular Glacial Till

Granular glacial till deposits were recorded underlying cohesive deposits in BH101A-BH103 to depths between 15m (32.95m AOD) and 17m bgl (35.10m AOD).

Deposits typically comprised dense to very dense brown slightly gravelly medium to coarse sand. Gravel is typically subrounded to well-rounded of sandstone.

5.4 Residual Soils (Weathered Bedrock)

Deposits indicative of heavily weathered bedrock were encountered in BH101A, BH102 and BH103 from depths of 15m (32.95m AOD) to 17m bgl (35.10m AOD) with a thickness between 3.00m (BH101A) and 8.20m (BH103).

Weathered bedrock was typically recorded as very dense red brown slightly gravelly medium to coarse sand. Gravel is subangular to subrounded, fine to medium of sandstone. The residual soils were distinguished from the granular glacial till by the reddish colour of the weathered bedrock.

5.5 Chester Formation

Solid geology of the Chester Formation was encountered in BH101A ((29.95m AOD), BH102 (28.10m AOD) and BH103 (26.22m AOD). The base of the deposit was not encountered with the boreholes terminated at 40m bgl (9.95-10.42m AOD).

The bedrock comprised weak to medium strong reddish brown fine to coarse sandstone. Shallow bedrock encountered was noted to be highly weathered. Fracture spacing was variable ranging from very closely spaced to medium spaced.

Details of the bedrock and a photographic log of the rock cores obtained can be referred to in the exploratory hole logs in *Appendix B*.

5.6 Observed Potential Contamination

A slight hydrocarbon odour was recorded in WS02 between 0.31m and 0.35m bgl, associated with a possible fuel oil spill onto a sand sub-base. It should be noted WS02 was adjacent to an inspection pit possibly used as a garage.

A similar sub-base was encountered in WS01, WS03 and WS04 though no evidence of contaminations was identified in these exploratory holes.

5.7 Obstructions Encountered

The following obstructions were encountered during site works detailed in *Table 5.7* on the following page.

Table 5.7 – *Obstructions Encountered*

Borehole Ref.	Obstruction	Depth (m bgl)
WS05	Hand pit terminated due to concrete possibly associated with existing foundations/basement wall	1.17
WS04	Deviation of drilling rig's sampler due to medium sized obstructions (bricks, concrete etc.) within made ground	0.00 – 2.25
BH101	Borehole terminated due to concrete slab at 1.50m.	1.50

5.8 Groundwater

A summary of the groundwater levels recorded during the siteworks is presented in *Table 5.8a*. Boreholes that did not record groundwater strikes during the investigations have not been referenced.

Table 5.8a – *Groundwater Noted During Ground Investigation*

	Borehole Ref.	Water Strikes			
		Strike Depth m bgl (m AOD)	Water Depth after 20 mins m bgl (m AOD)	Strata	Notes
Stage 1 GI	WS03	2.80 (48.30)	2.80 (48.30)	Made ground	Rising
Stage 2 GI	BH101A	14.00 (35.95)	12.90 (37.05)	Granular glacial till	Rising
	BH102	15.00 (35.10)	12.00 (38.10)	Granular glacial till	Rising
	BH103	16.00 (34.42)	12.40 (38.02)	Granular glacial till	Rising

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Six groundwater level monitoring visits, associated with Stage 1 GI, were undertaken between 25th September 2018 and 31st January 2019. Four groundwater level monitoring visits, associated with Stage 2 GI, were undertaken between 5th February and 5th March 2021. The results of which are presented in *Table 5.8b below.*

Table 5.8b – *Groundwater Monitoring Results*

	Borehole Ref.	Installation Strata	Depth m bgl (m AOD)					
			25/09/2018	10/10/2018	23/10/2018	13/11/2018	23/01/2019	31/01/2019
Stage 1 GI	WS01	Clay	Dry	Dry	Dry	Dry	Dry	-[1]
	WS02	Clay	Dry	4.61 (46.39)	4.55 (46.45)	4.52 (46.48)	4.45 (46.55)	4.31 (46.69)
	WS03	Made Ground/Clay	2.73 (48.37)	2.70 (48.40)	2.70 (48.40)	2.75 (48.35)	2.75 (48.35)	2.75 (48.35)
	WS04	Made Ground	Dry	Dry	Dry	Dry	Dry	Dry
	WS06[2]	Clay	2.73	2.46	-[1]	2.60	3.00	-[1]
	WS07[2]	Clay	1.23	1.19	-[1]	1.24	1.20	-[1]
	Borehole Ref.	**Installation Strata**	**05/02/2021**	**11/02/2021**	**18/02/2021**	**05/03/2021**		
Stage 2 GI	BH101A	Clay/Sand	14.25 (35.70)	14.30 (35.65)	14.33 (35.62)	-[1]		
	BH102	Sandstone	24.46 (25.65)	24.63 (25.47)	24.29 (25.81)	24.57 (25.53)		
	BH103	Made Ground/Clay	2.80 (47.62)	3.59 (46.83)	3.34 (47.08)	3.53 (46.89)		

1) Borehole inaccessible
2) Located in the basement, no estimated ground level available.

The groundwater level monitoring of both shallow and deeper installations has shown that the site is underlain by both perched water and deeper groundwater. The perched water is located within the Made Ground and top of the cohesive glacial till, while deeper groundwater is recorded at circa 14.30m bgl (35.65m AOD) in BH101A within the granular glacial till; and at circa 24.3-24.6m bgl (25.5-25.8m AOD) within the bedrock in BH102.

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6.0 Ground Model

6.1 Made Ground

Concrete was encountered within all exploratory hole locations from ground level to depths between 0.25m and 1.17m bgl. Made ground was encountered underlying the concrete in WS02-WS04 and BH101A-BH103 encountered as granular and cohesive soils.

Due to the variable nature of Made Ground, this layer is not deemed a suitable founding stratum. As such, parameters have not been derived for the Made Ground.

Table 6.1 – *Summary of geotechnical test results – Made Ground*

Parameter	No. of tests	Minimum	Maximum
pH	10	7.45	9.53
Water Soluble Sulphate (mg/l)	10	60	1480
SPT 'N' Value	6	2	30

6.2 Glacial Till

Glacial till deposits were recorded underlying the Made Ground, typically recorded as cohesive (8.2-12.8m thick) underlain by granular material at depths of 10-13m bgl (37.10-40.42m AOD, 2-6m thick).

6.2.1 Cohesive Glacial Till Deposits

The geotechnical tests recorded within the cohesive deposits are summarised in *Table 6.2.1a*.

Table 6.2.1a – *Summary of geotechnical test results – Glacial Till*

Parameter	No. of tests	Minimum	Maximum
Moisture Content (%)	13	15	34
Liquid Limit (%)	13	33	54
Plastic Limit (%)	13	14	25
Plasticity Index (%)	13	16	29
Modified Plasticity Index (%) (1)	13	15.81	29
pH	21	8.05	9.24
Water Soluble Sulphate (mg/l)	21	36	240
Undrained Shear Strength from Undrained Triaxial Test (kPa)	4	86	142
SPT 'N' Value (2)	39	10	49

(1) Modified plasticity index is the plasticity of components <425µm.
(2) Only includes SPTs tests in which full penetration was achieved.

The Atterberg Tests results indicate a low to intermediate plasticity and low to medium volume change potential. The Plasticity Indices were generally between 16% and 23%. A high moisture content, liquid limit and plasticity index were recorded in BH101A at 1.00m bgl. The results of the Atterberg Limits are presented on *Figure 6.2.1b* and *Casagrande graphs* are presented in *Appendix D*.

A moderately conservative unit weight of 19kN/m^3 is deemed suitable for firm to very stiff cohesive soils in accordance with BS8002:2015 (Ref. 8).

The Undrained Shear Strength (Cu) of the Glacial Till Deposits (Cohesive) has been determined from the relationship between SPT N values and the Plasticity Indices (PI), after Stroud, 1975, (Ref. 9) as presented in *Equation 1:*

$$Cu=f_1 \times SPT\ N \qquad \textbf{Equation 1}$$

Where:

Cu is the Undrained Shear Strength

f_1 is the Stroud Factor determined from Figure 1.5 (Ref. 9)

A f_1 value of 5.5 is deemed suitable for the average PI of 20%, determined from Atterberg test results and in line with the recommendations given in CIRIA C504 for a site specific approach with regards to f_1 values in tills. On this basis , Cu values of between 55.0 kPa to 269.5 kPa are calculated, corresponding with medium to very high strength material (BS 5930, 2015+2020). The Cu values, shown in *Figure 6.2.1c*, indicate lateral and vertical variability, particularly in shallow soils. Four Unconsolidated Quick Undrained Triaxial Compression Tests were taken on U100 samples recording Cu values between 86kPa and 143kPa correlating with calculated values, *Figure 6.2.1c* and indicative of High Strength material (BS 5930, 2015+2020).

It should be noted that the Unconsolidated Quick Undrained Triaxial Compression Test in BH101A at 12mbgl does not correlate well with those calculated by the Stroud formula for other boreholes at the same depth. Inspection of the logs at this depth does not indicate an obvious reason for the difference nor is an issue in the laboratory reported. It is recommended that the estimated values are used with caution.

A moderately conservative Coefficient of Consolidation, Mv, of the cohesive soils can be estimated from the correlation between Plasticity Indices (PI) and SPT N values (Ref. 9) described by Equation 2:

$$Mv=1/(f_2 \times SPT\ N) \qquad \textbf{Equation 2}$$

Where:

Mv is the coefficient of consolidation

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f_2 is the Stroud Factor determined from Figure 1.5 (Ref. 9)
SPT N is Characteristic Standard Penetration Test Result

Using an f2 factor of 0.55 for an average plasticity index of 20%, Mv values typically range between 0.037 and 0.18 m^2/MN indicating very low to medium compressibility. The compressibility generally decreases with depth. Two Dimensional Consolidation Tests were taken on U100 samples recording Mv values between 0.0067m^2/MN and 0.16m^2/MN correlating with calculated values, shown in *Figure 6.2.1d*

The Angle of Shearing Resistance, ϕ', for the cohesive Glacial Till has been derived from the correlation with Plasticity Indices (Ref. 10). The values are shown in *Figure 6.2.1e*.

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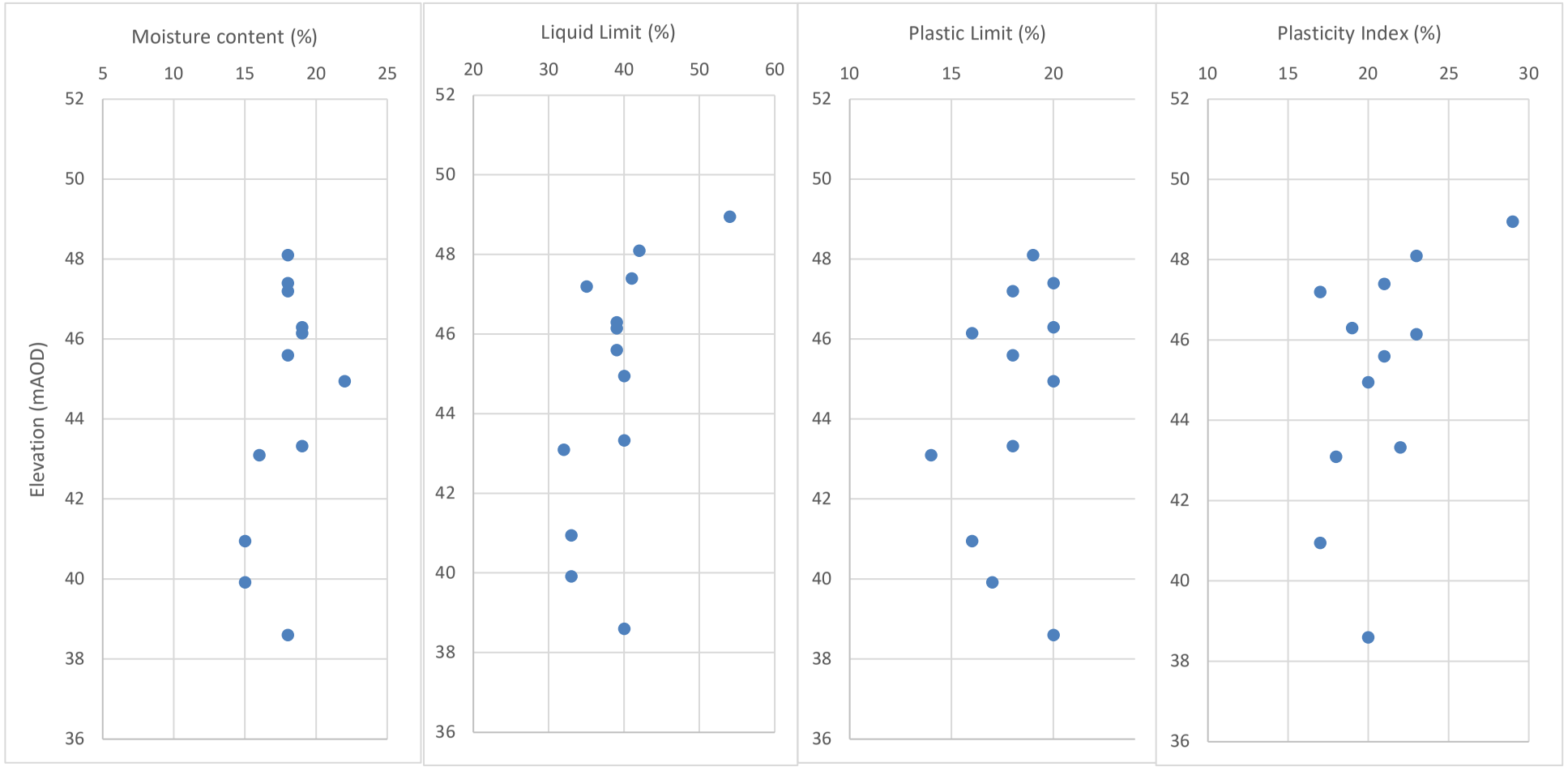


***Figure 6.2.1a** – Summary of Atterberg Test Results*

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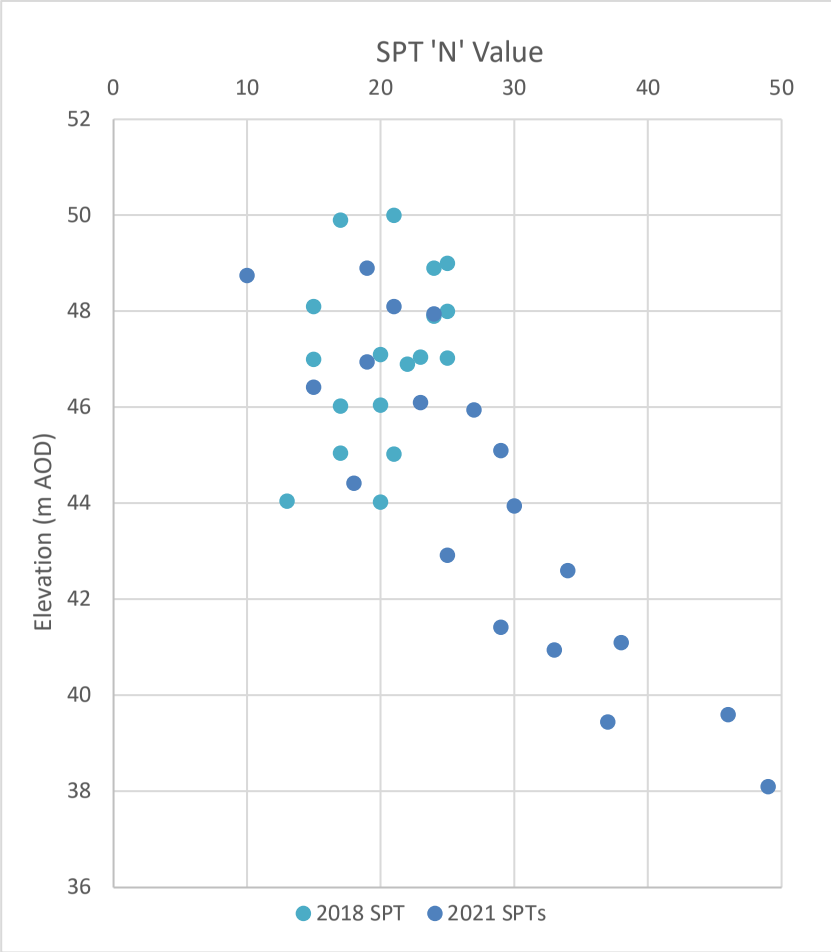


Figure 6.2.1b – *Standard Penetration Test vs. Depth*

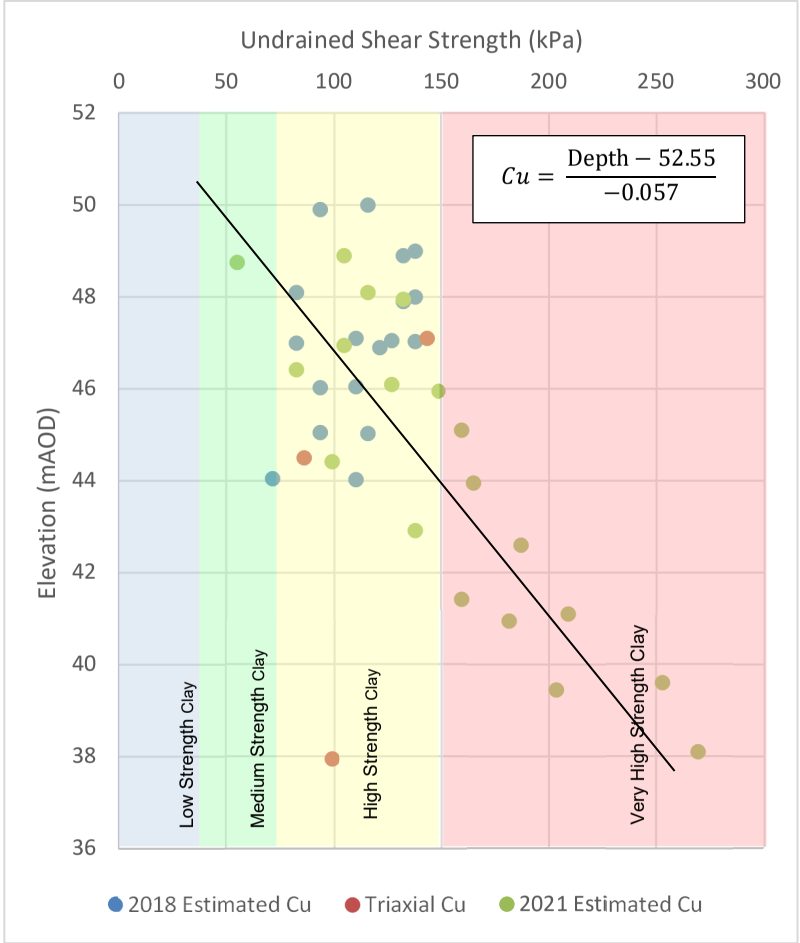


Figure 6.2.1c – *Estimated Undrained Shear Strength vs Depth*

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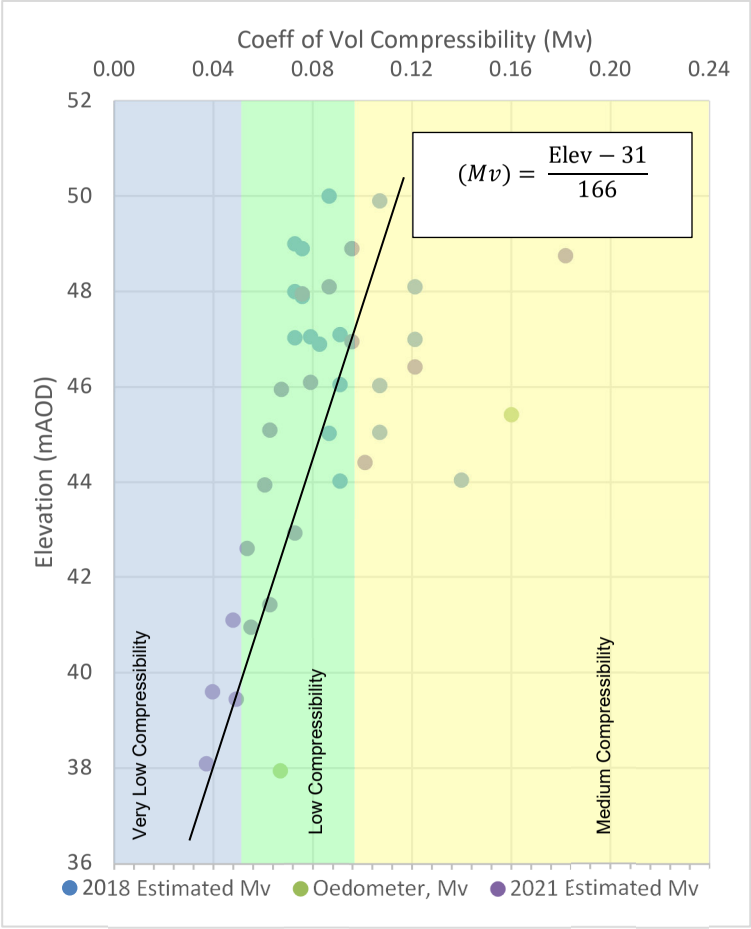


***Figure 6.2.1d** – Estimated Volume Compressibility Coefficients (Mv) vs Depth*

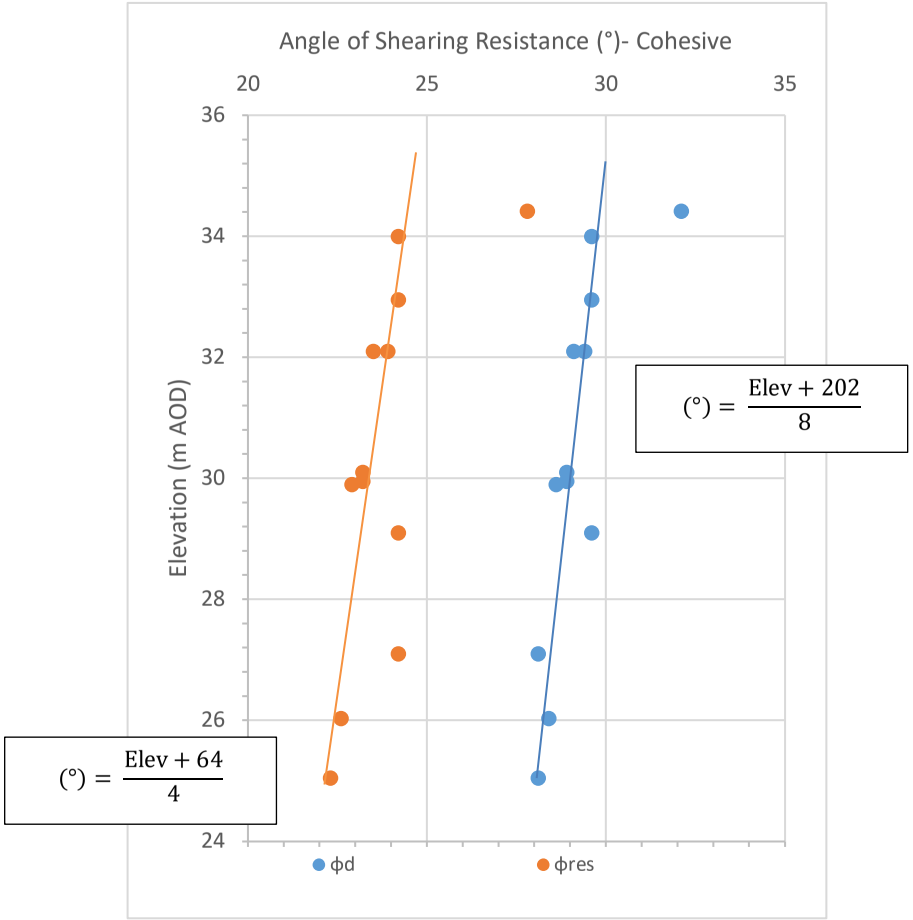


***Figure 6.2.1e** – Angle Shearing Resistance (Cohesive) vs Depth*

6.2.2 Granular Glacial Till Deposits

The geotechnical test results recorded within the granular deposits are summarised in *Table 6.2.2*.

Table 6.2.2 – *Summary of granular geotechnical test results*

Parameter	No. of tests	Minimum	Maximum
pH	1	9.19	-
Water Soluble Sulphate (mg/l)	1	10	-
SPT 'N' Value Granular (1)	5	31	36

(1) Only includes SPTs tests in which full penetration was achieved.

Eight SPT 'N' values were recorded in the granular strata, ranging between 31 and 36. Three SPT 'N' values were 50 indicating refusal. The SPT 'N' values indicate dense to very dense deposits. The results are shown in *Figure 6.2.2a*.

A moderately conservative characteristic unit weight of 19kN/m^3 above the water table and of 22kN/m^3 below the water table is deemed suitable for dense to very dense granular deposits in accordance with BS8002:2015 (Ref. 8)

A moderately conservative characteristic Angle of Shearing Resistance (ϕ') has been derived from correlation with SPT N values (Peck et al, 1967, Ref 11) and a review of published values. The results are shown in *Figure 6.2.2b*.

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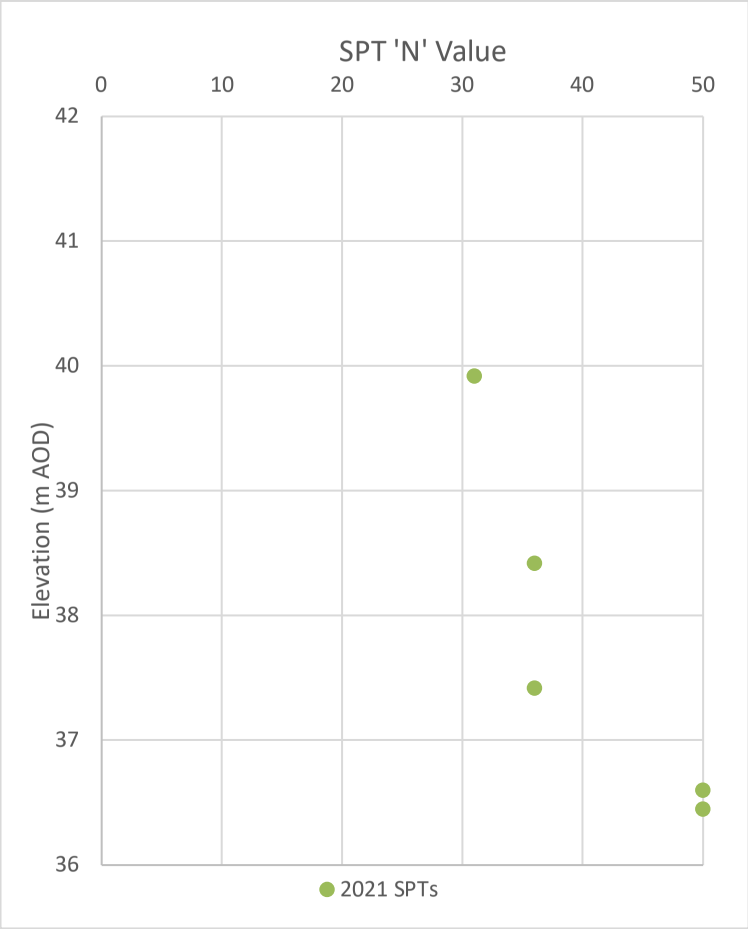


***Figure 6.2.2a** – Standard Penetration Test vs. Depth*

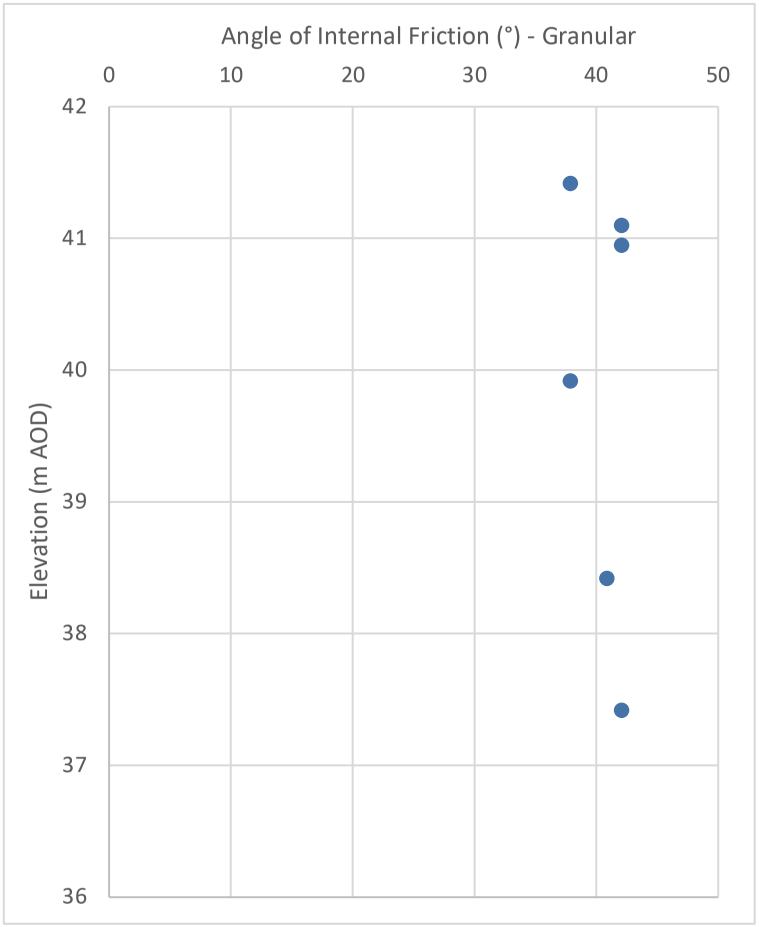


***Figure 6.2.2b** – Angle of Internal Friction (Granular) vs Depth*

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6.3 Chester Formation

The Chester Formation was encountered in three exploratory holes (BH101A-BH103) in the 2021 ground investigation, recovered as Residual Soils at 15-17m bgl (32.95-35.10m AOD), underlain by Chester Formation bedrock at 20-24.20m bgl (26.22-29.95m AOD).

6.3.1 Residual Soils (Weathered Bedrock)

The geotechnical test results recorded within the weathered bedrock deposits are summarised in *Table 6.3.1*.

Table 6.3.1 – *Summary of granular geotechnical test results*

Parameter	No. of tests	Minimum	Maximum
pH	2	9.14	9.38
Water Soluble Sulphate (mg/l)	2	10	-
PSD% Cobbles Gravel Sand Silt/Clay	1	 0 0 89 11	-
SPT 'N' Value Granular (1)	1	46	-

(1) Only includes SPTs tests in which full penetration was achieved.

Eight SPT tests were undertaken within the weathered bedrock deposits recording one value of 46 and seven values >50 (refusal) indicating very dense deposits.

A moderately conservative characteristic unit weight of 20kN/m^3 above the water table and of 23kN/m^3 below the water table is deemed suitable for very dense granular deposits in accordance with BS8002:2015 (Ref. 8)

A moderately conservative characteristic Angle of Shearing Resistance (ϕ') of 42° has been derived from correlation with SPT N values (Peck et al, 1967, Ref 11) and a review of published values.

6.3.2 Chester Formation

The Chester Formation was encountered below the residual soils at depths of between 20.0m, 22.0m and 24.2m bgl in BH101A, BH102 and BH103, respectively.

The bedrock comprised weak to medium strong reddish brown fine to coarse sandstone. Shallow bedrock encountered was noted to be highly weathered. Fracture spacing was variable ranging from very closely spaced to medium spaced.

Some assumed zones of core loss were recorded likely due to high degree of local weathering of the strata and are summarised in *Table 6.3.2a*. There were zones of non-intact core recorded in the exploratory holes, details of which can be referred to in exploratory hole logs in *Appendix B*.

Table 6.3.2a – *Summary of Zones of Core Loss*

Exploratory Hole ID	Core Loss Depth (m bgl)	Core Loss Depth (m AOD)
BH101A	20.00 – 20.65	29.95 – 29.30
	21.50 – 21.73	28.45 – 28.22
	22.95 – 23.35	27.00 – 26.60
	24.50 – 25.50	25.45 – 24.45
	25.90 – 26.00	24.05 – 23.95
	28.67 – 29.50	21.28 – 20.45
	31.82 – 32.00	18.13 – 17.95
	33.40 – 33.50	16.55 – 16.45
	35.05 – 35.50	14.90 – 14.45
	37.83 – 38.00	12.12 – 11.95
	39.40 – 39.50	10.55 – 10.45
BH102	23.20 – 24.15	26.90 – 25.95
	26.00 – 26.50	24.10 – 23.60
	29.35 – 30.12	20.75 – 19.98
	32.28 – 32.50	17.82 – 17.60
	36.83 – 37.10	13.27 – 13.00
	39.88 – 40.00	10.22 – 10.10
BH103	26.40 – 26.83	24.02 – 23.59
	30.65 – 31.00	19.77 – 19.42
	33.90 – 34.00	16.52 – 16.42
	35.43 – 35.50	14.99 – 14.92
	38.28 – 38.50	12.14 – 11.92

Rock Quality Designation (RQD) recorded in the sandstone cored samples ranged from 0 to 95% (averaging 42%) which classifies it as of very poor to excellent rock mass quality, generally

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increasing with depth. Total Core Recovery (TCR) and Solid Core Recovery (SCR) vary between core runs but overall show a general increase with depth. The Rock Quality Parameters are presented in *Figure 6.3.2a*.

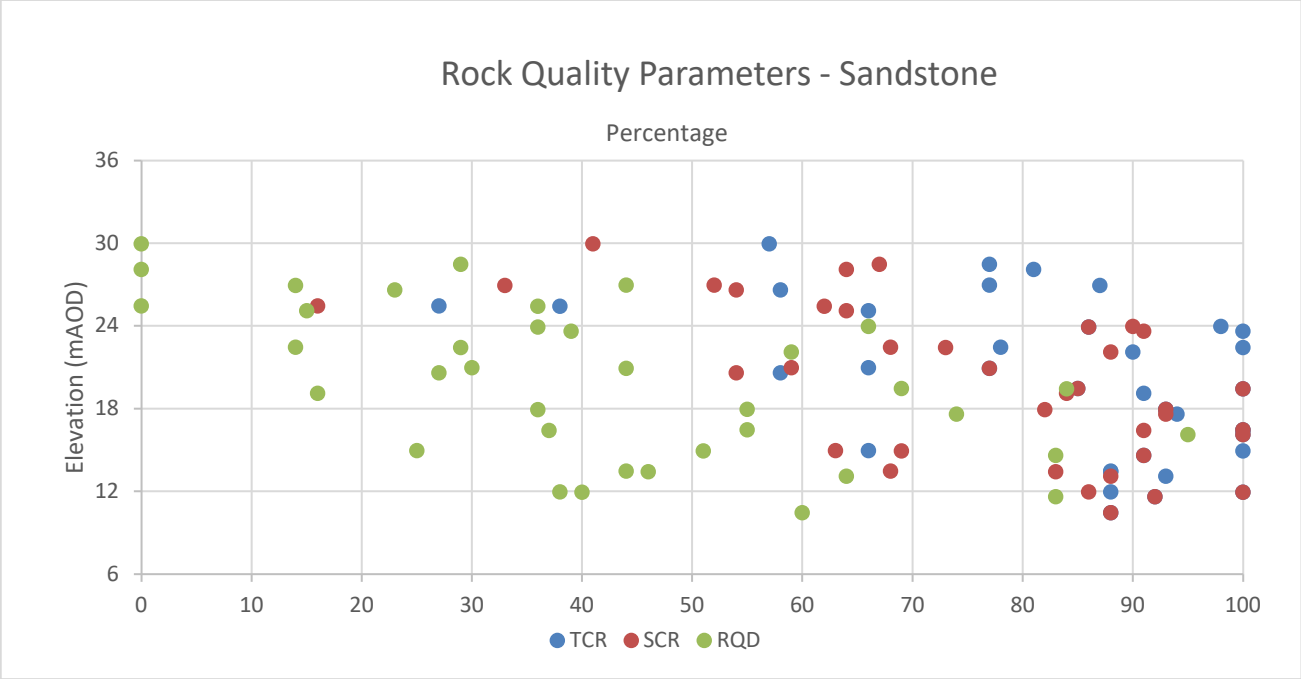


Figure 6.3.2a *– Summary of Rock Quality Parameters v. Elevation for Sandstone*

A summary of the geotechnical testing results for the sandstone bedrock are presented in *Table 6.3.2b*. Full details of geotechnical testing are included in *Appendix D*.

Table 6.3.2b – *Summary of granular geotechnical test results*

Parameter			No. of Tests	Summary of Results		
				Min	Max	Average
Laboratory Test Results	Point Load Indices (Is50) (MPa)	Axial Plane	12	0.10	0.33	0.19
		Diametral Plane	12	0.01	0.29	0.1125
	Unconfined Compressive Strength, UCS (Mpa)		11	5.20	13.6	8.47
	pH values		6	7.48	8.34	7.98
	Water Soluble Sulphate (mg/l)		6	10	20	18
Derived Parameters	Estimated UCS from Point Load Indices	Axial Plane	12	3.5	11.55	6.8
		Diametral Plane	12	0.35	10.15	3.94

Overall, 12no. axial and 12no. diametral Point Load Tests (PLT) were undertaken on selected samples of sandstone from rotary cores. Axial plane PLT (Is(50)) results ranged from 0.10MPa to 0.33MPa and diametral plane PLT (Is(50)) results ranged between 0.01MPa and 0.29MPa.

An approximation of the unconfined compression strength (UCS) of the rock may be derived from the following relationship, described in *Equation 5*:

$$UCS = PLT\ Is(50) \times f_1 \qquad \textbf{Equation 5 (Tomlinson)}$$

Where f_1 is derived from the correlation between PLT Is(50) and UCS Results

A significant variability in the correlation factor, ranging from 26 to 138, was derived from the correlation between PLT (Is(50)) results and UCS test results. In consideration of the correlation between Is(50) and UCS values reported from laboratory testing and of published literature (Tomlinson et al), a factor of 35 has been considered suitable.

Based on this relationship, estimated UCS values for sandstone range between 3.50MPa and 11.55mPa for axial tests and 0.35MPa and 10.15MPa for diametral tests, indicating the rock tested is highly variable with strength index indicating very weak to weak. These findings show lower strengths than indicating during field descriptions, typically recorded as weak to medium strength. This is likely due to localised areas of weaker strength sandstone chosen for laboratory analysis.

The estimated UCS are generally consistent with the UCS testing results which ranged between 5.20MPa and 13.60MPa. Test termination reasons varied between single shear, multiple shear and axial cleavage. The UCS testing results indicate that the intact rock is generally weak. This shows a lower strength than indicated during field descriptions, similarly, likely due to a localised area of strength material chose from laboratory analysis. The results are shown in *Figure 6.3.2b* overleaf.

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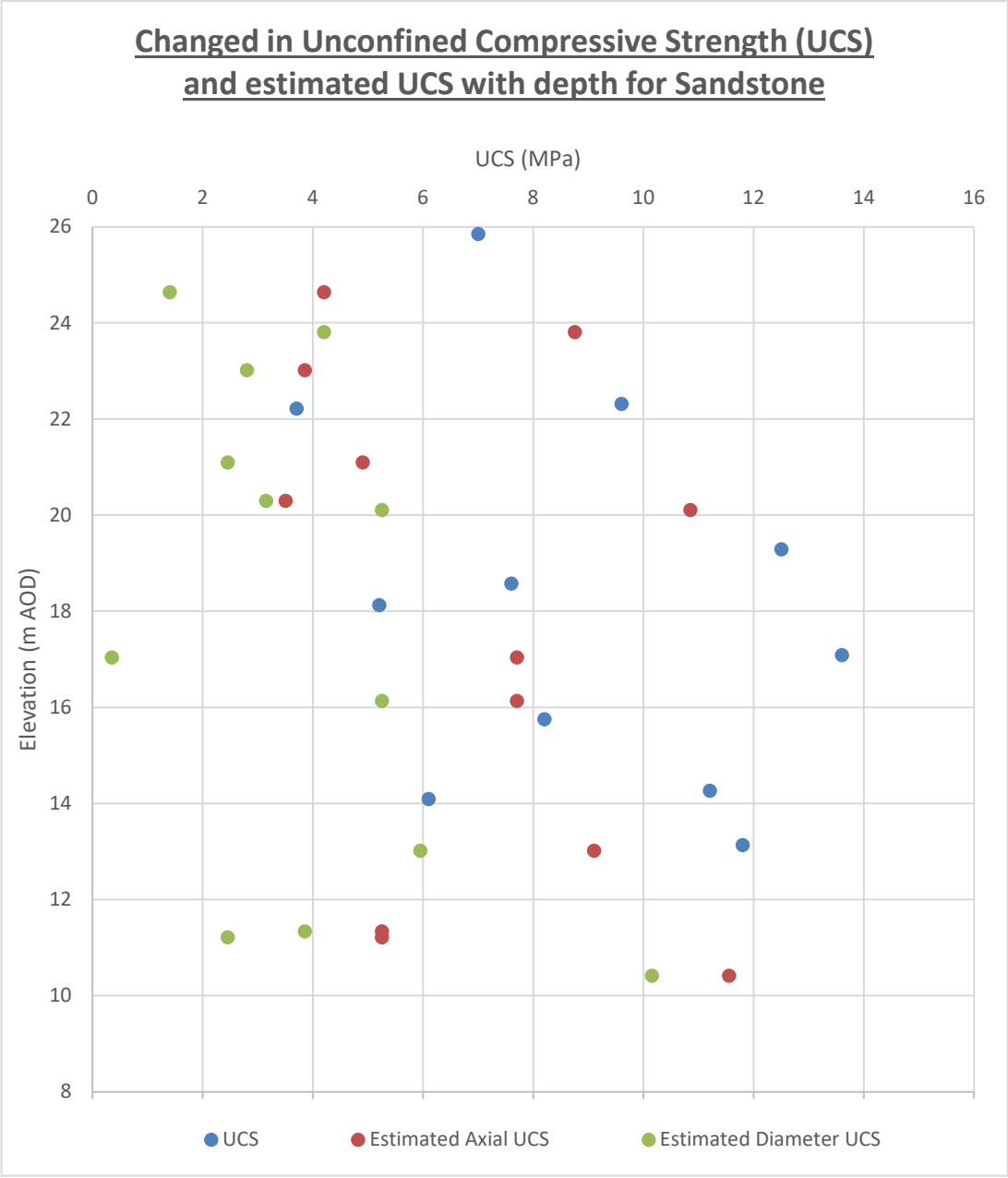


Figure 6.3.2b *– Variation of UCS Test and Estimated UCS Results*

6.4 Aggressive Ground Conditions

The classification of the site (Sites 1 and 2) 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 are summarised in *Table 6.4a*, and *Table 6.4b* details the classification.

Table 6.4a – *Aggressive Chemical Environment for Concrete (ACEC) Site Classification*

Stratum	Test Type	Range
Made Ground	pH	7.45 – 9.53
	Water Soluble Sulphate (mg/l)	60 - 1480
Glacial Till	pH	8.18 – 9.24
	Water Soluble Sulphate (mg/l)	30 - 120
Residual Soils	pH	9.14 – 9.38
	Water Soluble Sulphate (mg/l)	10
Chester Pebble Bed Formation	pH	7.48 – 8.34
	Water Soluble Sulphate (mg/l)	10 - 20

Table 6.4b – *Aggressive Chemical Environment for Concrete (ACEC) Site Classification*

Stratum	Design Sulphate Class	ACEC Class (1)
Made Ground	DS-2	AC-2s
Glacial Till	DS-1	AC-1
Residual Soils	DS-1	AC-1
Chester Pebble Bed Formation	DS-1	AC-1

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

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7.0 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 (Ref. 1) 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 9.0* of this report.

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

7.1 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) Report SC050021/SR2: Human Health Toxicological Assessment of Contaminants in Soil (Ref. 16) and Report SC059921/SR3: Updated Technical Background to the CLEA Model (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.

7.1.1 Adopted Soil Human Health GACs Screening Methodology

The use of the site, noted a multistorey structure of thirty one, thirteen and five stories comprising 373no. residential apartments, 12 no. serviced apartments and a ground floor commercial unit, is most analogous with a *Commercial* end use scenario and so the assessment has been undertaken against the following GACs, in order of preference for the development:

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 Made Ground site soils ranged from 0.8% to 11.6% and natural site soils ranged between 1.1% and 3.2%. The high concentration of SOM was encountered in cohesive Made Ground at 1.70m bgl in WS03.

With consideration for a calculated geometric average, made ground soils determine a SOM of 2.35% while natural soils determine a SOM of 1.82%. As such, a comparison against Tier 1 Thresholds for a conservative SOM of 1% for a Commercial end-use.

The adopted GAC's are listed in *Appendix F.*

7.1.2 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 thirteen soil samples obtained in 2018 and two soil samples in 2020.

With respect to the proposed end use of the site, no exceedances were recorded with respect to *Commercial* end-use.

Selected soil samples were screened for asbestos. No suspected asbestos containing materials (ACMs) were identified in the exploratory hole logs or during laboratory screening.

7.2 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, the EU Drinking Water Standards (Ref. 20) and/or Water Framework Directive Ecology Quality Standards (WFD EQS) (Ref. 21) can be utilised as primary screening values in a Tier 1 assessment. These can also be supplemented by World Health Organisation (WHO) guidelines (Ref. 22), where WFD or DWS do not exist.

7.2.1 Adopted Controlled Waters Tier 1 Screening Values and Methodology

The results of laboratory analysis of the groundwater samples taken from BH102 and BH103 been assessed against UK/EU Drinking Water Standards (DWS) due to the underlying Principal aquifer within the bedrock, albeit it is overlain by a Secondary Undifferentiated aquifer within the superficial deposits.

Granular Glacial Till was encountered from depths of 10-13m bgl, underlain by granular residual soils at 15-17m bgl and sandstone bedrock at 20-24.20m bgl. Natural soil of limited permeability thus overlies the secondary aquifer with thickness varying from 7.5m to 12.3m.

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

7.2.2 Tier 1 Screening of Groundwater Laboratory Results

The groundwater sample from BH102 is from the sandstone and as detailed in *Table 3.2* and the logs within *Appendix B*, the sampling pipe is sealed off at rockhead. The slotted pipework was installed 22-32m bgl (28.10-18.10m AOD), with groundwater levels recorded between 24.29-24.63m bgl (25.81-25.47m AOD) during the four monitoring visits. This water sample is

therefore considered representative of the groundwater within the sandstone bedrock underlying the site.

The groundwater sample from BH103 is influenced by the Made Ground and as detailed in *Table 3.2* and the logs within *Appendix B*, the response zone is sealed in the cohesive Made Ground and underlying cohesive Glacial Till to a depth of 5m bgl. Perched groundwater levels were recorded between 2.80-3.59m bgl (47.62-46.83m AOD) during the four monitoring visits. This water sample is therefore considered representative of the perched groundwater within the Made Ground and on top of the relatively impermeable cohesive Glacial Till. sandstone bedrock underlying the site.

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

The two groundwater samples collected and tested in line with *Table 4.2* show a difference in water quality as might be expected for samples taken from natural solid strata and from superficial strata influenced by made ground close to the surface

Neither water sample shows significant impact by metals or inorganic compounds when compared with the UK Drinking Water Standards (DWS) contained within *Appendix F*.

However, the sample from BH103 records more elevated hydrocarbon concentrations but not exceeding Environmental Quality Standards (EQS) threshold for the named aromatic fractions. There are some elevations against WHO thresholds in the lower to mid-range fractions of the sample from BH103.

There are no elevated TPH concentrations of concern in the water sample taken from the solid strata.

Surprisingly, the total concentrations of PAH's are not dissimilar for both samples. However, there are no exceedances of the named determinands other than Benzo(a)pyrene for which the EQS threshold is very low and cannot be tested to that limit by Earth Sciences laboratories.

It is also noted that the Secondary and Principal Aquifers are overlain by a relatively thick layer of low permeability soils and that there is no evidence of significant contamination in the made ground soils on site nor a continuing potentially contaminative use of the site.

With consideration of the above there is no indication of a significant contamination risk, arising from the development site, to groundwater and or evidence of existing significant contamination of ground water underlying the development site.

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7.3 Re-use of Soils and Waste Classification

7.3.1 Re-use of Site Soils

Based on the geochemical testing results presented, it is considered that there is currently no requirement to remove soils on site.

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 (version 2) (Ref.15) 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.

7.3.2 Initial 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.16).

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 shallow Made Ground and shallow superficial soils encountered on site 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 classification of ten made ground soil samples collected and analysed during the Stage 1 and Stage 2 investigations indicates that nine samples may be classed as non-hazardous with respect to Environmental Agency waste classes, using guidance given in WM3.

The initial classification classed one made ground sample as hazardous waste for off-site disposal, WS02 at 0.35m from the Stage 1 investigation in 2018. The result is due to the moderately elevated hydrocarbons determine when assessed by CatWaste as Unknown Oils.

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.

Additional analysis of soils being removed from site may be required to confirm waste materials are complaint with the descriptions above.

7.3.3 Waste Acceptance Criteria (WAC) Testing

Two made ground soil samples were obtained in the Stage 2 investigation for Waste Acceptance Criteria (WAC) testing. The results can be referred to in Appendix C.

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8.0 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. 23), BSI Publication Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings BS8485:2015 (Ref. 24) and other broadly accepted references such as the Ground Gas Handbook 2009 (Ref. 25).

The ground 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 and thereafter validating this conceptual model with the ground gas data, the semi-quantitative risk assessment.

8.1 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 six window sample borehole locations from the Stage 1 investigation and three borehole locations from the Stage 2 investigations. The details of the response zone of each monitoring installation are outlined in *Section 3.2*.

The Phase 1 highlighted a **Moderate/Low** risk from ground gases potentially arising from organic/ putrescible content in Made Ground soils.

The result logs sheets are contained within *Appendix E* and summarised in *Table 8.1a* and *Table 8.1b*.

8.1.1 2018, Stage 1 Investigation

The Stage 1 investigation proposed an initial programme of six monitoring visits over three months. Six gas monitoring visits were undertaken between 25th September 2018 and 31st January 2019 with barometric pressure recorded between 983mb and 1029mb and the monitoring period included at least one monitoring visit during falling barometric pressure.

On the third and sixth monitoring visits, it was not possible to monitor WS06, WS07 and WS01 due to them being inaccessible.

Methane (CH_4) was recorded at or below the instrument's detection limit within in all the monitoring wells. A maximum hydrogen sulphide (H_2S) concentration of 7ppm was recorded in WS04 on the fifth monitoring visit and a maximum carbon monoxide (CO) concentration of 7ppm was recorded in WS04 on the fifth monitoring visit.

Elevated concentrations of carbon dioxide above 5% were recorded in WS02 on the fifth and sixth visit. Maximum gas flow rates ranged between <0.1l/hr and 0.7l/hr. The greatest flow rate was recorded in WS04 on the fourth monitoring visit.

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Table 8.1a – *Summary of Ground Gas Monitoring Results for Stage 1 2018 Investigation*

Exploratory Hole ID	Maximum Methane Concentration (% v/v)	Maximum Carbon Dioxide Concentration (% v/v)	Minimum Steady Oxygen Concentration (% v/v)	Maximum Gas Flow (l/hr)	Steady State Gas Flow (l/hr)
WS01	<0.1	2.1	17.0	-0.6	-0.6
WS02	<0.1	5.4	13.1	-0.6	-0.6
WS03	<0.1	0.3	20.5	-0.6	-0.6
WS04	<0.1	2.0	20.3	0.7	-0.6
WS06	<0.1	1.4	17.0	-0.6	-0.6
WS07	<0.1	0.7	18.3	-0.6	-0.6

8.1.2 2021, Stage 2 Investigation

The Stage 2 investigation proposed a programme of four monitoring visits over two months. Four monitoring visits were undertaken between 5th February and 5th March 2021 with barometric pressure recorded between 991mb and 1029mb.

Methane was recorded in BH103 on the second and the third monitoring visit, with a maximum concentration recorded at 2.2% on the second visit.

A maximum hydrogen sulphide (H_2S) concentration of 3ppm were recorded in BH101A and BH102 on the first monitoring visit. A maximum carbon monoxide (CO) concentration of 4ppm was recorded in BH102 on the second monitoring visit.

No elevated carbon dioxide concentrations above 5% were recorded, with a maximum concentration recorded at 0.6% in BH102 on the second monitoring visit.

Gas flow was recorded at a maximum peak flow rate of -1.0l/hr in BH101A on the second and third monitoring visit. The greatest steady state gas flow rate of -0.8l/hr in BH101A on the second monitoring visit.

Table 8.1b – *Summary of Ground Gas Monitoring Results for Stage 2 2021 Investigation*

Exploratory Hole ID	Maximum Methane Concentration (% v/v)	Maximum Carbon Dioxide Concentration (% v/v)	Minimum Steady Oxygen Concentration (% v/v)	Maximum Gas Flow (l/hr)	Steady State Gas Flow (l/hr)
BH101A	<0.1	<0.1	20.9	-1.0	-1.0
BH102	<0.1	0.6	20.4	<0.1	<0.1
BH103	2.2	1.2	0.3	0.4	<0.1

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8.2 Ground Gas Assessment

The Conceptual Site Model presented within the Phase I Preliminary Risk Assessment identified Made Ground as a potential sources of ground gas generation. The report suggests no records of organic rich drift deposits (e.g. peat) being present. Noxious and asphyxiate gases were attributed to include, but not limited to, carbon dioxide, carbon monoxide, methane and hydrogen sulphide. The Phase 1 identified a **Moderate/Low** Risk.

The ground investigations revealed a ground model generally consistent with the preliminary conceptual site model. Made ground soils were encountered to depths between 0.25m and 3.00m bgl with limited putrescible content generally. Natural deposits comprised glacial till, cohesive and granular, to a maximum depth of 17.00m bgl. Residual soils of the Chester Pebble Bed Formation were encountered to depths of 20.00m and 24.20m bgl and bedrock to the maximum depth of the investigation.

The proposed development is noted as a multistorey structure of thirty one, thirteen and five stories comprising 373no. residential apartments, 12 no. serviced apartments and a ground floor commercial unit.

As a result, this assessment has been undertaken in accordance with guidance within BS8485:2019 (Ref. 24)

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.

In accordance with BS8485:2015 (Ref.24), consideration of the recorded soil gas flow rates, presented above, enables hazardous gas flow rates (Q_{hg}) 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.

A total of ten monitoring visits have been undertaken, six in 2018 and four in 2021. It is considered that the gas monitoring results recorded represent the site's ground gas regime and so the 'worst case' scenario has not been assessed further.

For a 'representative' scenario (highest hazardous gas flow rate that is realistically possible, i.e. in a single borehole) steady state flow rates and peak gas concentrations 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 0.324 l/hr for carbon dioxide corresponding to elevated carbon dioxide of 5.4% $^{v}/_{v}$ recorded during visit no. 5. In WS02.

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 0.0022 l/hr for methane with the highest concentration of methane recorded un BH103 at 2.2% $^{v}/_{v}$.

Typical concentrations of carbon dioxide are below 5% $^{v}/_{v}$ with only one reading, in one borehole on one occasion, recorded above (WS02 5.4% $^{v}/_{v}$). Similarly, typical concentrations of methane are below 1% $^{v}/_{v,}$ with only one reading, in one borehole on one occasion recording about the 1% $^{v}/_{v}$ threshold (BH103, 2.2% $^{v}/_{v}$).

It is considered that adoption of a higher Characteristic Situation gas regime due to one carbon dioxide and one methane reading over 5% $^{v}/_{v}$ and 1% $^{v}/_{v}$ respectively would result in unnecessarily conservative protection measures given the low flow rates identified and typically low concentrations of hazardous gases.

Consequently, the sites Gas Screening Value (GSV) has been adopted and 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.

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

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9.0 Revised Conceptual Site Model

The Preliminary Conceptual Site Model (PCSM) presented in the Phase 1 Report (Ref.1) and discussed in *Section 2.7* of this report has been revised following the GQRA in *Section 7.0* 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. The GQRA details the associated level of risk relating to these potential pollutant linkages.

The CSM follows the framework outlined within CIRIA C552 (Ref. 26) which is summarised within *Appendix H*.

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 Mining are discussed and assessed within *Section 2.4.4.*

Risks presented by Unexploded Ordnance are 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. 27) 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 and therefore construction workers involved in the building works at the site have been discounted as a human receptor in the conceptual site model.

Reference should be given to the environmental testing results discussed within *Section 7.0* and presented within *Appendix C*.

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- 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.

Conceptual Site Model			Generic Qualitative Risk Assessment			Comments	Action
Identified Source	**Pathway(s)**	**Receptor(s)**	**Consequence**	**Likelihood of Occurrence**	**Risk Rating**		
Organic and inorganic contaminations within made ground soils across the site.	Direct contact and dermal uptake, soil and dust ingestion, dust and migration inhalation	**Site end-users** Commercial at ground level	**Medium**	**Unlikely**	**Low**	Environmental chemical analysis did not record any exceedances with respect to a *'Commercial'* end use scenario. No significant visual evidence of contamination was identified in site soils. Olfactory evidence was encountered in WS02 recorded as a slight hydrocarbon odour. No suspected asbestos containing materials (ACMs) were identified in exploratory hole logs and laboratory screening.	No further action required. Construction and maintenance works should be provided with suitable PPE with respect to environmental chemical results presented herein. Standard Health & Safety precautions likely to be used by workers.
	Direct contact and dermal uptake, soil and dust ingestion, dust and migration inhalation	Construction and maintenance workers	**Mild** Standard Health & Safety precautions likely to be used by workers	**Unlikely**	**Very Low**		
	Soil dust ingestion/inhalation produced during construction	Adjacent residents	**Medium**	**Unlikely**	**Low**		
	Vertical and horizontal migration through superficial deposits	Controlled Waters (Principal Aquifer)	**Medium**	**Unlikely**	**Low**	While groundwater samples from perched water (BH103) and from within the bedrock (BH102) show a difference in water quality as might be expected from that perched within the made ground and that within the solid strata, when compared against DWS the results do not indicate significant groundwater contamination. Furthermore, the risk to the underlying Principal Aquifer from proposed piling techniques is considered to be **Low**	No further action required.
Organic matter and/or contamination as source material for the generation of ground gas.	Ground gas & vapour migration and inhalation	**Site end-users** Commercial	**Medium**	**Unlikely**	**Low**	While a single elevated carbon dioxide concentration and a single methane concentration above the threshold levels were recorded in separate boreholes; due to the low flow rates and typically low concentrations of hazardous ground gases recorded, a Characteristic Situation 1 (CS1) gas regime has been assigned.	No ground gas protection measures required.
		Construction and maintenance workers	**Mild** Standard Health & Safety precautions likely to be used by workers)	**Unlikely**	**Very Low**		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

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10.0 Engineering Assessment and Recommendations

10.1 Introduction

This section will assess the relevant geotechnical issues for the proposed development comprising the construction of a multistorey structure of thirty one, thirteen and five stories providing 373 no. residential apartments, 12 no. serviced apartments and a ground floor commercial unit with associated car parking. The proposed development plan is contained within *Appendix A*.

The engineering assessment considers foundation design, bearing capacity, settlement, excavations, ground floor slabs and pavement design for the site. Finished Floor Levels for the buildings along with structural details and loadings have not yet been provided. It should be noted that detail may change in the development of designs beyond the issue of this Phase 2 Report and the Construction Designer should satisfy themselves regarding the adequacy of their design and proposed approach to construction by reference to the on-going project design proposals, the ground investigation information and their own examination of the site.

10.2 Summary of Ground Conditions

The ground conditions on site generally comprised concrete overlying predominantly granular made ground to depths of 0.25-3.00m bgl. The made ground was underlain by cohesive glacial till comprising stiff to very stiff brown/grey slightly sandy slightly gravelly clay to 10-13m bgl (37.10-40.42m AOD). Deeper granular glacial till deposits, encountered in BH101A-BH103 comprised dense to very dense brown slightly gravelly medium to coarse sand to 15-17m bgl (32.95-35.10m AOD).

The glacial till is underlain by the Chester Formation encountered as residual soils to depths of 20-24.2m bgl (26.22-29.95m AOD) and sandstone bedrock to the termination of boreholes at 40m bgl (<9.95m AOD). The residual soils are encountered as very dense red/brown slightly gravelly medium to coarse sand and bedrock described as weak to medium strong reddish brown fine to coarse sandstone.

10.3 Geotechnical Considerations

10.3.1 Presence of Existing Services

The presence of existing services may require capping and/or diversion associated with the development, which should be managed through the appropriate utility suppliers during the construction phase. The Principal Contractor should ensure that appropriate mitigation measures are put in place during the construction phase (i.e. during excavation of foundations).

10.3.2 Obstructions and Relict Foundations

As detailed in *Table 5.7* and within the logs (*Appendix B*), obstructions were recorded during the ground investigation in WS04 (1.17m bgl), WS05 (2.25m bgl) and BH101 (1.50m bgl) possibly related to existing concrete foundations whilst structures/further foundations will be present associated with the current warehouse building, neighbouring buildings and in un-investigated areas of the site.

Detailed design of the foundations over these areas will be required following determination of the final development layout, at which time a specialist demolition contractor should be consulted. Where demolition works are to be undertaken of the existing structures, it should be ensured that all obstructions within influencing depth of the proposed development are safely removed as required. Existing foundations should be removed to avoid forming hard spots and backfilled in accordance with an engineering specification to avoid soft spots.

Consideration should be given, in liaison with the Principal Contractor, to re-use of former foundations/concrete obstructions via crushing, appropriate testing (environmental and geotechnical), screening and re-use on site as capping or fill to structures in accordance with Series 600 of the Specification for Highways Works (SHW) to reduce export/import costs.

Movement monitoring of adjacent buildings is likely to be required during demolition and construction works.

10.3.3 Variable Made Ground

Made Ground was encountered in all the exploratory hole locations from ground level to depths of between 0.25m and 3.00m bgl across the site. The Made Ground should not be considered as a suitable founding stratum.

10.3.4 Soft Superficial Deposits

There were no very soft silt or clay superficial drift deposits encountered in the near surface soils during the ground investigation. The contractor should however be aware that these soils are recorded within proximity to the site and should very soft cohesive deposits be encountered they are to be removed and replaced with a suitable well compacted granular fill.

10.3.5 Earthworks

When considering earthworks and potential for re-use materials should be tested to show that they are chemically and geotechnically suitable for re-use at their proposed locations and to ensure that there are no unacceptable risks to identified receptors, which should be outlined in a site specific earthworks specification and strategy.

It is currently unknown whether site levels will need to be changed at the site. Any arisings and cut levels will predominantly comprise the Glacial Till which would likely classify in accordance with the Specification for Highways Works (SHW) Series 600 as Class 2 materials, subject to specific classification testing and environmental suitability.

As an increased performance of materials placed below structures will be required over and above those defined for a general fill, soils that are to be used below structures would be reclassified and replaced to an appropriate Class (6N or 6P) as defined in the Specification for Highway Works (Highways Agency 2014). The formation strata shall be proof rolled and inspected for any soft/loose materials. Any soft/loose materials should be replaced with Engineered Fill or granular capping materials.

10.4 Foundation Options

10.4.1 Shallow Foundations

It is understood that the proposed development is to comprise a multistorey structure of thirty one, thirteen and five stories providing 373 no. residential apartments, 12 no. serviced apartments and a ground floor commercial unit with associated car parking.

The shallow ground conditions on site comprises made ground overlying cohesive and granular glacial till underlain by the Chester Formation which was encountered at depths of 20-24.20m bgl.

Due to the likely loads of the proposed development, it is considered that a shallow spread foundation in the superficial deposits are unlikely to be suitable at the site.

10.4.2 Piled Foundations

The advice of reputable piling specialists, experienced in the ground conditions considered here, should be sought. They should be responsible for the selection of appropriate piling equipment and the final design of the piles. Given below are some preliminary comments.

The ground conditions on site are considered to potentially be amenable to CFA or bored piles, taking into account the following comments.

CFA piles are generally limited to 25m for smaller diameter piles (<400mm) and 30m for larger diameter piles (>600mm), which should be taken into account when determining the number of piles under heavily loaded areas. CFA piles require good workmanship to ensure they are adequately constructed and may struggle to penetrate the rock encountered on site (subject to rig utilised).

Bored piles should be able to penetrate rock bands and bedrock encountered on site.

The presence of shallow and variable groundwater levels should be considered during pile design whilst the presence of existing buildings surrounding the site should also be taken into account to ensure ground movements are limited.

The use of casing or bentonite slurry or other suitable support fluid may be required to support the pile bore through the Made Ground and weathered water bearing granular bedrock materials. It should be noted that the possibility of groundwater strikes additional to those encountered during the ground investigation works cannot be ruled out.

The risk of over-flighting should be considered during pile construction due to the presence of loose / soft soils at the of intact rock bands / bedrock.

Due to Low to Medium volume change potential of some on site soils at a shallow depth, the specialist pile designer should consider the potential for desiccation, shrink / swell clays and the requirements for void formers below ground beams and pile caps and against the inside faces of external ground beams and piles caps where clay soils are present, so as to provide a suitable minimum void dimension as per NHBC guidelines.

10.5 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. 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.

The void dimensions associated with any suspended floor slabs should be determined in accordance with Chapter 4.2 of the NHBC Standards

10.6 Excavations

Based on observations on site, together with the results of in-situ and laboratory tests, it is considered that excavations to <1.20m bgl should stand unsupported in the short term. Side support for safety purposes should of course be provided to all excavations which appear unstable, and those >1.20m deep, in accordance with Health and Safety Regulations.

Suitable side slope angles must be checked and provided by a suitably qualified temporary works contractor for any excavations.

Groundwater may be encountered as seepages in shallow excavations for foundations or services as perched water present. It is considered that groundwater inflows, if encountered, may be controlled by pumping from sumps.

Excavation through layers of Made Ground and Glacial Till encountered across the site should be feasible using conventional site plant.

10.7 Chemical Attack on Buried Concrete

The site has been classified in accordance with BRE Special Digest (Ref. 7) and laboratory testing undertaken accordingly in *Section 6.3*.

In the consideration of sulphate attack on buried concrete, reference has been made to BRE SD1 (2005 Ed), which classifies the site as a brownfield site with a mobile groundwater conditions.

The results of the concrete classification tests received have indicated a DS-2, AC-2 classification for the Made Ground, decreasing to DS-1, AC-1s in natural geologies.

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11.0 Conclusions & Recommendations

11.1 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 9.0*.

11.1.1 Ground Contamination

With respect to the proposed end use of the site, no exceedances were recorded with respect to Commercial end-use.

A **Low** risk rating is therefore identified to proposed site end-users from direct contact, inhalation and ingestion of contaminants within Made Ground soils.

11.1.2 Controlled Waters

While groundwater samples from perched water (BH103) and from within the bedrock (BH102) show a difference in water quality as might be expected from that perched within the made ground and that within the solid strata, when compared against DWS the results do not indicate significant groundwater contamination

Furthermore, the risk to the underlying Principal Aquifer from proposed piling techniques is considered to be **Low.**

11.1.3 Ground Gas Assessment

While a single elevated carbon dioxide concentration and a single methane concentration above the threshold levels were recorded in separate boreholes; due to the low flow rates and typically low concentrations of hazardous ground gases recorded, a Characteristic Situation 1 (CS1) gas regime has been assigned to the site.

A **Low** risk rating is therefore identified to proposed site end users from inhalation of hazardous ground gases corresponding to CS1 gas regime and no ground gas protection measures required**.**

The Curtins Phase 1 Report (Ref. 1) confirms the site is situated in a lower probability radon area where <1% of homes are above the radon action level. On this basis radon protection measures are not considered necessary in the construction of new dwellings or extensions.

If the new development incorporates a basement the advice of a specialist Radon assessor must be obtained.

11.2 Recommendations

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

1) Further ground investigation is recommended in the areas of the development site currently inaccessible; this will be for confirming geotechnical design parameters:
2) The engineering recommendations contained within the report should be reviewed once the final development proposals and site levels are confirmed;
3) 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.*
4) With respect to the risk from Unexploded Ordnance during construction, the following steps are recommended:
    a) UXO Risk Management Plan;
    b) Site Specific UXO Awareness Briefings to all personnel conducting intrusive works.

12.0 References

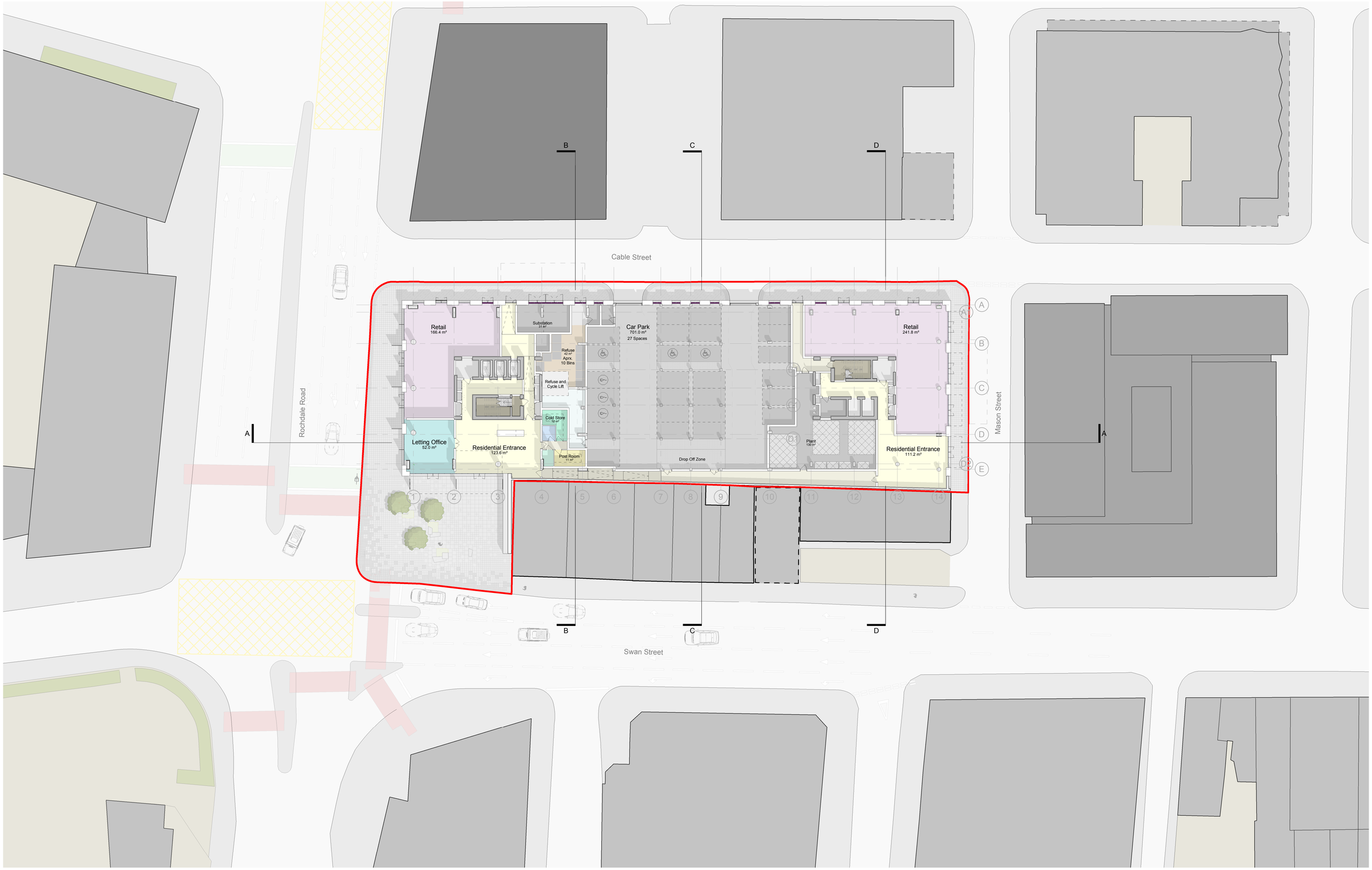
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Appendix A – Drawings

- Simpson Haugh (2018) *General Arrangement Plan Ground Level 00 for Swan House*, ref. 10133-Z1-00-PL-A-B5D8-G200-0001 Rev 1
- Curtins (2021) *Exploratory Hole Location Plan for Swan House,* ref. 077409-CUR-00-XX-DR-GE-80002-P01

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This drawing is copyright
Do not scale off dimensions.

All dimensions to be checked on site by contractor.

Contractor to report any dimensional discrepancies, errors or omissions prior to commencing on site.

Scale Bar 1:250 @ A1

0.5 1 2 5 10m

NORTH

Rev	Date	Description
00	2018-07-06	Issued for Planning
01	2018-07-25	Updated landscaping proposals

Project Title
Swan House
2 Rochdale Road
Manchester

Status
Planning Issue

Drawing Title
General Arrangement Plan
Ground Level 00

Job No
10133

Scale
1:500 @ A3
1 : 250@ A1

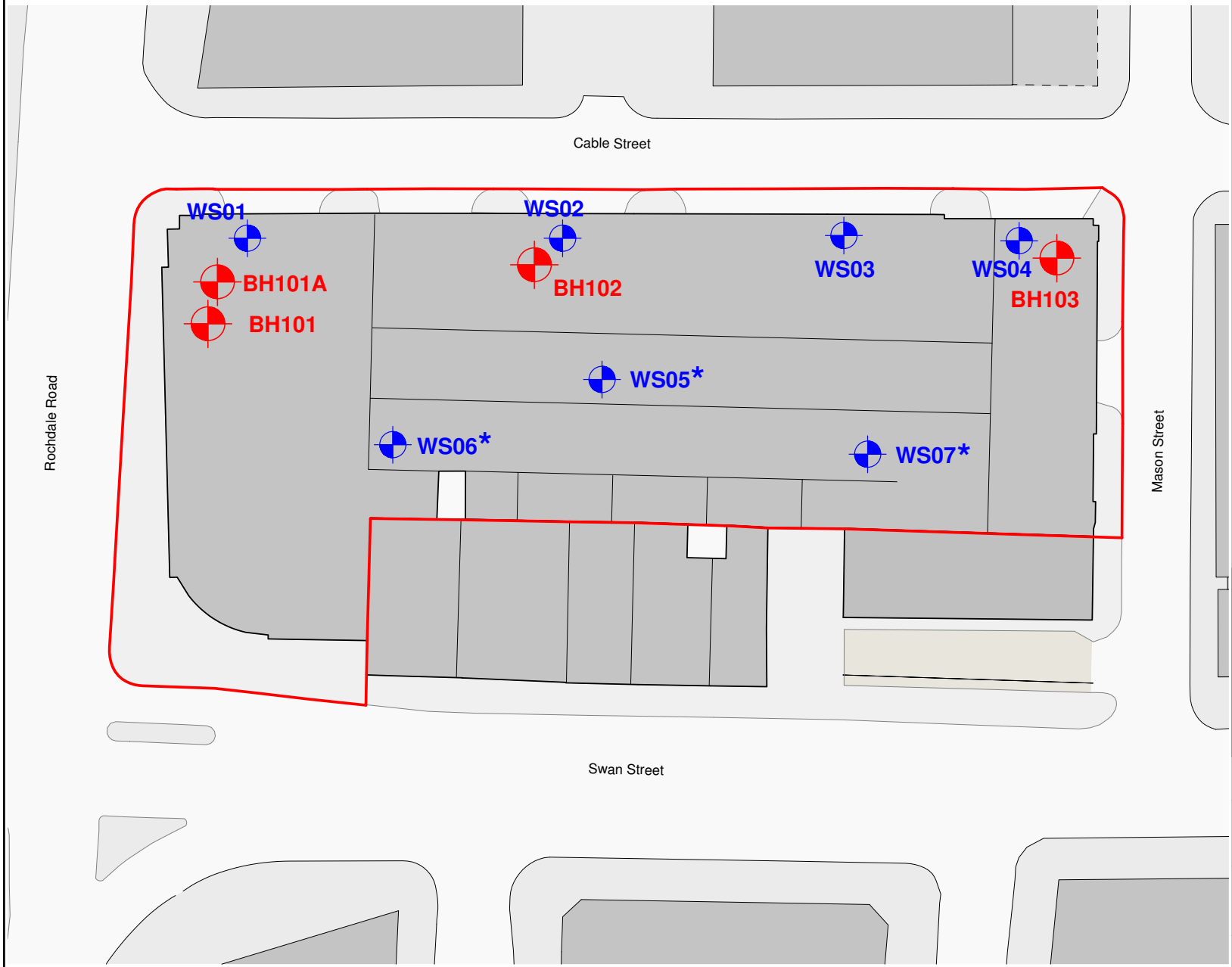
Date
Jun 2018

SHP Drawing Code
10133-Z1- 00 - PL - A - B5D8-G200-0001

Revision
01

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2019 Investigation

Window Sample Borehole Location

* Denotes borehole drilled in basement

All boreholes were followed on by dynamic probing with the exception of WS05.

All boreholes were installed with the exception of WS06.

2021 Investigation

Sonic Borehole Location

Rev:	Description:	Date:	By:	Chkd:

curtins

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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: Swan House

Drg Title: Exploratory Hole Location Plan

Scale:	Size:	First Issue:	Drawn:	Checked:
NTS	A3	02/02/21	PN	SH

Drg No: 077409-CUR-00-XX-DR-GE-80002-P01 Rev: /

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Appendix B – Exploratory Hole Logs

- 2018 Exploratory Borehole logs.
    - Window Sample Boreholes with Dynamic Probing
- 2021 Exploratory Borehole logs.
    - Sonic Boreholes with Rock Coring
    - Photographic Log, Rock Cores

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Borehole Log

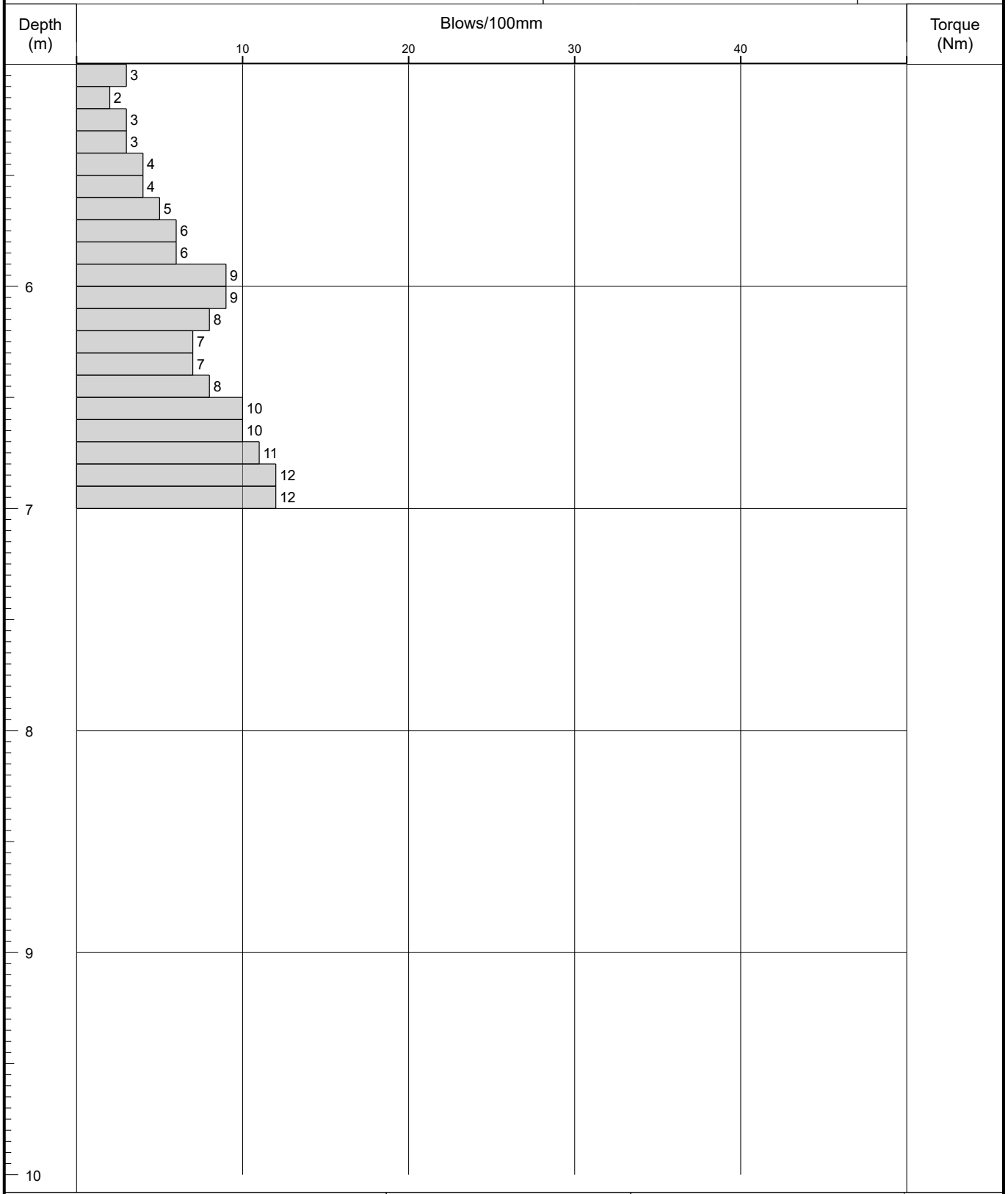
Borehole No.
WS01
Sheet 1 of 1

Project Name: Swan House, Manchester	Project No. B067266.201	Co-ords: -	Hole Type WS
Location: Cable Street, Manchester		Level: 50.90	Scale 1:50
Client: Foundation Real Estate		Dates: 13/09/2018 - 13/09/2018	Logged By MH

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.28	50.62		MADE GROUND: CONCRETE.
					0.34	50.56		MADE GROUND: Reddish brown medium SAND.
		0.55 - 0.65	ES		0.47	50.43		MADE GROUND: CONCRETE.
		1.00		N=17 (2,2/4,4,4,5)				Stiff brown mottled grey sandy slightly gravelly CLAY. Gravel is fine, angular to subrounded sandstone and coal. Rare medium gravel of sandstone and coal.
		1.70 - 2.00	D					
		2.00		N=24 (2,3/5,5,7,7)				
		3.00		N=24 (2,4/4,6,7,7)				
		3.50	D					*Rare grey mottling from 3.40m bgl.*
		4.00		N=22 (2,3/4,5,6,7)				
		4.70 - 5.00	D		4.60	46.30		Stiff brown sandy CLAY. Rare gravel of fine and medium subangular to subrounded sandstone.
					5.00	45.90		End of borehole at 5.00 m

Remarks
Borehole undertaken in loading bay from existing ground level. Ground level estimated from previous GPR survey. Hand dug service clearance pit to 1.20m bgl. No groundwater encountered. Dynamic Probe follow on to 7.00m bgl. Downhole magnetometery conducted by UXO specialist. Borehole cleared for UXO to a maximum depth of 7.00m bgl.

Curtins Merchant Exchange, 17 - 19 Whitworth Street West, Manchester M1 5WG	# Probe Log		Borehole No. **WS01(DP)** Sheet 1 of 1
Project Name: Swan House, Manchester	Project No. B067266.201	Co-ords: -	Hole Type DP
Location: Cable Street, Manchester		Level: 50.90	Scale 1:25
Client: Foundation Real Estate		Dates: 13/09/2018 - 13/09/2018	Logged By



Remarks Dynamic Probing terminated at 7.00m bgl. Base of testing in accordance with limit of UXO clearance. Ground level estimated from previous GPR survey.	Fall Height	Cone Base Diameter	
	Hammer Wt	Final Depth 7.00	
	Probe Type DPSH- A	Log Scale 1:25	

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Borehole Log

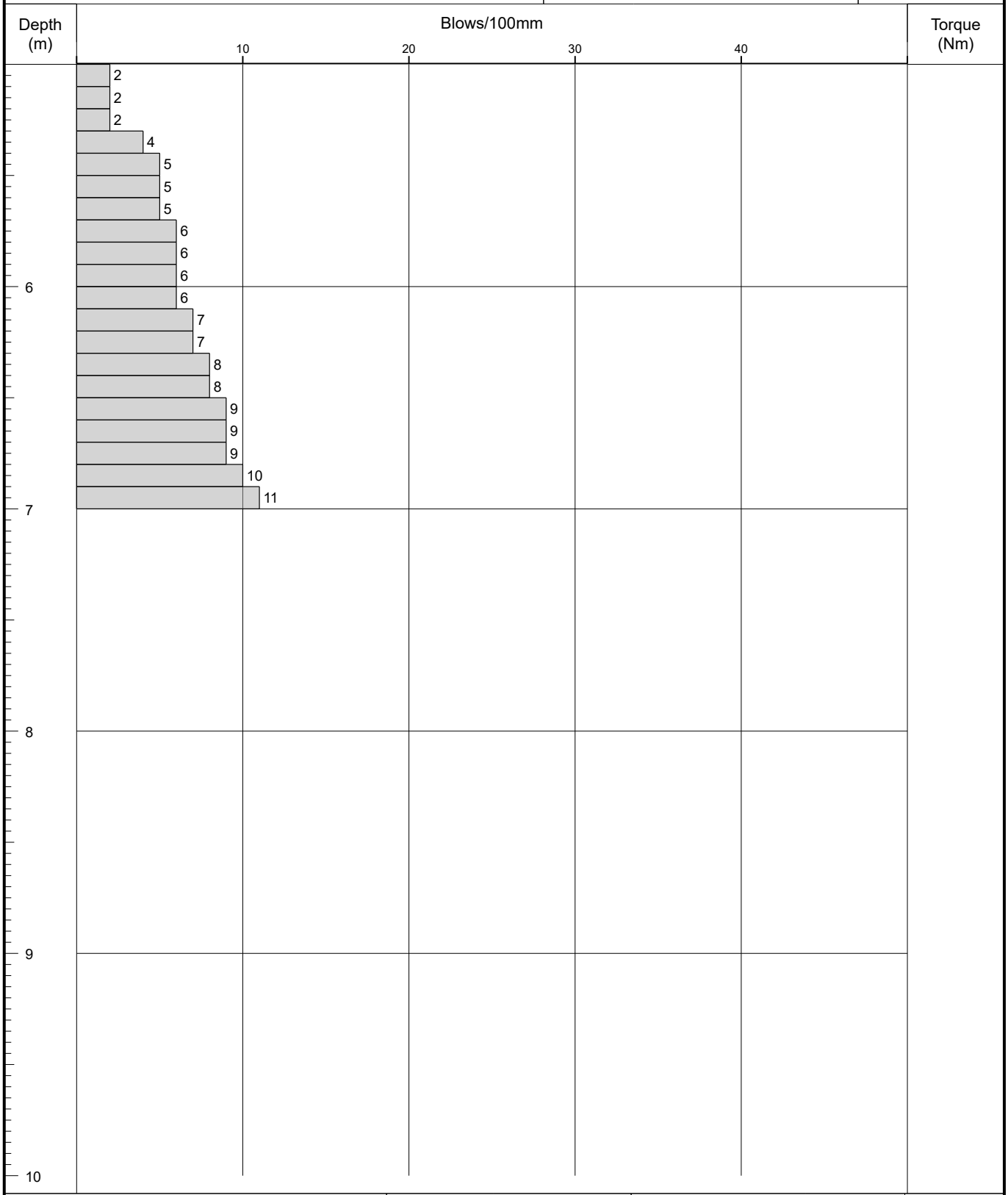
Borehole No.
WS02
Sheet 1 of 1

Project Name: Swan House, Manchester	Project No. B067266.201	Co-ords: -	Hole Type WS
Location: Cable Street, Manchester		Level: 51.00	Scale 1:50
Client: Foundation Real Estate		Dates: 14/09/2018 - 14/09/2018	Logged By MH

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.35	ES		0.31	50.69		MADE GROUND: CONCRETE.
					0.35	50.65		MADE GROUND: Very loose dark greyish brown slightly clayey fine SAND. Slight hydrocarbon odour (Possible fuel oil).
		0.70	ES		0.49	50.51		MADE GROUND: CONCRETE.
		1.00		N=21 (2,4/4,5,6,6)	1.05	49.95		MADE GROUND: Loose black slightly silty fine and medium SAND. Rare subangular to subrounded cobble of brick.
		1.05 - 1.30	ES					*Rare pockets of red sand (Weathered brick).*
		1.80 - 2.00	D					Stiff brown with grey mottling slightly sandy slightly gravelly CLAY. Gravel is fine and medium angular to subrounded sandstone and coal.
		2.00		N=25 (2,4/5,6,7,7)				
		3.00		N=25 (2,4/5,6,7,7)	3.00	48.00		Stiff brown with occasional light brown and grey mottling sandy slightly gravelly CLAY. Gravel is fine, subangular to subrounded sandstone and coal.
								Rare gravel from 3.50m bgl.
		3.80 - 4.00	D					
		4.00		N=15 (2,2/3,3,4,5)				
					5.00	46.00		End of borehole at 5.00 m

Remarks
Borehole undertaken in loading bay from existing ground level. Ground level estimated from previous GPR survey. Hand dug service clearance pit to 1.20m bgl. No groundwater encountered. Dynamic Probe follow on to 7.00m bgl. Downhole magnetometery conducted by UXO specialist. Borehole cleared for UXO to a maximum depth of 7.00m bgl.

Curtins Merchant Exchange, 17 - 19 Whitworth Street West, Manchester M1 5WG	# Probe Log		Borehole No. **WS02 (DP)** Sheet 1 of 1
Project Name: Swan House, Manchester	Project No. B067266.201	Co-ords: -	Hole Type DP
Location: Cable Street, Manchester		Level: 51.00	Scale 1:25
Client: Foundation Real Estate		Dates: 14/09/2018 - 14/09/2018	Logged By



Remarks Dynamic Probing terminated at 7.00m bgl. Base of testing in accordance with limit of UXO clearance. Ground level estimated from previous GPR survey.	Fall Height	Cone Base Diameter	
	Hammer Wt	Final Depth 7.00	
	Probe Type DPSH- A	Log Scale 1:25	

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Borehole Log

Borehole No.
WS03
Sheet 1 of 1

Project Name: Swan House, Manchester	Project No. B067266.201	Co-ords: -	Hole Type WS
Location: Cable Street, Manchester		Level: 51.10	Scale 1:50
Client: Foundation Real Estate		Dates: 13/09/2018 - 14/09/2018	Logged By MH

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.15	50.95		MADE GROUND: CONCRETE.
					0.19	50.91		MADE GROUND: Reddish brown medium SAND.
		0.40	ES		0.34	50.76		MADE GROUND: CONCRETE.
		1.00		N=4 (0,0/0,1,2,1)				MADE GROUND: Loose black gravelly fine to coarse SAND. Gravel is fine to coarse angular to subrounded brick, concrete, ash, clinker, slate, rare coal, and sandstone.
					1.30	49.80		MADE GROUND: Very soft brown slightly sandy slightly gravelly CLAY. Gravel is fine angular to subrounded brick, coal and sandstone.
		1.70	ES					
		2.00		N=2 (0,0/0,0,1,1)				
	▼				2.80	48.30		Firm brown sandy slightly gravelly CLAY. Gravel is fine and medium subangular to rounded sandstone.
		3.00	ES					
		3.00		N=15 (3,3/3,3,4,5)	3.20	47.90		Stiff brown with grey mottling sandy slightly gravelly CLAY. Gravel is fine sandstone and coal.
		4.00		N=20 (2,3/3,4,6,7)				
		4.80 - 5.00	D		5.00	46.10		End of borehole at 5.00 m

Remarks
Borehole undertaken in loading bay from existing ground level. Ground level estimated from previous GPR survey.
Hand dug service clearance pit to 1.20m bgl. Groundwater encountered at 2.80m bgl. Dynamic Probe follow on to 7.00m bgl.
Downhole magnetometery conducted by UXO specialist. Borehole cleared for UXO to a maximum depth of 7.00m bgl.

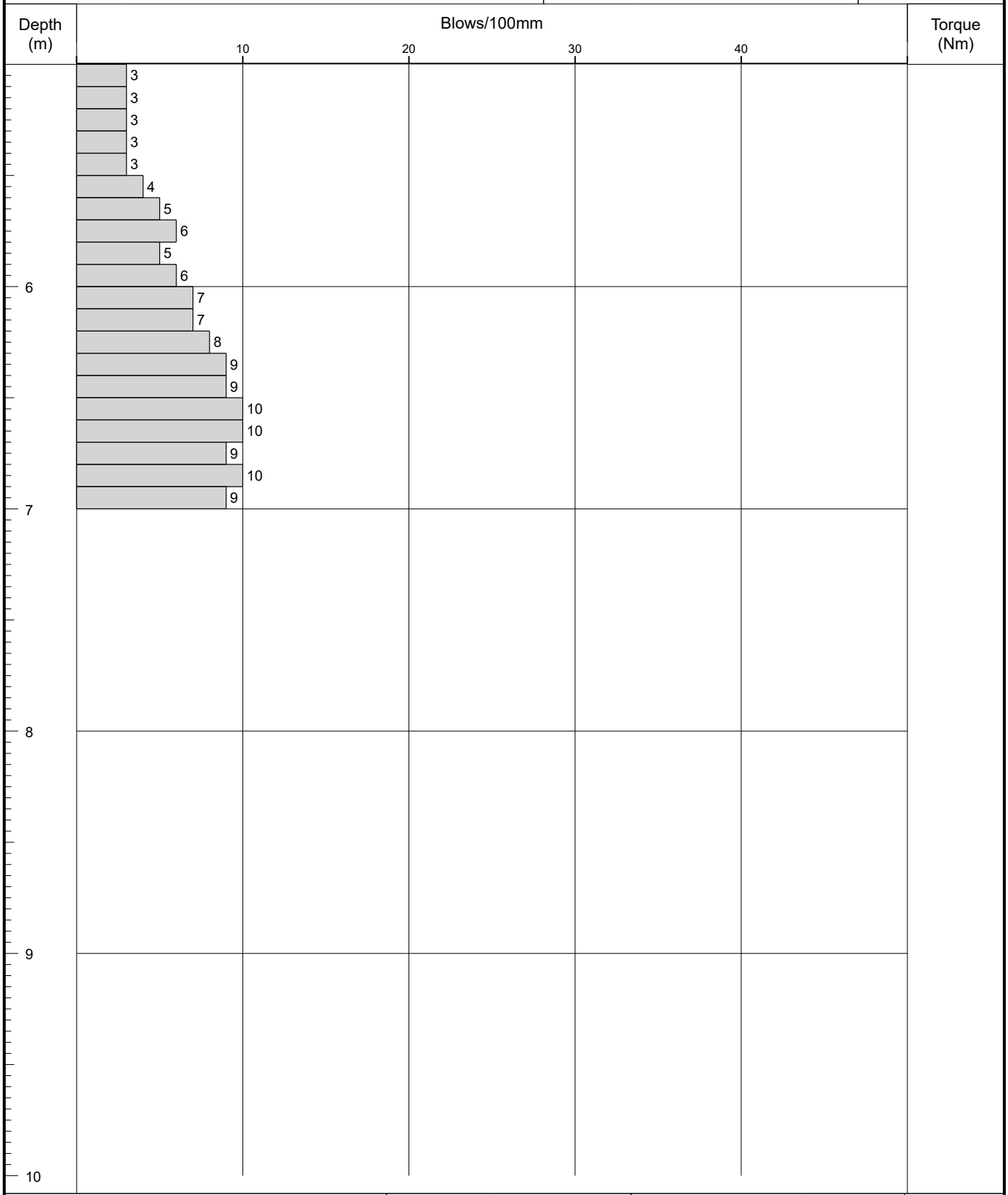
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Probe Log

Borehole No.
WS03 (DP)
Sheet 1 of 1

Project Name: Swan House, Manchester	Project No. B067266.201	Co-ords: -	Hole Type DP
Location: Cable Street, Manchester		Level: 51.10	Scale 1:25
Client: Foundation Real Estate		Dates: 13/09/2018 - 13/09/2018	Logged By



Remarks
Dynamic Probing terminated at 7.00m bgl. Base of testing in accordance with limit of UXO clearance. Ground level estimated from previous GPR survey.

Fall Height		Cone Base Diameter	
Hammer Wt		Final Depth	7.00
Probe Type	DPSH- A	Log Scale	1:25

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Borehole Log

Borehole No.
WS04
Sheet 1 of 1

Project Name: Swan House, Manchester	Project No. B067266.201	Co-ords: -	Hole Type WS
Location: Cable Street, Manchester		Level: 51.10	Scale 1:50
Client: Foundation Real Estate		Dates: 13/09/2018 - 13/09/2018	Logged By MH

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.13	50.97		MADE GROUND: CONCRETE.
		0.30	ES		0.24	50.86		MADE GROUND: Light brownish grey and black GRAVEL of concrete and tarmac.
					0.31	50.79		
		0.70	ES		0.47	50.63		MADE GROUND: Reddish brown medium SAND.
					0.85	50.25		MADE GROUND: CONCRETE.
					1.13	49.97		MADE GROUND: Brown and black gravelly medium and coarse SAND. Gravel is fine to coarse angular to subangular brick, concrete and clinker. rare metal fragments. Localised clay pockets.
		1.35		N=30 (1,5/9,7,7,7)	1.35	49.75		
		1.40 - 1.70	ES					MADE GROUND: Light red medium grained SANDSTONE.
		2.00		N=5 (3,3/3,1,1,0)				MADE GROUND: Limestone GRAVEL (Drillers Description).
					2.25	48.85		MADE GROUND: Red sandy GRAVEL. Gravel is fine to coarse angular to subrounded brick, concrete and slate.
		2.40 - 2.70	ES					
		2.70 - 3.00	ES		2.70	48.40		MADE GROUND: Very soft brown sandy slightly gravelly CLAY. Gravel is fine to medium sandstone and coal. (Reworked).
					3.00	48.10		MADE GROUND: Very soft dark greyish brown sandy slightly gravelly CLAY. Rare blackened plant/wood fragments. Slight organic odour. (Reworked).
								End of borehole at 3.00 m

Remarks

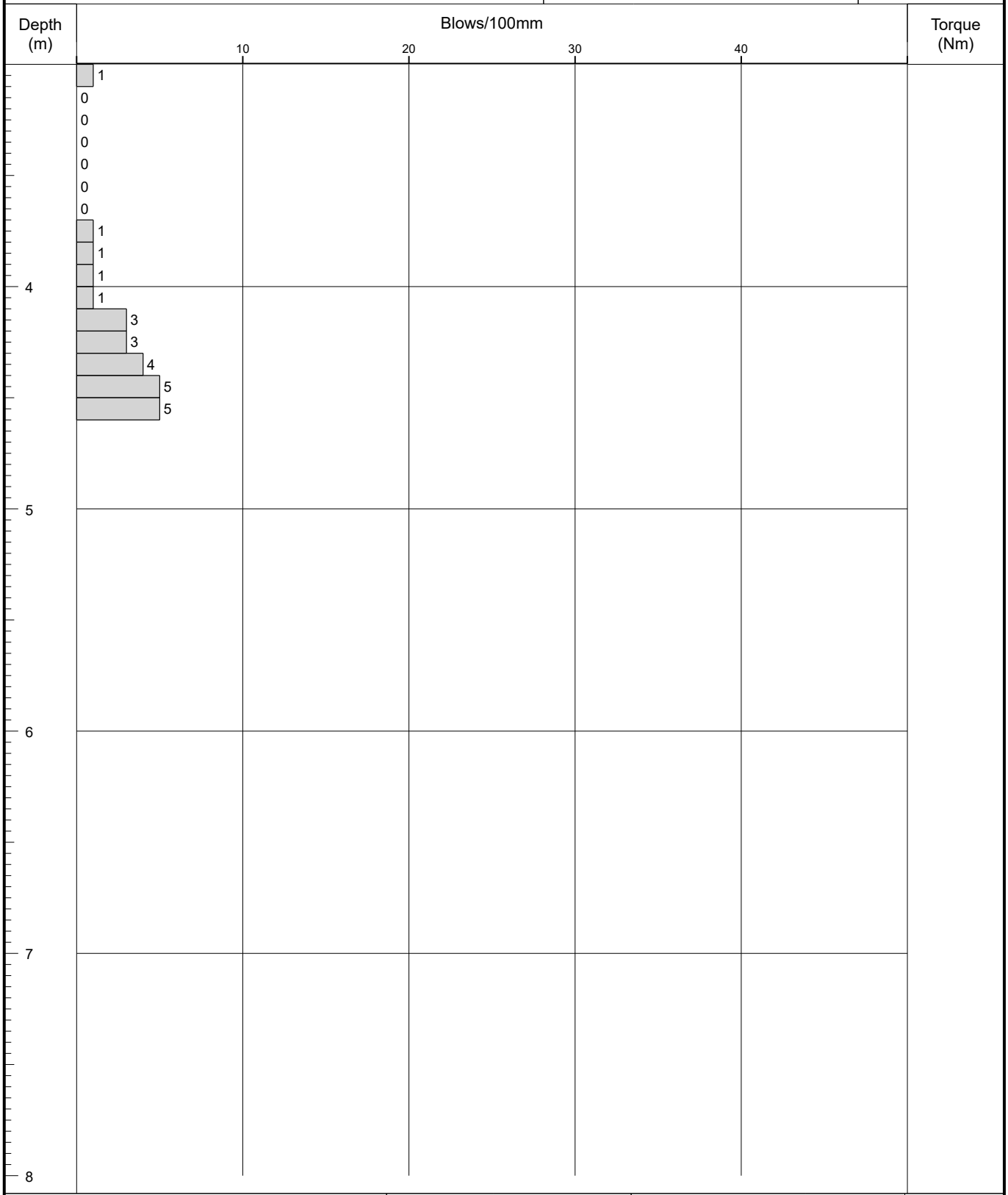
Borehole undertaken in loading bay from existing ground level. Ground level estimated from previous GPR survey.
Hand dug service clearance pit to 1.20m bgl. Possible brick wall encountered between 1.35m - 2.25m bgl. Deviation of window sampler within Made Ground deposits prevented progression of borehole. Borehole terminated at 3.00m bgl. No groundwater encountered. Dynamic Probe follow on to 4.50m bgl.
Downhole magnetometery conducted by UXO specialist. Borehole cleared for UXO to a maximum depth of 4.50m bgl.

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Probe Log

Borehole No.
WS04 (DP)
Sheet 1 of 1

Project Name: Swan House, Manchester	Project No. B067266.201	Co-ords: -	Hole Type DP
Location: Cable Street, Manchester		Level: 51.10	Scale 1:25
Client: Foundation Real Estate		Dates: 13/09/2018 - 13/09/2018	Logged By



Remarks
Dynamic Probing terminated at 4.60m bgl. Base of testing in accordance with limit of UXO clearance. Ground level estimated from previous GPR survey.

Fall Height		Cone Base Diameter	
Hammer Wt		Final Depth	4.60
Probe Type	DPSH- A	Log Scale	1:25

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

Borehole Log

Borehole No.
WS05
Sheet 1 of 1

Project Name: Swan House, Manchester	Project No. B067266.201	Co-ords: -	Hole Type WS
Location: Cable Street, Manchester		Level:	Scale 1:50
Client: Foundation Real Estate		Dates: 10/09/2018 - 10/09/2018	Logged By SH

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								MADE GROUND: CONCRETE.
					1.17			End of borehole at 1.17 m

Remarks
Borehole undertaken within basement.
Hand dug service clearance pit to 1.20m bgl. Possible pad foundation identified. Borehole terminated at 1.17m bgl. No groundwater encountered.

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

Borehole Log

Borehole No.
WS06
Sheet 1 of 1

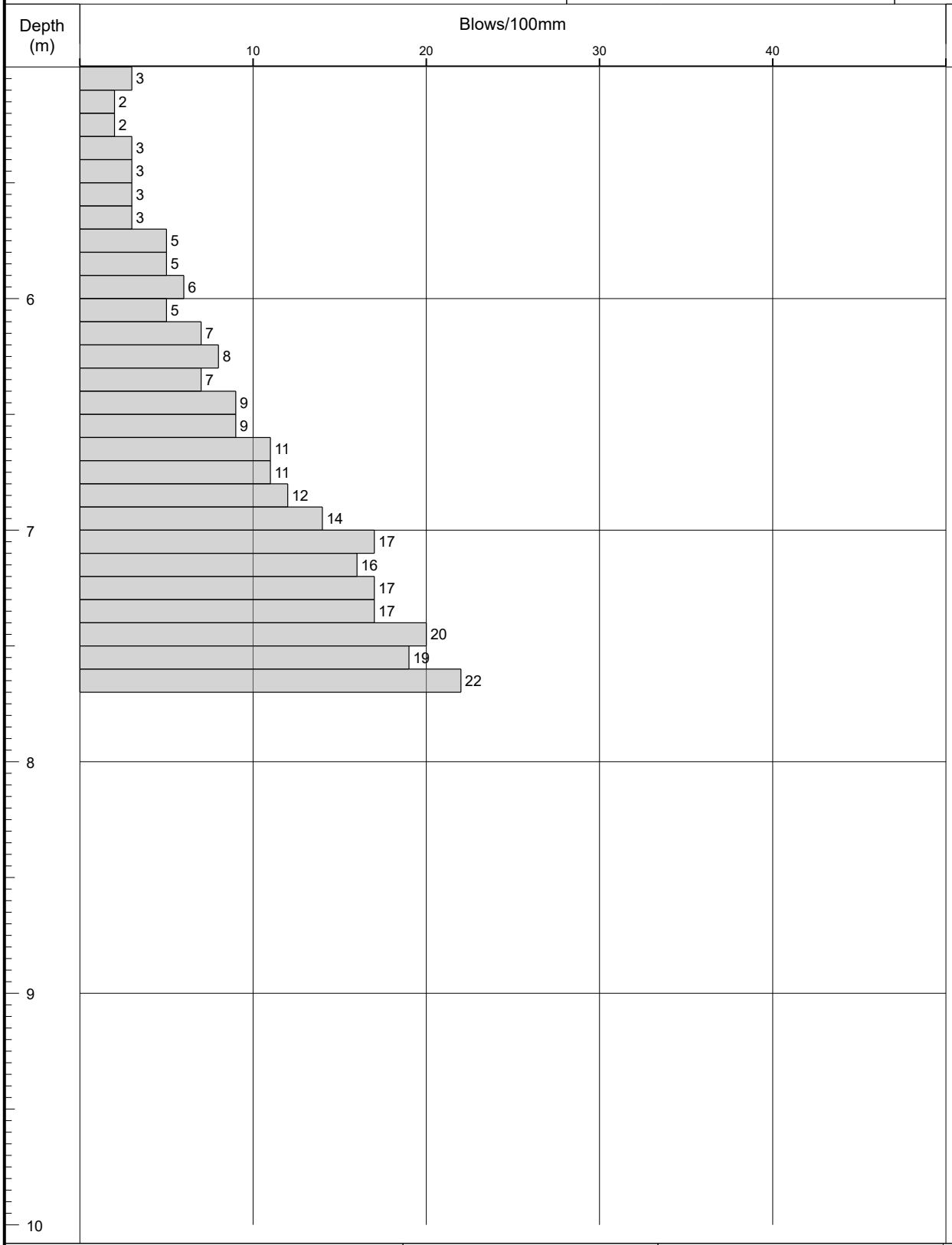
Project Name: Swan House, Manchester	Project No. B067266.201	Co-ords: -	Hole Type WS
Location: Cable Street, Manchester		Level:	Scale 1:50
Client: Foundation Real Estate		Dates: 10/09/2018 - 11/09/2018	Logged By SH/MH

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.30	ES		0.25			MADE GROUND: CONCRETE.
		1.00		N=25 (3,4/5,6,6,8)				Stiff brown with grey mottling sandy slightly gravelly CLAY.
		2.00		N=17 (3,3/3,4,4,6)				
		3.00		N=21 (3,3/4,5,6,6)				
		3.00 - 3.25	D					
					3.50			Firm brown sandy CLAY. Slightly damp.
					3.80			Stiff brown sandy CLAY.
		4.00		N=20 (3,4/4,5,5,6)				
					4.20			Stiff brown sandy CLAY. Rare gravel of fine sandstone and coal.
		4.70 - 4.90	D					
					5.00			End of borehole at 5.00 m

Remarks
Borehole undertaken within basement.
Hand dug service clearance pit to 1.20m bgl. No groundwater encountered. Dynamic Probe follow on to 7.00m bgl.

AGS

Curtins Merchant Exchange, 17 - 19 Whitworth Street West, Manchester M1 5WG	# Probe Log		Borehole No. **WS06 (DP)** Sheet 1 of 1
Project Name: Swan House, Manchester	Project No. B067266.201	Co-ords: -	Hole Type DP
Location: Cable Street, Manchester		Level:	Scale 1:25
Client: Foundation Real Estate		Dates: 11/09/2018 - 11/09/2018	Logged By



Remarks Dynamic Probing terminated at 7.60m bgl due to refusal.	Fall Height	Cone Base Diameter	
	Hammer Wt	Final Depth	7.70
	Probe Type DPSH- A	Log Scale	1:25

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

Borehole Log

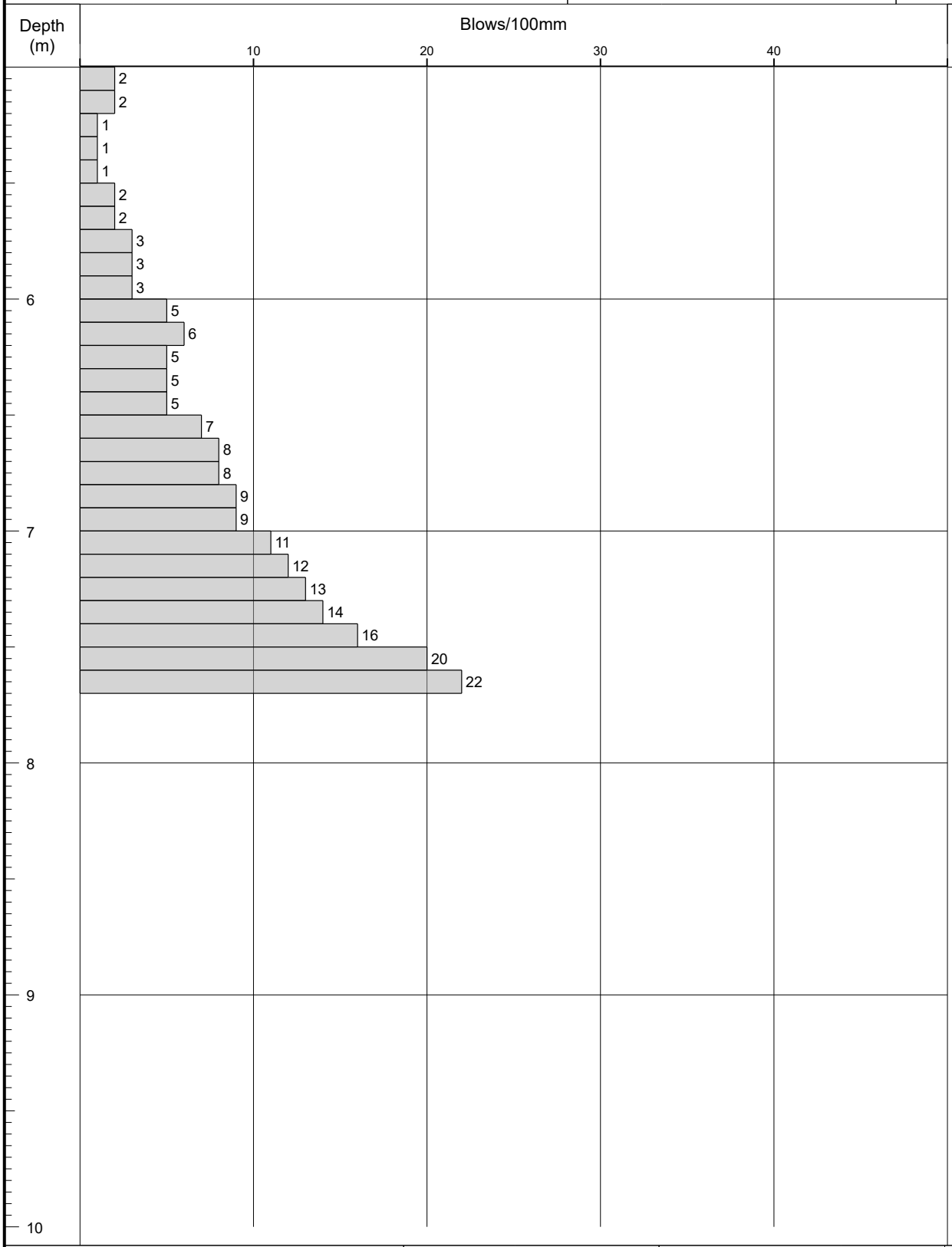
Borehole No.
WS07
Sheet 1 of 1

Project Name: Swan House, Manchester	Project No. B067266.201	Co-ords: -	Hole Type WS
Location: Cable Street, Manchester		Level:	Scale 1:50
Client: Foundation Real Estate		Dates: 11/09/2018 - 12/09/2018	Logged By MH

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.40 - 0.50	ES		0.31			MADE GROUND: CONCRETE.
		1.00		N=23 (2,3/5,5,6,7)				Stiff dark brown with occasional dark grey mottling slightly sandy slightly gravelly CLAY. Gravel is fine, angular to rounded sandstone and coal.
		1.90 - 2.00	D					
		2.00		N=20 (2,3/4,5,5,6)				
		3.00		N=17 (2,3/4,4,4,5)				
		3.80 - 4.00	D		3.90			Firm dark brown with rare light brown mottling sandy slightly gravelly CLAY. Rare light brown mottling. Gravel is fine subangular sandstone.
		4.00		N=13 (2,1/2,3,4,4)				*Deposits recorded as wet between 4.60m - 4.80m bgl.*
					5.00			End of borehole at 5.00 m

Remarks
Borehole undertaken within basement.
Hand dug service clearance pit to 1.20m bgl. No groundwater encountered. Dynamic Probe follow on to 7.00m bgl.

Curtins Merchant Exchange, 17 - 19 Whitworth Street West, Manchester M1 5WG	# Probe Log		Borehole No. **WS07 (DP)** Sheet 1 of 1
Project Name: Swan House, Manchester	Project No. B067266.201	Co-ords: -	Hole Type DP
Location: Cable Street, Manchester		Level:	Scale 1:25
Client: Foundation Real Estate		Dates: 12/09/2018 - 12/09/2018	Logged By



Remarks Dynamic Probing terminated at 7.60m bgl due to refusal.	Fall Height	Cone Base Diameter	
	Hammer Wt	Final Depth	7.70
	Probe Type DPSH- A	Log Scale	1:25

Borehole Log

Borehole No.
BH101
Sheet 1 of 1

Project Name:	Swan House Supplementary Investigation	Project No. 077409	Co-ords: -	Hole Type BH
Location:	Manchester		Level:	Scale 1:50
Client:	RGCM Ltd		Dates: 19/01/2021 - 19/01/2021	Logged By PN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.10			MADE GROUND: Tarmac
					0.30			MADE GROUND: Concrete block
					0.50			MADE GROUND: Concrete slab
					0.80			MADE GROUND: Reddish brown slightly clayey angular to subangular fine to coarse gravel of brick and concrete.
								MADE GROUND: Dark brown slightly silty gravelly clay with low cobble content. Gravel is angular to subrounded, fine to coarse of brick.
					1.50			MADE GROUND: Concrete slab
					1.55			End of borehole at 1.55 m

Remarks
Service inspection pit hand excavated from GL to 1.20m. Borehole terminated at 1.50m bgl due to possible slab encountered. Position reviewed in relation to services and decision made to relocate to BH101A.

Borehole Log

Borehole No. **BH101A**

Sheet 1 of 4

Project Name: Swan House Supplementary Investigation	Project No. 077409	Co-ords: -	Hole Type BH
Location: Manchester		Level: 49.95	Scale 1:50
Client: RGCM Ltd		Dates: 19/01/2021 - 22/01/2021	Logged By PN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.04	49.91		MADE GROUND: Tarmac
					0.24	49.71		MADE GROUND: Concrete slab
					0.40	49.55		MADE GROUND: Concrete block
		0.66 - 0.70	D		0.60	49.35		MADE GROUND: Concrete slab
					0.65	49.30		MADE GROUND: Dark brown slightly gravelly clay. Gravel is angular to subrounded, fine to coarse including brick.
		1.00 - 1.10	D					
		1.20	D					Firm to very stiff brown occassional orange mottling slightly sandy slightly gravelly CLAY. Gravel is subangular to rounded, fine to coarse including sandstone and mudstone.
		1.20		N=10 (0,3/2,3,1,4)				
		1.70 - 1.80	D					
		2.00		N=24 (4,6/5,6,6,7)				
		2.00 - 2.45	D					
		2.50 - 2.60	D					
		3.00		N=19 (7,6/7,4,3,5)				
		3.00 - 3.45	D					
		3.50 - 3.60	D					
		4.00		N=27 (8,7/8,6,6,7)				
		4.00 - 4.45	D					
		4.50 - 4.60	D					
		5.00 - 5.45	U	Ublow=100				
		5.50 - 5.60	D					
		6.00		N=30 (9,8/7,9,7,7)				
		6.00 - 6.45	D					
		7.00 - 7.10	D					
		7.50 - 7.95	U	Ublow=100				
		8.50 - 8.60	D					
		9.00		N=33 (8,8/9,8,7,9)				
		9.00 - 9.45	D					
		10.00 - 10.10	D					

Continued on next sheet

Remarks

Service inspection pit hand excavated from GL to 1.20m. Groundwater encountered at 14.00m bgl rising to 12.90m bgl.
Refer to BH101A RC log for rotary drilling details and core recovery parameters.

AGS

Borehole Log

Borehole No. **BH101A**
Sheet 2 of 4

Project Name:	Swan House Supplementary Investigation	Project No. 077409	Co-ords:	-	Hole Type BH
Location:	Manchester		Level:	49.95	Scale 1:50
Client:	RGCM Ltd		Dates:	19/01/2021 - 22/01/2021	Logged By PN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		10.50		N=37 (10,9/10,8,9,10)				
		10.50 - 10.95	D					
		11.50 - 11.60	D					
		12.00 - 12.45	U	Ublow=100				
		12.60 - 12.70	D		12.55	37.40		Very dense brown slightly gravelly fine to coarse SAND. Gravel is subrounded to well rounded including sandstone, mudstone and siltstone.
	▼	13.50		50 (25 for 15mm/50 for 150mm)				
		14.50 - 14.60	D					
		15.00	D					
		15.00		50 (19,6/50 for 170mm)				
		16.00 - 16.10	D					
					17.00	32.95		Very dense reddish brown slightly gravelly medium to coarse SAND. Gravel is subangular to subrounded, fine to medium of sandstone.
					20.00	29.95		

Continued on next sheet

Remarks
Service inspection pit hand excavated from GL to 1.20m. Groundwater encountered at 14.00m bgl rising to 12.90m bgl.
Refer to BH101A RC log for rotary drilling details and core recovery parameters.

Borehole Log

Borehole No. **BH101A**

Sheet 3 of 4

Project Name: Swan House Supplementary Investigation	Project No. 077409	Co-ords: -	Hole Type BH
Location: Manchester		Level: 49.95	Scale 1:50
Client: RGCM Ltd		Dates: 19/01/2021 - 22/01/2021	Logged By PN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					23.65	26.30		Weak reddish brown fine to medium grained SANDSTONE. *From 20.00 to 20.65m no recovery.* *From 20.65 to 20.85m recovered as non-intact core of sandy gravel.* *20.85 to 21.50m 0 - 10 degrees very closely spaced to closely spaced, planar rough* *From 21.50 to 21.73m no recovery.* *21.73 to 21.79m 0 - 10 degrees extremely closely spaced to very closely spaced, planar rough* *From 21.79 to 21.83m recovered as non-intact core of fine to medium sand.* *21.85 to 21.90m 0 - 10 degrees extremely closely to very closely spaced, planar rough* *From 21.90 to 22.00m recovered as non-intact core of fine to medium sand.* *22.00 to 22.95m 0 - 10 degrees extremely closely spaced to very closely spaced, planar rough* *From 22.95 to 23.35m no recovery* *From 23.35 to 23.50m recovered as non-intact core of gravelly fine to medium sand.* *From 23.50 to 23.65m highly weathered.*
		24.10 - 24.32	C					Medium strong reddish brown fine to medium grained SANDSTONE. *23.65 to 24.50m 0-10 degrees closely spaced to medium spaced locally extremely closely spaced, planar rough* *From 24.50 to 25.50m no recovery.* *From 25.50 to 25.70m highly weathered.* *25.70 to 25.90m 0-10 degrees extremely closely spaced to very closely spaced, planar rough* *From 25.90 to 26.0m no recovery.*
		26.14 - 26.27	C					*26.00 to 27.5m 0 - 10 degrees closely spaced to medium spaced locally very closely spaced, planar rough*
		26.93 - 27.17	C					*27.50 to 28.67m 0 - 10 degrees extremely closely spaced to very closely spaced, planar rough* *From 28.67 to 29.50m no recovery.* *From 29.50 to 29.60m recovered as non-intact core of slightly sandy subrounded fine to coarse gravel of sandstone.*
		29.84 - 30.00	C					

Continued on next sheet

Remarks

Service inspection pit hand excavated from GL to 1.20m. Groundwater encountered at 14.00m bgl rising to 12.90m bgl.
Refer to BH101A RC log for rotary drilling details and core recovery parameters.

Borehole Log

Borehole No. **BH101A** Sheet 4 of 4

Project Name: Swan House Supplementary Investigation	Project No. 077409	Co-ords: -	Hole Type BH
Location: Manchester		Level: 49.95	Scale 1:50
Client: RGCM Ltd		Dates: 19/01/2021 - 22/01/2021	Logged By PN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		30.66 - 31.01	C					*29.60 to 31.82m 0 - 10 degrees closely spaced to medium spaced locally extremely closely spaced, planar rough*
								From 31.82 to 32.00m no recovery.
								32.00 to 33.40m 0 - 10 degrees medium spaced locally extremely closely spaced, planar rough
		32.86 - 33.27	C					
								From 33.40 to 33.50m no recovery.
								33.50 to 35.05m 0 - 10 degrees very closely spaced to closely spaced, planar rough
					33.90	16.05		Medium strong reddish brown medium to coarse grained SANDSTONE.
								From 35.05 to 35.50m no recovery.
		35.85 - 35.99	C					
					36.50	13.45		*From 36.34 to 36.40m recovered as non-intact core of sandy subangular to well rounded, fine to coarse gravel of sandstone.*
								36.40 to 36.50m 0 - 10 degrees closely spaced to medium spaced, planar rough
		36.93 - 37.15	C					Medium strong reddish brown fine to medium grained SANDSTONE.
								From 36.50 to 36.77m recovered as non-intact core of angular to subangular fine to coarse gravel and cobbles.
								36.71 to 37.83m 0 - 10 degrees closely spaced to medium spaced, planar rough
					37.85	12.10		*From 37.83 to 38.00m no recovery.*
								Medium strong reddish brown coarse SANDSTONE.
		38.83 - 38.97	C					
								From 39.20 to 39.25m recovered as non-intact core of sandy subangular coarse gravel of sandstone.
								From 39.40 to 39.50m no recovery.
								39.50 to 40.00m 0 - 10 degrees very closely spaced to closely spaced, planar rough
					40.00	9.95		End of borehole at 40.00 m

Remarks

Service inspection pit hand excavated from GL to 1.20m. Groundwater encountered at 14.00m bgl rising to 12.90m bgl.
Refer to BH101A RC log for rotary drilling details and core recovery parameters.

AGS

Borehole Log

Borehole No. **BH101A**

Sheet 1 of 4

Project Name: Swan House Supplementary Investigation	Project No. 077409	Co-ords: -	Hole Type BH
Location: Manchester		Level: 49.95	Scale 1:50
Client: RGCM Ltd		Dates: 19/01/2021 - 22/01/2021	Logged By PN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.04	49.91		MADE GROUND: Tarmac
					0.24	49.71		MADE GROUND: Concrete slab
					0.40	49.55		MADE GROUND: Concrete block
					0.60	49.35		MADE GROUND: Concrete slab
		0.66 - 0.70	D		0.65	49.30		MADE GROUND: Dark brown slightly gravelly clay. Gravel is angular to subrounded, fine to coarse including brick.
		1.00 - 1.10	D					
		1.20	D					Firm to very stiff brown occassional orange mottling slightly sandy slightly gravelly CLAY. Gravel is subangular to rounded, fine to coarse including sandstone and mudstone.
		1.20		N=10 (0,3/2,3,1,4)				
		1.70 - 1.80	D					
		2.00		N=24 (4,6/5,6,6,7)				
		2.00 - 2.45	D					
		2.50 - 2.60	D					
		3.00		N=19 (7,6/7,4,3,5)				
		3.00 - 3.45	D					
		3.50 - 3.60	D					
		4.00		N=27 (8,7/8,6,6,7)				
		4.00 - 4.45	D					
		4.50 - 4.60	D					
		5.00 - 5.45	U	Ublow=100				
		5.50 - 5.60	D					
		6.00		N=30 (9,8/7,9,7,7)				
		6.00 - 6.45	D					
		7.00 - 7.10	D					
		7.50 - 7.95	U	Ublow=100				
		8.50 - 8.60	D					
		9.00		N=33 (8,8/9,8,7,9)				
		9.00 - 9.45	D					
		10.00 - 10.10	D					

Continued on next sheet

Remarks

Service inspection pit hand excavated from GL to 1.20m. Groundwater encountered at 14.00m bgl rising to 12.90m bgl.
Refer to BH101A RC log for rotary drilling details and core recovery parameters.

AGS

Borehole Log

Borehole No. **BH101A**

Sheet 2 of 4

Project Name:	Swan House Supplementary Investigation	Project No. 077409	Co-ords:	-	Hole Type BH
Location:	Manchester		Level:	49.95	Scale 1:50
Client:	RGCM Ltd		Dates:	19/01/2021 - 22/01/2021	Logged By PN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		10.50		N=37 (10,9/10,8,9,10)				
		10.50 - 10.95	D					
		11.50 - 11.60	D					
		12.00 - 12.45	U	Ublow=100				
		12.60 - 12.70	D		12.55	37.40		Very dense brown slightly gravelly fine to coarse SAND. Gravel is subrounded to well rounded including sandstone, mudstone and siltstone.
	▼	13.50		50 (25 for 15mm/50 for 150mm)				
		14.50 - 14.60	D					
		15.00	D					
		15.00		50 (19,6/50 for 170mm)				
		16.00 - 16.10	D					
					17.00	32.95		Very dense reddish brown slightly gravelly medium to coarse SAND. Gravel is subangular to subrounded, fine to medium of sandstone.
					20.00	29.95		

Continued on next sheet

Remarks

Service inspection pit hand excavated from GL to 1.20m. Groundwater encountered at 14.00m bgl rising to 12.90m bgl.
Refer to BH101A RC log for rotary drilling details and core recovery parameters.

AGS

Borehole Log

Borehole No. **BH101A**

Sheet 3 of 4

Project Name: Swan House Supplementary Investigation	Project No. 077409	Co-ords: -	Hole Type BH
Location: Manchester		Level: 49.95	Scale 1:50
Client: RGCM Ltd		Dates: 19/01/2021 - 22/01/2021	Logged By PN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					23.65	26.30		Weak reddish brown fine to medium grained SANDSTONE. *From 20.00 to 20.65m no recovery.* *From 20.65 to 20.85m recovered as non-intact core of sandy gravel.* *20.85 to 21.50m 0 - 10 degrees very closely spaced to closely spaced, planar rough* *From 21.50 to 21.73m no recovery.* *21.73 to 21.79m 0 - 10 degrees extremely closely spaced to very closely spaced, planar rough* *From 21.79 to 21.83m recovered as non-intact core of fine to medium sand.* *21.85 to 21.90m 0 - 10 degrees extremely closely to very closely spaced, planar rough* *From 21.90 to 22.00m recovered as non-intact core of fine to medium sand.* *22.00 to 22.95m 0 - 10 degrees extremely closely spaced to very closely spaced, planar rough* *From 22.95 to 23.35m no recovery* *From 23.35 to 23.50m recovered as non-intact core of gravelly fine to medium sand.* *From 23.50 to 23.65m highly weathered.*
		24.10 - 24.32	C					Medium strong reddish brown fine to medium grained SANDSTONE. *23.65 to 24.50m 0-10 degrees closely spaced to medium spaced locally extremely closely spaced, planar rough* *From 24.50 to 25.50m no recovery.* *From 25.50 to 25.70m highly weathered.* *25.70 to 25.90m 0-10 degrees extremely closely spaced to very closely spaced, planar rough* *From 25.90 to 26.0m no recovery.*
		26.14 - 26.27	C					*26.00 to 27.5m 0 - 10 degrees closely spaced to medium spaced locally very closely spaced, planar rough*
		26.93 - 27.17	C					*27.50 to 28.67m 0 - 10 degrees extremely closely spaced to very closely spaced, planar rough* *From 28.67 to 29.50m no recovery.*
		29.84 - 30.00	C					*From 29.50 to 29.60m recovered as non-intact core of slightly sandy subrounded fine to coarse gravel of sandstone.*

Continued on next sheet

Remarks

Service inspection pit hand excavated from GL to 1.20m. Groundwater encountered at 14.00m bgl rising to 12.90m bgl.
Refer to BH101A RC log for rotary drilling details and core recovery parameters.

Borehole Log

Borehole No. **BH101A**
Sheet 4 of 4

Project Name: Swan House Supplementary Investigation	Project No. 077409	Co-ords: -	Hole Type BH
Location: Manchester		Level: 49.95	Scale 1:50
Client: RGCM Ltd		Dates: 19/01/2021 - 22/01/2021	Logged By PN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		30.66 - 31.01	C					*29.60 to 31.82m 0 - 10 degrees closely spaced to medium spaced locally extremely closely spaced, planar rough*
								From 31.82 to 32.00m no recovery.
								32.00 to 33.40m 0 - 10 degrees medium spaced locally extremely closely spaced, planar rough
		32.86 - 33.27	C					*From 33.40 to 33.50m no recovery.*
								33.50 to 35.05m 0 - 10 degrees very closely spaced to closely spaced, planar rough
					33.90	16.05		Medium strong reddish brown medium to coarse grained SANDSTONE.
								From 35.05 to 35.50m no recovery.
		35.85 - 35.99	C					
					36.50	13.45		*From 36.34 to 36.40m recovered as non-intact core of sandy subangular to well rounded, fine to coarse gravel of sandstone.*
								36.40 to 36.50m 0 - 10 degrees closely spaced to medium spaced, planar rough
		36.93 - 37.15	C					Medium strong reddish brown fine to medium grained SANDSTONE.
								From 36.50 to 36.77m recovered as non-intact core of angular to subangular fine to coarse gravel and cobbles.
								36.71 to 37.83m 0 - 10 degrees closely spaced to medium spaced, planar rough
					37.85	12.10		*From 37.83 to 38.00m no recovery.*
								Medium strong reddish brown coarse SANDSTONE.
		38.83 - 38.97	C					
								From 39.20 to 39.25m recovered as non-intact core of sandy subangular coarse gravel of sandstone.
								From 39.40 to 39.50m no recovery.
								39.50 to 40.00m 0 - 10 degrees very closely spaced to closely spaced, planar rough
					40.00	9.95		End of borehole at 40.00 m

Remarks
Service inspection pit hand excavated from GL to 1.20m. Groundwater encountered at 14.00m bgl rising to 12.90m bgl.
Refer to BH101A RC log for rotary drilling details and core recovery parameters.

Borehole Log

Borehole No. **BH102**

Sheet 1 of 5

Project Name: Swan House Supplementary Investigation	Project No. 077409	Co-ords: -	Hole Type BH
Location: Manchester		Level: 50.10	Scale 1:50
Client: RGCM Ltd		Dates: 21/01/2021 - 26/01/2021	Logged By PN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.10	50.00		MADE GROUND: Concrete slab
					0.30	49.80		MADE GROUND: Concete block
		0.45 - 0.60	ES		0.40	49.70		MADE GROUND: Reinforced concrete
					0.45	49.65		MADE GROUND: Reddish brown angular to subangular, fine to coarse gravel of brick.
		0.90 - 1.00	D		0.80	49.30		MADE GROUND: Brown/orange slightly sandy slightly gravelly clay with low cobble content. Sand is medium to coarse. Gravel is angular to subrounded, fine to coarse including brick and concrete. Cobbles are angular of brick.
		1.20 1.20	D	N=19 (5,6/4,5,5,5)				
		1.70 - 1.80	D					Stiff to very stiff brown with occasional light brown mottling slightly sandy slightly gravelly CLAY. Sand is fine to medium. Gravel is subangular to rounded, fine to coarse of sandstone and mudstone.
		2.00 2.00	D	N=21 (6,5/6,5,4,6)				
		2.50 - 2.60	D					
		3.00 - 3.45	D	Ublow=100				
		3.50 - 3.60	D					
		4.00 4.00	D	N=23 (8,4/4,6,6,7)				
		4.50 - 4.60	D					
		5.00 5.00	D	N=29 (8,7/7,6,8,8)				
		5.50 - 5.60	D					
		6.00 - 6.45	U	Ublow=100				
		7.00 - 7.10	D					
		7.50 7.50	D	N=34 (8,9/10,8,8,8)				
		8.50 - 8.60	D					
		9.00 9.00	D	N=38 (11,10/10,10,8,10)				
		10.00 - 10.10	D					

Continued on next sheet

Remarks

Service inspection pit hand excavated from GL to 1.20m. Groundwater encountered at 15.00m bgl to 12.00m bgl. Refer for BH102 RC log for rotary drilling details and core recovery parameters.

Borehole Log

Borehole No. **BH102**

Sheet 2 of 5

Project Name:	Swan House Supplementary Investigation	Project No. 077409	Co-ords:	-	Hole Type BH
Location:	Manchester		Level:	50.10	Scale 1:50
Client:	RGCM Ltd		Dates:	21/01/2021 - 26/01/2021	Logged By PN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		10.50 10.50	D	N=46 (12,11/12,12,11,11)				
		11.50 - 11.60	D					
		12.00 12.00	D	N=49 (13,12/13,13,11,12)				
		13.00 - 13.10	D		13.00	37.10		Very dense brown slightly gravelly fine to coarse SAND. Gravel is subrounded to well rounded of sandstone, mudstone and siltstone.
		13.50 13.50	D	N=50 (14,11/14,14,13,9)				
		14.50 - 14.60	D					
	▼	15.00 15.00	D	50 (20,5/50 for 165mm)	15.00	35.10		Very dense reddish brown slightly gravelly medium to coarse SAND. Gravel is subangular to subrounded, fine to medium of sandstone.
		16.00 - 16.10	D					
		16.50 16.50	D	50 (19,6/50 for 170mm)				
		17.50 - 17.60	D					
		18.00 18.00	D	50 (25 for 50mm/50 for 152mm)				
		19.00 - 19.10	D					
		19.50 19.50	D	50 (25 for 40mm/50 for 145mm)				

Continued on next sheet

Remarks

Service inspection pit hand excavated from GL to 1.20m. Groundwater encountered at 15.00m bgl to 12.00m bgl. Refer for BH102 RC log for rotary drilling details and core recovery parameters.

Borehole Log

Borehole No. **BH102**

Sheet 3 of 5

Project Name:	Swan House Supplementary Investigation	Project No. 077409	Co-ords: -	Hole Type BH
Location:	Manchester		Level: 50.10	Scale 1:50
Client:	RGCM Ltd		Dates: 21/01/2021 - 26/01/2021	Logged By PN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		20.50 - 20.60	D					
		21.00		50 (25 for 30mm/50 for 85mm)				
		22.00 - 22.10	D		22.00	28.10		Weak reddish brown medium to coarse grained SANDSTONE.
								From 22.00 to 22.24m highly fractured.
								22.42 to 23.20m 0 - 10 degrees extremely closely spaced to closely spaced , planar rough
								From 23.20 to 24.15m no recovery.
								From 24.15 to 24.20m recovered as non-intact core of sandy angular cobbles.
								24.20 to 26.00m 0 - 10 degrees very closely spaced to closely spaced locally extremely closely spaced, planar rough
								From 26.00 to 26.50m no recovery.
								26.50 to 28.00m 5 - 15 degrees very closely spaced to closely spaced locally extremely closely spaced, planar rough
		27.78 - 27.96	C					
								28.00 to 29.35m 10 - 30 degrees very closely spaced to closely spaced, planar rough
		29.00 - 29.16	C					
								From 29.35 to 30.12m no recovery.

Continued on next sheet

Remarks

Service inspection pit hand excavated from GL to 1.20m. Groundwater encountered at 15.00m bgl to 12.00m bgl. Refer for BH102 RC log for rotary drilling details and core recovery parameters.

Borehole Log

Borehole No. **BH102**

Sheet 4 of 5

Project Name:	Swan House Supplementary Investigation	Project No. 077409	Co-ords: -	Hole Type BH
Location:	Manchester		Level: 50.10	Scale 1:50
Client:	RGCM Ltd		Dates: 21/01/2021 - 26/01/2021	Logged By PN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		31.52 - 31.77	C					*30.12 to 30.24m 0 - 10 degrees very closely spaced, planar rough* *From 30.24 to 30.30m recovered as non-intact core of sandy subangular coarse gravel of sandstone.* *30.30 to 32.28m 5 - 15 degrees closely spaced to medium spaced locally very closely, planar rough*
								From 32.28 to 32.5m no recovery.
					32.50	17.60		Medium strong reddish brown fine to medium grained SANDSTONE. *32.50 to 34.00m 0 - 5 degrees medium spaced locally very closely spaced, planar rough*
		33.06 - 33.44	C					
					34.00	16.10		Medium strong reddish brown medium to coarse grained SANDSTONE. *34.00 to 36.83m 0 - 10 degrees closely spaced to medium spaced locally very closely spaced, planar rough*
		34.34 - 34.50	C					
		35.83 - 36.09	C					
								From 36.83 to 37.10m no recovery.
								37.10 to 37.17m 0 - 10 degrees very closely spaced, planar rough *From 37.17 to 37.28m recovered as non-intact core of angular to subangular fine to coarse gravel and cobbles.* *37.28 to 37.69m 5 - 10 degrees medium spaced, planar rough* *From 37.69 to 37.83m highly weathered.* *37.83 to 39.88m 5 - 25 degrees closely spaced to medium spaced locally very closely spaced, planar rough*
		39.68 - 39.88	C					
					40.00	10.10		Continued on next sheet

Remarks

Service inspection pit hand excavated from GL to 1.20m. Groundwater encountered at 15.00m bgl to 12.00m bgl. Refer for BH102 RC log for rotary drilling details and core recovery parameters.

Borehole Log

Borehole No. **BH102**

Sheet 1 of 5

Project Name: Swan House Supplementary Investigation	Project No. 077409	Co-ords: -	Hole Type BH
Location: Manchester		Level: 50.10	Scale 1:50
Client: RGCM Ltd		Dates: 21/01/2021 - 26/01/2021	Logged By PN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.10	50.00		MADE GROUND: Concrete slab
					0.30	49.80		MADE GROUND: Concete block
		0.45 - 0.60	ES		0.40	49.70		MADE GROUND: Reinforced concrete
					0.45	49.65		MADE GROUND: Reddish brown angular to subangular, fine to coarse gravel of brick.
		0.90 - 1.00	D		0.80	49.30		MADE GROUND: Brown/orange slightly sandy slightly gravelly clay with low cobble content. Sand is medium to coarse. Gravel is angular to subrounded, fine to coarse including brick and concrete. Cobbles are angular of brick.
		1.20 1.20	D	N=19 (5,6/4,5,5,5)				
		1.70 - 1.80	D					Stiff to very stiff brown with occasional light brown mottling slightly sandy slightly gravelly CLAY. Sand is fine to medium. Gravel is subangular to rounded, fine to coarse of sandstone and mudstone.
		2.00 2.00	D	N=21 (6,5/6,5,4,6)				
		2.50 - 2.60	D					
		3.00 - 3.45	D	Ublow=100				
		3.50 - 3.60	D					
		4.00 4.00	D	N=23 (8,4/4,6,6,7)				
		4.50 - 4.60	D					
		5.00 5.00	D	N=29 (8,7/7,6,8,8)				
		5.50 - 5.60	D					
		6.00 - 6.45	U	Ublow=100				
		7.00 - 7.10	D					
		7.50 7.50	D	N=34 (8,9/10,8,8,8)				
		8.50 - 8.60	D					
		9.00 9.00	D	N=38 (11,10/10,10,8,10)				
		10.00 - 10.10	D					

Continued on next sheet

Remarks

Service inspection pit hand excavated from GL to 1.20m. Groundwater encountered at 15.00m bgl to 12.00m bgl. Refer for BH102 RC log for rotary drilling details and core recovery parameters.

Borehole Log

Borehole No. **BH102**

Sheet 2 of 5

Project Name:	Swan House Supplementary Investigation	Project No. 077409	Co-ords:	-	Hole Type BH
Location:	Manchester		Level:	50.10	Scale 1:50
Client:	RGCM Ltd		Dates:	21/01/2021 - 26/01/2021	Logged By PN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		10.50 10.50	D	N=46 (12,11/12,12,11,11)				
		11.50 - 11.60	D					
		12.00 12.00	D	N=49 (13,12/13,13,11,12)				
		13.00 - 13.10	D		13.00	37.10		Very dense brown slightly gravelly fine to coarse SAND. Gravel is subrounded to well rounded of sandstone, mudstone and siltstone.
		13.50 13.50	D	N=50 (14,11/14,14,13,9)				
		14.50 - 14.60	D					
	▼	15.00 15.00	D	50 (20,5/50 for 165mm)	15.00	35.10		Very dense reddish brown slightly gravelly medium to coarse SAND. Gravel is subangular to subrounded, fine to medium of sandstone.
		16.00 - 16.10	D					
		16.50 16.50	D	50 (19,6/50 for 170mm)				
		17.50 - 17.60	D					
		18.00 18.00	D	50 (25 for 50mm/50 for 152mm)				
		19.00 - 19.10	D					
		19.50 19.50	D	50 (25 for 40mm/50 for 145mm)				

Continued on next sheet

Remarks

Service inspection pit hand excavated from GL to 1.20m. Groundwater encountered at 15.00m bgl to 12.00m bgl. Refer for BH102 RC log for rotary drilling details and core recovery parameters.

Borehole Log

Borehole No. **BH102**

Sheet 3 of 5

Project Name:	Swan House Supplementary Investigation	Project No. 077409	Co-ords: -	Hole Type BH
Location:	Manchester		Level: 50.10	Scale 1:50
Client:	RGCM Ltd		Dates: 21/01/2021 - 26/01/2021	Logged By PN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		20.50 - 20.60	D					
		21.00		50 (25 for 30mm/50 for 85mm)				
		22.00 - 22.10	D		22.00	28.10		Weak reddish brown medium to coarse grained SANDSTONE.
								From 22.00 to 22.24m highly fractured.
								22.42 to 23.20m 0 - 10 degrees extremely closely spaced to closely spaced , planar rough
								From 23.20 to 24.15m no recovery.
								From 24.15 to 24.20m recovered as non-intact core of sandy angular cobbles.
								24.20 to 26.00m 0 - 10 degrees very closely spaced to closely spaced locally extremely closely spaced, planar rough
								From 26.00 to 26.50m no recovery.
								26.50 to 28.00m 5 - 15 degrees very closely spaced to closely spaced locally extremely closely spaced, planar rough
		27.78 - 27.96	C					
								28.00 to 29.35m 10 - 30 degrees very closely spaced to closely spaced, planar rough
		29.00 - 29.16	C					
								From 29.35 to 30.12m no recovery.

Continued on next sheet

Remarks

Service inspection pit hand excavated from GL to 1.20m. Groundwater encountered at 15.00m bgl to 12.00m bgl. Refer for BH102 RC log for rotary drilling details and core recovery parameters.

Borehole Log

Borehole No. **BH102**

Sheet 4 of 5

Project Name:	Swan House Supplementary Investigation	Project No. 077409	Co-ords: -	Hole Type BH
Location:	Manchester		Level: 50.10	Scale 1:50
Client:	RGCM Ltd		Dates: 21/01/2021 - 26/01/2021	Logged By PN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		31.52 - 31.77	C					*30.12 to 30.24m 0 - 10 degrees very closely spaced, planar rough* *From 30.24 to 30.30m recovered as non-intact core of sandy subangular coarse gravel of sandstone.* *30.30 to 32.28m 5 - 15 degrees closely spaced to medium spaced locally very closely, planar rough*
								From 32.28 to 32.5m no recovery.
					32.50	17.60		Medium strong reddish brown fine to medium grained SANDSTONE. *32.50 to 34.00m 0 - 5 degrees medium spaced locally very closely spaced, planar rough*
		33.06 - 33.44	C					
					34.00	16.10		Medium strong reddish brown medium to coarse grained SANDSTONE. *34.00 to 36.83m 0 - 10 degrees closely spaced to medium spaced locally very closely spaced, planar rough*
		34.34 - 34.50	C					
		35.83 - 36.09	C					
								From 36.83 to 37.10m no recovery.
								37.10 to 37.17m 0 - 10 degrees very closely spaced, planar rough *From 37.17 to 37.28m recovered as non-intact core of angular to subangular fine to coarse gravel and cobbles.* *37.28 to 37.69m 5 - 10 degrees medium spaced, planar rough* *From 37.69 to 37.83m highly weathered.* *37.83 to 39.88m 5 - 25 degrees closely spaced to medium spaced locally very closely spaced, planar rough*
		39.68 - 39.88	C					
					40.00	10.10		Continued on next sheet

31 32 33 34 35 36 37 38 39 40

Remarks

Service inspection pit hand excavated from GL to 1.20m. Groundwater encountered at 15.00m bgl to 12.00m bgl. Refer for BH102 RC log for rotary drilling details and core recovery parameters.

AGS

Borehole Log

Borehole No.
BH102
Sheet 5 of 5

Project Name:	Swan House Supplementary Investigation	Project No. 077409	Co-ords: -	Hole Type BH
Location:	Manchester		Level: 50.10	Scale 1:50
Client:	RGCM Ltd		Dates: 21/01/2021 - 26/01/2021	Logged By PN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								From 39.88 to 40.00m no recovery. End of borehole at 40.00 m

41
42
43
44
45
46
47
48
49
50

Remarks
Service inspection pit hand excavated from GL to 1.20m. Groundwater encountered at 15.00m bgl to 12.00m bgl. Refer for BH102 RC log for rotary drilling details and core recovery parameters.

Borehole Log

Borehole No.
BH102
Sheet 5 of 5

Project Name:	Swan House Supplementary Investigation	Project No. 077409	Co-ords: -	Hole Type BH
Location:	Manchester		Level: 50.10	Scale 1:50
Client:	RGCM Ltd		Dates: 21/01/2021 - 26/01/2021	Logged By PN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								From 39.88 to 40.00m no recovery.
								End of borehole at 40.00 m

41
42
43
44
45
46
47
48
49
50

Remarks
Service inspection pit hand excavated from GL to 1.20m. Groundwater encountered at 15.00m bgl to 12.00m bgl. Refer for BH102 RC log for rotary drilling details and core recovery parameters.

Borehole Log

Borehole No. **BH103**

Sheet 1 of 4

Project Name:	Swan House Supplementary Investigation	Project No. 077409	Co-ords: -	Hole Type BH
Location:	Manchester		Level: 50.42	Scale 1:50
Client:	RGCM Ltd		Dates: 25/01/2021 - 28/01/2021	Logged By PN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.10	50.32		MADE GROUND: Concrete slab
					0.30	50.12		MADE GROUND: Concrete block
					0.40	50.02		MADE GROUND: Concrete slab
					0.50	49.92		MADE GROUND: Reinforced concrete
								MADE GROUND: Reddish brown angular to subangular, fine to coarse gravel of brick.
					1.00	49.42		
		1.20	D					MADE GROUND: Dark brown sandy gravelly clay with low ash content. Sand is medium to coarse. Gravel is angular to subrounded, fine to coarse including brick and concrete.
		1.20		N=7 (2,1/3,1,2,1)				
		1.40 - 1.60	ES					
		1.70 - 1.80	D					
					1.80	48.62		
		2.00		N=7 (2,2/3,1,1,2)				Soft brown mottled light brown/orange CLAY.
		2.00 - 2.45	D					
		2.50 - 2.60	D		2.50	47.92		
		3.00 - 3.45	U	Ublow=100				Stiff to very stiff brown silty slightly gravelly CLAY with moderate cobble content. Gravel is subangular to well rounded incluidng sandstone, mudstone and siltstone. Cobbles are subrounded of sandstone and mudstone.
		3.50 - 3.60	D					
		4.00		N=15 (2,3/4,3,4,4)				
		4.00 - 4.45	D					
		5.00 - 5.45	U	Ublow=100				
		5.50 - 5.60	D					
		6.00		N=18 (5,4/4,5,3,6)				
		6.00 - 6.45	D					
		7.00 - 7.10	D					
		7.50		N=25 (5,6/5,7,6,7)				
		7.50 - 7.95	D					
		8.50 - 8.60	D					
		9.00		N=29 (7,8/7,6,8,8)				
		9.00 - 9.45	D					
		10.00 - 10.10	D		10.00	40.42		

Continued on next sheet

Remarks

Service inspection pit hand excavated from GL to 1.20m. Groundwater encountered at 16.00m bgl to 12.40m bgl. Refer to BH103 RC log for rotary drilling details and core recovery parameters.

Borehole Log

Borehole No. **BH103**

Sheet 2 of 4

Project Name:	Swan House Supplementary Investigation	Project No. 077409	Co-ords:	-	Hole Type BH
Location:	Manchester		Level:	50.42	Scale 1:50
Client:	RGCM Ltd		Dates:	25/01/2021 - 28/01/2021	Logged By PN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		10.50		N=31 (9,10/9,7,8,7)				Dense brown slightly gravelly medium to coarse SAND. Gravel is subangular to rounded, fine to coarse of sandstone, siltstone and mudstone.
		10.50 - 10.95	D					
		11.50 - 11.60	D					
		12.00		N=36 (10,9/10,8,10,8)				
		12.00 - 12.45	D					
		13.00 - 13.10	D					
		13.10		N=36 (8,7/9,8,9,10)				
		15.00		N=36 (9,9/10,9,8,9)				
		15.00 - 15.45	D					
	▼	16.00	D		16.00	34.42		
		16.50		N=46 (11,12/12,13,10,11)				Dense to very dense reddish brown slightly gravelly medium to coarse SAND. Gravel is subangular to rounded, fine to coarse of sandstone.
		17.50 - 17.60	D					
		18.00	D					
		18.00		50 (20,5/50 for 170mm)				
		19.00 - 19.10	D					
		19.50	D					
		19.50		50 (23,2/50 for 157mm)				

Continued on next sheet

Remarks

Service inspection pit hand excavated from GL to 1.20m. Groundwater encountered at 16.00m bgl to 12.40m bgl. Refer to BH103 RC log for rotary drilling details and core recovery parameters.

Borehole Log

Borehole No. **BH103**

Sheet 3 of 4

Project Name:	Swan House Supplementary Investigation	Project No. 077409	Co-ords:	-	Hole Type BH
Location:	Manchester		Level:	50.42	Scale 1:50
Client:	RGCM Ltd		Dates:	25/01/2021 - 28/01/2021	Logged By PN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		20.50 - 20.60	D					
		21.00 21.00	D	50 (25 for 75mm/50 for 160mm)				
		22.00 - 22.10	D					
					24.20	26.22		Weak reddish brown fine to medium grained SANDSTONE. *From 24.20 to 24.45m highly weathered.* *24.40 to 25.05m 0 - 10 degrees very closely spaced to closely space, planar rough* *From 25.05 to 25.12m recovered as non-intact core of sandy angular to subangular fine to coarse gravel and cobbles.* *25.12 to 25.17m 0 - 10 degrees very closely spaced, planar rough* *From 25.17 to 25.23m recovered as non-intact core of sandy angular to subangular fine to coarse gravel and cobbles.* *25.23 to 25.40m 0 - 10 degrees very closely spaced to closely spaced locally extremely closely spaced, planar rough* *From 25.40 to 25.55m recovered as non-intact core of gravelly medium to coarse sand.* *25.55 to 26.26 0 - 10 degrees extremely closely spaced to closely spaced, planar rough* *From 26.26 to 26.40 highly weathered.* *From 26.40 to 26.50m no recovery.* *From 26.50 to 26.83m no recovery.* *26.83 to 28.60m 0 - 10 degrees very closely spaced to closely spaced, planar rough*
		25.78 - 26.00	C					
		28.20 - 28.38	C					
								From 28.38 to 23.40m sandy infill *From 28.60 to 29.00m recovered as non-intact core of sandy angular to subangular fine to coarse gravel and cobbles.*
					29.00	21.42		Medium strong reddish brown fine to medium grained SANDSTONE. *29.00 to 30.65m 0 - 10 degrees closely spaced to medium sapced, locally extremely closely to very closely paced, planar rough*

Continued on next sheet

Remarks

Service inspection pit hand excavated from GL to 1.20m. Groundwater encountered at 16.00m bgl to 12.40m bgl. Refer to BH103 RC log for rotary drilling details and core recovery parameters.

Borehole Log

Borehole No. **BH103** Sheet 4 of 4

Project Name:	Swan House Supplementary Investigation	Project No. 077409	Co-ords: -	Hole Type BH
Location:	Manchester		Level: 50.42	Scale 1:50
Client:	RGCM Ltd		Dates: 25/01/2021 - 28/01/2021	Logged By PN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		30.12 - 30.33	C					*From 30.65 to 31.00m no recovery.*
								31.00 to 33.90m 0 - 10 degrees closely spaced to medium spaced, planar rough
								From 31.10 to 31.35m very weak.
								From 31.73 to 31.82m very weak.
		32.29 - 32.46	C					
								From 33.62 to 33.78m extremely closely spaces thin dark grey laminations
								From 33.78 to 33.90 very weak.
								From 33.90 to 34.00m no recovery.
		34.28 - 34.46	C					*34.00 to 35.43m 0 - 10 degrees extremely closely spaced to closely spaced, planar rough*
								From 35.43 to 35.50 no recovery.
								35.50 to 35.57m 1 No. discontinuity 0 -10 degrees planar rough
								From 35.57 to 35.64m recovered as non-intact core of sandy angular to subangular fine to coarse gravel.
								35.64 to 37.10m 10 - 20 degrees closely spaced to medium spaced locally very closely spaced, planar rough
								From 36.46 to 36.72m extremely to very closely spaced think dark grey laminations.
		37.28 - 37.60	C					*From 37.1 to 37.15m recovered as non-intact core of sandy angular to subangular fine to coarse gravel.*
								37.15 to 37.28m 0 - 10 degrees very closely spaced to closely spaced, planar rough
								From 37.28 to 37.31m recovered as non-intact core of sandy angular to subangular fine to coarse gravel.
								37.31 to 38.28m 0 - 10 degrees closely spaced to medium spaced locally very closely spaced, planar rough
								From 38.28 to 38.50m no recovery
								38.50 to 40.00m 0 - 10 degrees very closely spaced to closely spaced, planar rough
		39.08 - 39.28	C					
					40.00	10.42		End of borehole at 40.00 m

Remarks

Service inspection pit hand excavated from GL to 1.20m. Groundwater encountered at 16.00m bgl to 12.40m bgl. Refer to BH103 RC log for rotary drilling details and core recovery parameters.

Rotary Core Log

Borehole No. **BH103**

Sheet 1 of 4

Project Name: Swan House Supplementary Investigation	Project No. 077409	Co-ords: -	Hole Type RC
Location: Manchester		Level:	Scale 1:50
Client: RGCM Ltd		Dates: 25/01/2021 - 28/01/2021	Logged By PN

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.10			MADE GROUND: Concrete slab
							0.30			MADE GROUND: Concrete block
							0.40			MADE GROUND: Concrete slab
							0.50			MADE GROUND: Reinforced concrete
							1.00			MADE GROUND: Reddish brown angular to subangular, fine to coarse gravel of brick.
		1.20	D							MADE GROUND: Dark brown sandy gravelly clay with low ash content. Sand is medium to coarse. Gravel is angular to subrounded, fine to coarse including brick and concrete.
		1.40 - 1.60	ES							
		1.70 - 1.80	D							
		2.00 - 2.45	D				1.80			Soft brown mottled light brown/orange CLAY.
		2.50 - 2.60	D				2.50			Stiff to very stiff brown silty slightly gravelly CLAY with moderate cobble content. Gravel is subangular to well rounded incluidng sandstone, mudstone and siltstone. Cobbles are subrounded of sandstone and mudstone.
		3.00 - 3.45	U							
		3.50 - 3.60	D							
		4.00 - 4.45	D							
		5.00 - 5.45	U							
		5.50 - 5.60	D							
		6.00 - 6.45	D							
		7.00 - 7.10	D							
		7.50 - 7.95	D							
		8.50 - 8.60	D							
		9.00 - 9.45	D							
		10.00 - 10.10	D				10.00			Continued on next sheet

Remarks

Service inspection pit hand excavated from GL to 1.20m. Groundwater encountered at 16.00m bgl to 12.40m bgl. Refer to BH103 superficial log for in-situ test results in superficial soils.

Rotary Core Log

Borehole No. **BH103**

Sheet 2 of 4

Project Name: Swan House Supplementary Investigation	Project No. 077409	Co-ords: -	Hole Type RC
Location: Manchester		Level:	Scale 1:50
Client: RGCM Ltd		Dates: 25/01/2021 - 28/01/2021	Logged By PN

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.50 - 10.95	D							Dense brown slightly gravelly medium to coarse SAND. Gravel is subangular to rounded, fine to coarse of sandstone, siltstone and mudstone.
		11.50 - 11.60	D							
		12.00 - 12.45	D							
		13.00 - 13.10	D							
		15.00 - 15.45	D							
	▼	16.00	D				16.00			
		17.50 - 17.60	D							Dense to very dense reddish brown slightly gravelly medium to coarse SAND. Gravel is subangular to rounded, fine to coarse of sandstone.
		18.00	D							
		19.00 - 19.10	D							
		19.50	D							

Continued on next sheet

Remarks

Service inspection pit hand excavated from GL to 1.20m. Groundwater encountered at 16.00m bgl to 12.40m bgl. Refer to BH103 superficial log for in-situ test results in superficial soils.

Rotary Core Log

Borehole No. **BH103**

Sheet 3 of 4

Project Name: Swan House Supplementary Investigation	Project No. 077409	Co-ords: -	Hole Type RC
Location: Manchester		Level:	Scale 1:50
Client: RGCM Ltd		Dates: 25/01/2021 - 28/01/2021	Logged By PN

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		20.50 - 20.60	D							
		21.00	D							
		22.00 - 22.10	D							
		23.50 - 25.00	NI	87	33	14	24.20			Weak reddish brown fine to medium grained SANDSTONE. *From 24.20 to 24.45m highly weathered.* *24.40 to 25.05m 0 - 10 degrees very closely spaced to closely space, planar rough*
		25.00 - 26.50	C	38	62	36				*From 25.05 to 25.12m recovered as non-intact core of sandy angular to subangular fine to coarse gravel and cobbles.* *25.12 to 25.17m 0 - 10 degrees very closely spaced, planar rough* *From 25.17 to 25.23m recovered as non-intact core of sandy angular to subangular fine to coarse gravel and cobbles.* *25.23 to 25.40m 0 - 10 degrees very closely spaced to closely spaced locally extremely closely spaced, planar rough* *From 25.40 to 25.55m recovered as non-intact core of gravelly medium to coarse sand.* *25.55 to 26.26 0 - 10 degrees extremely closely spaced to closely spaced, planar rough* *From 26.26 to 26.40 highly weathered.* *From 26.40 to 26.50m no recovery.* *From 26.50 to 26.83m no recovery.* *26.83 to 28.60m 0 - 10 degrees very closely spaced to closely spaced, planar rough*
		26.50 - 28.00		86	86	36				
		28.20 - 28.38	C							*From 28.38 to 23.40m sandy infill*
		28.00 - 29.50		100	73	29				*From 28.60 to 29.00m recovered as non-intact core of sandy angular to subangular fine to coarse gravel and cobbles.*
							29.00			Medium strong reddish brown fine to medium grained SANDSTONE. *29.00 to 30.65m 0 - 10 degrees closely spaced to medium sapced, locally extremely closely to very closely paced, planar rough*

Continued on next sheet

Remarks

Service inspection pit hand excavated from GL to 1.20m. Groundwater encountered at 16.00m bgl to 12.40m bgl. Refer to BH103 superficial log for in-situ test results in superficial soils.

Rotary Core Log

Borehole No. **BH103**

Sheet 4 of 4

Project Name: Swan House Supplementary Investigation	Project No. 077409	Co-ords: -	Hole Type RC
Location: Manchester		Level:	Scale 1:50
Client: RGCM Ltd		Dates: 25/01/2021 - 28/01/2021	Logged By PN

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		30.12 - 30.33	C							
		29.50 - 31.00		77	77	44				*From 30.65 to 31.00m no recovery.*
		31.00 - 32.50		100	100	84				*31.00 to 33.90m 0 - 10 degrees closely spaced to medium spaced, planar rough* *From 31.10 to 31.35m very weak.* *From 31.73 to 31.82m very weak.*
		32.29 - 32.46	C							
		32.50 - 34.00		93	82	36				*From 33.62 to 33.78m extremely closely spaces thin dark grey laminations* *From 33.78 to 33.90 very weak.* *From 33.90 to 34.00m no recovery.*
		34.28 - 34.46	C							*34.00 to 35.43m 0 - 10 degrees extremely closely spaced to closely spaced, planar rough*
		34.00 - 35.50		100	91	37				*From 35.43 to 35.50 no recovery.*
		35.50 - 37.00		100	69	51				*35.50 to 35.57m 1 No. discontinuity 0 -10 degrees planar rough* *From 35.57 to 35.64m recovered as non-intact core of sandy angular to subangular fine to coarse gravel.* *35.64 to 37.10m 10 - 20 degrees closely spaced to medium spaced locally very closely spaced, planar rough* *From 36.46 to 36.72m extremely to very closely spaced think dark grey laminations.*
		37.28 - 37.60	C							*From 37.1 to 37.15m recovered as non-intact core of sandy angular to subangular fine to coarse gravel.*
		37.00 - 38.50		88	83	46				*37.15 to 37.28m 0 - 10 degrees very closely spaced to closely spaced, planar rough* *From 37.28 to 37.31m recovered as non-intact core of sandy angular to subangular fine to coarse gravel.* *37.31 to 38.28m 0 - 10 degrees closely spaced to medium spaced locally very closely spaced, planar rough* *From 38.28 to 38.50m no recovery*
		39.08 - 39.28	C							*38.50 to 40.00m 0 - 10 degrees very closely spaced to closely spaced, planar rough*
		38.50 - 40.00		100	100	40				
							40.00			End of borehole at 40.00 m

Remarks

Service inspection pit hand excavated from GL to 1.20m. Groundwater encountered at 16.00m bgl to 12.40m bgl. Refer to BH103 superficial log for in-situ test results in superficial soils.

AGS

Client Name: RGCM Ltd		Project Name: Swan House	Project No: B077409
No. 1	**Date:** 27/01/2021	**Description:** BH101A Rock Logging Photographs 20.50m to 24.50m bgl	





Client Name: RGCM Ltd		Project Name: Swan House	Project No: B077409
No. 2	**Date:** 27/01/2021	**Description:** BH101A Rock Logging Photographs 24.50m to 28.50m bgl	





Client Name: RGCM Ltd		Project Name: Swan House	Project No: B077409
No. 3	**Date:** 27/01/2021	**Description:** BH101A Rock Logging Photographs 28.50m to 32.50m bgl	





Client Name: RGCM Ltd		Project Name: Swan House	Project No: B077409
No. 4	**Date:** 27/01/2021	**Description:** BH101A Rock Logging Photographs 32.50m to 36.50m bgl	





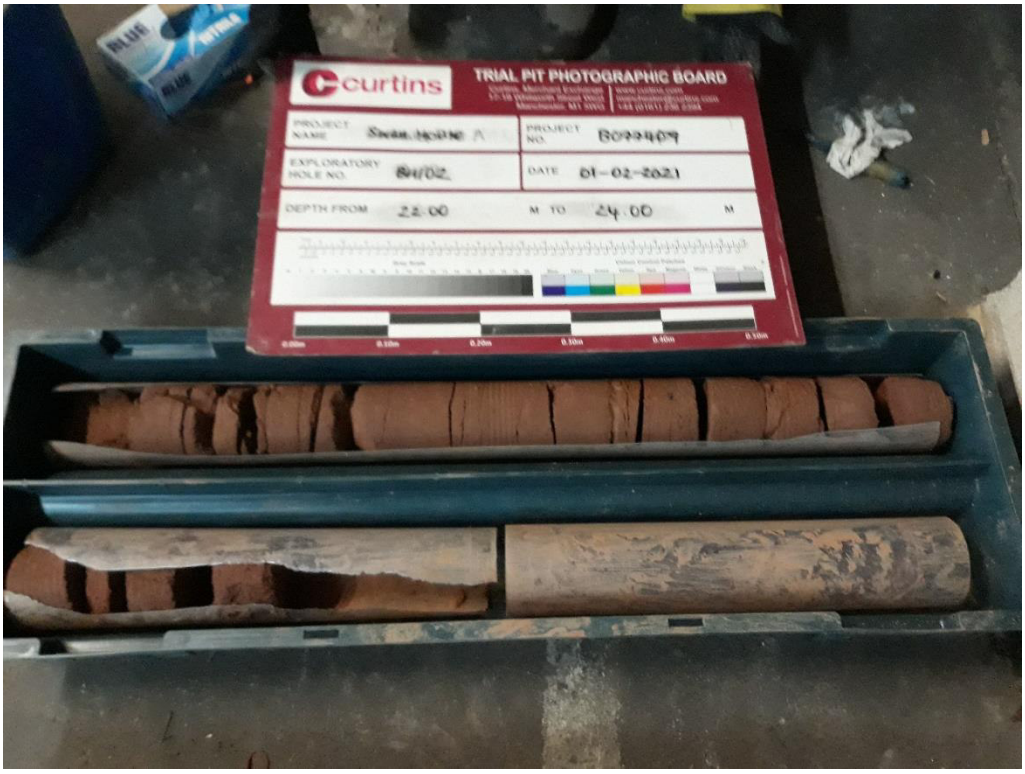
Client Name: RGCM Ltd	Project Name: Swan House	Project No: B077409

No.	Date:	Description:
5	27/01/2021	BH101A Rock Logging Photographs 36.50 to 40.50m



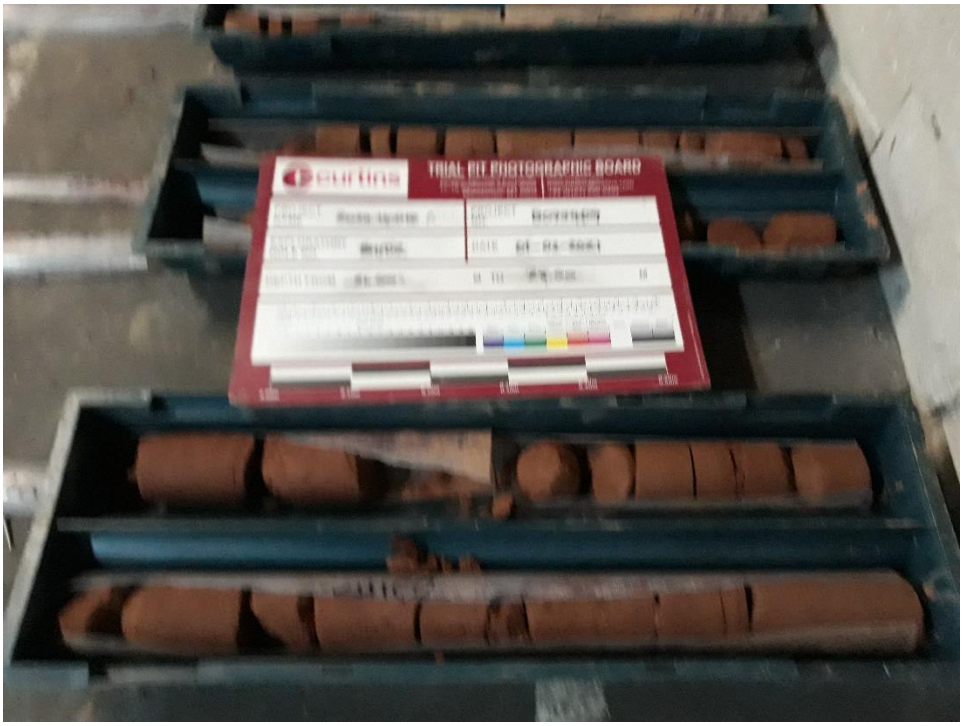


Client Name: RGCM Ltd		Project Name: Swan House	Project No: B077409
No. 6	**Date:** 01/02/2021	**Description:** BH102 Rock Logging Photographs 22.00 to 26.00m	





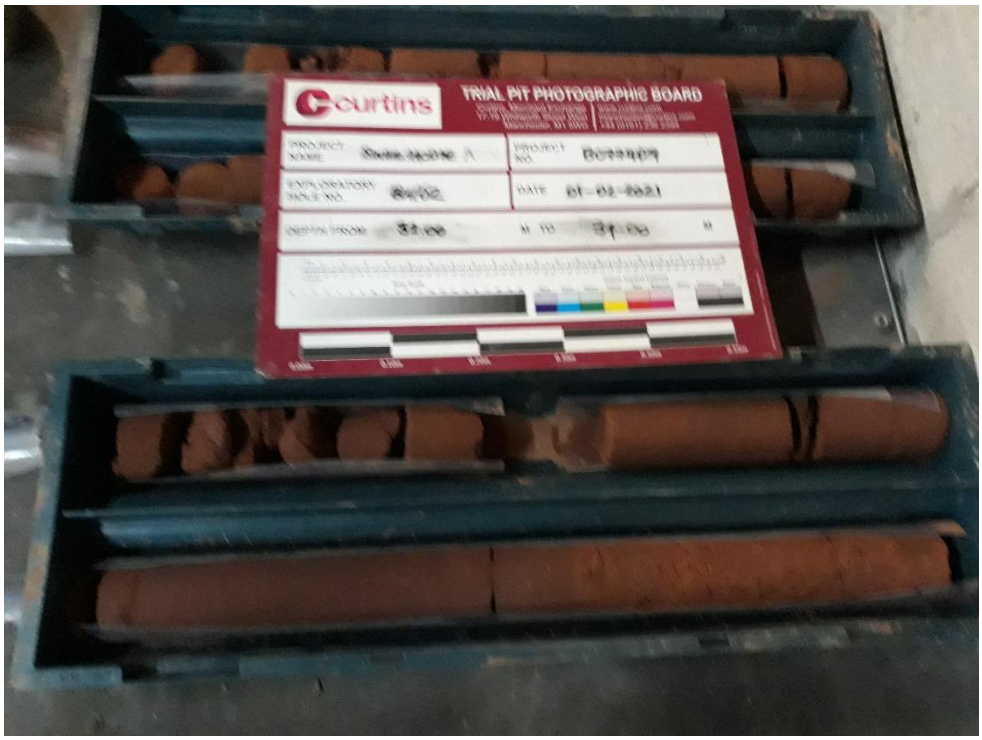
Client Name: RGCM Ltd		Project Name: Swan House	Project No: B077409
No. 7	**Date:** 01/02/2021	**Description:** BH102 Rock Logging Photographs 26.00 to 30.00m	





Client Name: RGCM Ltd		Project Name: Swan House	Project No: B077409
No. 8	**Date:** 01/02/2021	**Description:** BH102 Rock Logging Photographs 30.00 to 34.00m	





Client Name: RGCM Ltd		Project Name: Swan House	Project No: B077409
No. 9	**Date:** 01/02/2021	**Description:** BH102 Rock Logging Photographs 34.00 to 38.00m	





Client Name:		Project Name:	Project No:
RGCM Ltd		Swan House	B077409
No.	**Date:**	**Description:**	
10	01/02/2021	BH102 Rock Logging Photographs 38.00 to 40.00m	



Client Name: RGCM Ltd		Project Name: Swan House	Project No: B077409
No. 11	**Date:** 27/01/2021	**Description:** BH103 Rock Logging Photographs 24.00 to 28.00m	





Client Name: RGCM Ltd		Project Name: Swan House	Project No: B077409
No. 12	**Date:** 27/01/2021	**Description:** BH103 Rock Logging Photographs 28.00 to 32.00m	





Client Name: RGCM Ltd		Project Name: Swan House	Project No: B077409
No. 13	**Date:** 27/01/2021	**Description:** BH103 Rock Logging Photographs 32.00 to 36.00m	





Client Name: RGCM Ltd		Project Name: Swan House	Project No: B077409
No. 14	**Date:** 27/01/2021	**Description:** BH103 Rock Logging Photographs 36.00 to 40.00m	





Appendix C – Chemical Laboratory Testing Results

- 2018 Investigation
  - Envirolab, Final Analytical Test Report 18-07339-1
  - Envirolab, Final Analytical Test Report 18-07504-1
- 2021 Investigation
  - Envirolab, Final Analytical Test Report 21/00959-1 WAC Testing
  - Envirolab, Final Analytical Test Report 21/00959-1
  - Envirolab, Final Analytical Test Report 21/01742-1 Groundwater

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envirolab
Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 18/07339
Issue Number: 1 **Date:** 19 September, 2018

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

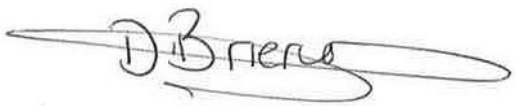
Project Manager: Matthew Holroyd/Siobhán Hyde
Project Name: Swan House, Manchester
Project Ref: B067266.201
Order No: EBMA1393
Date Samples Received: 12/09/18
Date Instructions Received: 13/09/18
Date Analysis Completed: 19/09/18

Prepared by:



Holly Neary-King
Sales Executive

Approved by:



Danielle Brierley
Client Manager

Envirolab Job Number: 18/07339

Client Project Name: Swan House, Manchester

Client Project Ref: B067266.201

Lab Sample ID	18/07339/1	18/07339/2							Units	Method ref
Client Sample No	ES1	ES1								
Client Sample ID	WS06	WS07								
Depth to Top	0.30	0.40								
Depth To Bottom		0.50								
Date Sampled	10-Sep-18	10-Sep-18								
Sample Type	Soil - ES	Soil - ES								
Sample Matrix Code	3	3								
% Stones >10mm$_A$	<0.1	<0.1							% w/w	A-T-044
pH$_D$$^{M\#}$	8.30	8.86							pH	A-T-031s
Sulphate (water sol 2:1)$_D$$^{M\#}$	0.09	0.07							g/l	A-T-026s
Cyanide (total)$_A$$^{M\#}$	<1	<1							mg/kg	A-T-042sTCN
Phenols - Total by HPLC$_A$	<0.2	<0.2							mg/kg	A-T-050s
Organic matter$_D$$^{M\#}$	1.4	1.4							% w/w	A-T-032 OM
Arsenic$_D$$^{M\#}$	3	3							mg/kg	A-T-024s
Boron (water soluble)$_D$$^{M\#}$	<1.0	<1.0							mg/kg	A-T-027s
Cadmium$_D$$^{M\#}$	1.5	1.5							mg/kg	A-T-024s
Copper$_D$$^{M\#}$	23	22							mg/kg	A-T-024s
Chromium$_D$$^{M\#}$	32	31							mg/kg	A-T-024s
Chromium (hexavalent)$_D$	<1	<1							mg/kg	A-T-040s
Lead$_D$$^{M\#}$	14	12							mg/kg	A-T-024s
Mercury$_D$	<0.17	<0.17							mg/kg	A-T-024s
Nickel$_D$$^{M\#}$	39	38							mg/kg	A-T-024s
Selenium$_D$$^{\#}$	1	<1							mg/kg	A-T-024s
Zinc$_D$$^{M\#}$	62	60							mg/kg	A-T-024s

Envirolab Job Number: 18/07339

Client Project Name: Swan House, Manchester

Client Project Ref: B067266.201

Lab Sample ID	18/07339/1	18/07339/2							Units	Method ref
Client Sample No	ES1	ES1								
Client Sample ID	WS06	WS07								
Depth to Top	0.30	0.40								
Depth To Bottom		0.50								
Date Sampled	10-Sep-18	10-Sep-18								
Sample Type	Soil - ES	Soil - ES								
Sample Matrix Code	3	3								
Asbestos in Soil (inc. matrix)										
Asbestos in soil$_A^{\#}$	NAD	NAD								A-T-045
Asbestos ACM - Suitable for Water Absorption Test?	N/A	N/A								

Envirolab Job Number: 18/07339

Client Project Name: Swan House, Manchester

Client Project Ref: B067266.201

Lab Sample ID	18/07339/1	18/07339/2							Units	Method ref
Client Sample No	ES1	ES1								
Client Sample ID	WS06	WS07								
Depth to Top	0.30	0.40								
Depth To Bottom		0.50								
Date Sampled	10-Sep-18	10-Sep-18								
Sample Type	Soil - ES	Soil - ES								
Sample Matrix Code	3	3								
PAH-16MS										
Naphthalene$_A^{M\#}$	<0.03	<0.03							mg/kg	A-T-019s
Acenaphthylene$_A^{M\#}$	<0.01	<0.01							mg/kg	A-T-019s
Acenaphthene$_A^{M\#}$	<0.01	<0.01							mg/kg	A-T-019s
Fluorene$_A^{M\#}$	<0.01	<0.01							mg/kg	A-T-019s
Phenanthrene$_A^{M\#}$	0.04	<0.03							mg/kg	A-T-019s
Anthracene$_A^{M\#}$	<0.02	<0.02							mg/kg	A-T-019s
Fluoranthene$_A^{M\#}$	<0.08	<0.08							mg/kg	A-T-019s
Pyrene$_A^{M\#}$	<0.07	<0.07							mg/kg	A-T-019s
Benzo(a)anthracene$_A^{M\#}$	<0.04	<0.04							mg/kg	A-T-019s
Chrysene$_A^{M\#}$	<0.06	<0.06							mg/kg	A-T-019s
Benzo(b)fluoranthene$_A^{M\#}$	<0.05	<0.05							mg/kg	A-T-019s
Benzo(k)fluoranthene$_A^{M\#}$	<0.07	<0.07							mg/kg	A-T-019s
Benzo(a)pyrene$_A^{M\#}$	<0.04	<0.04							mg/kg	A-T-019s
Indeno(123-cd)pyrene$_A^{M\#}$	<0.03	<0.03							mg/kg	A-T-019s
Dibenzo(ah)anthracene$_A^{M\#}$	<0.04	<0.04							mg/kg	A-T-019s
Benzo(ghi)perylene$_A^{M\#}$	<0.05	<0.05							mg/kg	A-T-019s
Total PAH-16MS$_A^{M\#}$	<0.08	<0.08							mg/kg	A-T-019s

Envirolab Job Number: 18/07339

Client Project Name: Swan House, Manchester

Client Project Ref: B067266.201

Lab Sample ID	18/07339/1	18/07339/2							Units	Method ref
Client Sample No	ES1	ES1								
Client Sample ID	WS06	WS07								
Depth to Top	0.30	0.40								
Depth To Bottom		0.50								
Date Sampled	10-Sep-18	10-Sep-18								
Sample Type	Soil - ES	Soil - ES								
Sample Matrix Code	3	3								
TPH CWG										
Ali >C5-C6$_A^{\#}$	<0.01	<0.01							mg/kg	A-T-022s
Ali >C6-C8$_A^{\#}$	<0.01	<0.01							mg/kg	A-T-022s
Ali >C8-C10$_A^{M\#}$	<1	<1							mg/kg	A-T-055s
Ali >C10-C12$_A^{M\#}$	<1	<1							mg/kg	A-T-055s
Ali >C12-C16$_A^{M\#}$	2	1							mg/kg	A-T-055s
Ali >C16-C21$_A^{M\#}$	1	1							mg/kg	A-T-055s
Ali >C21-C35$_A$	1	1							mg/kg	A-T-055s
Total Aliphatics >C5-C35$_A$	5	5							mg/kg	A-T-055s
Aro >C5-C7$_A^{\#}$	<0.01	<0.01							mg/kg	A-T-022s
Aro >C7-C8$_A^{\#}$	<0.01	<0.01							mg/kg	A-T-022s
Aro >C8-C10$_A^{M\#}$	<1	<1							mg/kg	A-T-055s
Aro >C10-C12$_A^{M\#}$	<1	<1							mg/kg	A-T-055s
Aro >C12-C16$_A$	1	1							mg/kg	A-T-055s
Aro >C16-C21$_A^{M\#}$	1	1							mg/kg	A-T-055s
Aro >C21-C35$_A^{M\#}$	8	7							mg/kg	A-T-055s
Total Aromatics >C5-C35$_A$	12	9							mg/kg	A-T-055s
TPH (Ali & Aro >C5-C35)$_A$	16	14							mg/kg	A-T-055s
BTEX - Benzene$_A^{\#}$	<0.01	<0.01							mg/kg	A-T-022s
BTEX - Toluene$_A^{\#}$	<0.01	<0.01							mg/kg	A-T-022s
BTEX - Ethyl Benzene$_A^{\#}$	<0.01	<0.01							mg/kg	A-T-022s
BTEX - m & p Xylene$_A^{\#}$	<0.01	<0.01							mg/kg	A-T-022s
BTEX - o Xylene$_A^{\#}$	<0.01	<0.01							mg/kg	A-T-022s
MTBE$_A^{\#}$	<0.01	<0.01							mg/kg	A-T-022s

REPORT NOTES

General:
This report shall not be reproduced, except in full, without written approval from Envirolab.
All samples contained within this report, and any received with the same delivery, will be disposed of one month after the date of this report.
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 and there is insufficient sample to repeat the analysis. 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
Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

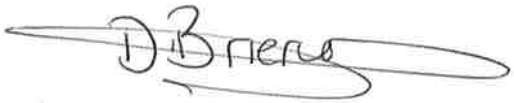
FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 18/07504
Issue Number: 1 **Date:** 24 September, 2018

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

Project Manager: Matthew Holroyd/Siobhán Hyde
Project Name: Swan House, Manchester
Project Ref: B067266.201
Order No: EBMA1404
Date Samples Received: 14/09/18
Date Instructions Received: 18/09/18
Date Analysis Completed: 24/09/18

Prepared by:



Danielle Brierley
Client Manager

Approved by:



Richard Wong
Client Manager

Envirolab Job Number: 18/07504

Client Project Name: Swan House, Manchester

Client Project Ref: B067266.201

Lab Sample ID	18/07504/2	18/07504/3	18/07504/4	18/07504/5	18/07504/6	18/07504/7	18/07504/8	18/07504/9	Units	Method ref
Client Sample No	2	3	4	5	1	1	2	3		
Client Sample ID	WS04	WS04	WS04	WS04	WS01	WS03	WS03	WS03		
Depth to Top	0.70	1.40	2.40	2.70	0.55	0.40	1.70	3.00		
Depth To Bottom		1.70	2.70	3.00	0.65					
Date Sampled	13-Sep-18	13-Sep-18	13-Sep-18	13-Sep-18	13-Sep-18	13-Sep-18	13-Sep-18	13-Sep-18		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	5AB	4AB	6	3	6	4A	6A	6		
% Stones >10mm$_A$	5.5	15.9	<0.1	<0.1	<0.1	2.8	5.1	<0.1	% w/w	A-T-044
pH$_D^{M\#}$	8.14	9.53	8.25	7.52	8.53	8.40	7.45	8.25	pH	A-T-031s
Sulphate (water sol 2:1)$_D^{M\#}$	1.48	0.40	0.06	0.36	0.24	0.18	0.29	0.07	g/l	A-T-026s
Cyanide (total)$_A^{M\#}$	<1	<1	<1	<1	<1	<1	<1	<1	mg/kg	A-T-042sTCN
Phenols - Total by HPLC$_A$	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	mg/kg	A-T-050s
Organic matter$_D^{M\#}$	2.1	0.8	3.7	8.4	3.2	5.9	11.6	2.9	% w/w	A-T-032 OM
Arsenic$_D^{M\#}$	9	5	1	2	4	12	16	<1	mg/kg	A-T-024s
Boron (water soluble)$_D^{M\#}$	1.1	1.0	<1.0	2.2	<1.0	1.4	1.5	<1.0	mg/kg	A-T-027s
Cadmium$_D^{M\#}$	0.9	0.7	0.5	<0.5	1.1	1.0	1.1	1.2	mg/kg	A-T-024s
Copper$_D^{M\#}$	26	11	9	8	20	84	69	20	mg/kg	A-T-024s
Chromium$_D^{M\#}$	16	19	17	23	27	10	21	39	mg/kg	A-T-024s
Chromium (hexavalent)$_D$	<1	<1	<1	<1	<1	<1	<1	<1	mg/kg	A-T-040s
Lead$_D^{M\#}$	69	18	21	12	36	412	335	23	mg/kg	A-T-024s
Mercury$_D$	0.31	<0.17	<0.17	<0.17	<0.17	0.37	<0.17	<0.17	mg/kg	A-T-024s
Nickel$_D^{M\#}$	20	16	10	12	20	17	28	34	mg/kg	A-T-024s
Selenium$_D^{\#}$	<1	<1	<1	<1	<1	<1	<1	<1	mg/kg	A-T-024s
Zinc$_D^{M\#}$	36	27	29	33	60	46	78	59	mg/kg	A-T-024s

Envirolab Job Number: 18/07504

Client Project Name: Swan House, Manchester

Client Project Ref: B067266.201

Lab Sample ID	18/07504/2	18/07504/3	18/07504/4	18/07504/5	18/07504/6	18/07504/7	18/07504/8	18/07504/9	Units	Method ref
Client Sample No	2	3	4	5	1	1	2	3		
Client Sample ID	WS04	WS04	WS04	WS04	WS01	WS03	WS03	WS03		
Depth to Top	0.70	1.40	2.40	2.70	0.55	0.40	1.70	3.00		
Depth To Bottom		1.70	2.70	3.00	0.65					
Date Sampled	13-Sep-18	13-Sep-18	13-Sep-18	13-Sep-18	13-Sep-18	13-Sep-18	13-Sep-18	13-Sep-18		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	5AB	4AB	6	3	6	4A	6A	6		
Asbestos in Soil (inc. matrix)										
Asbestos in soil$_A^{\#}$	NAD	NAD	NAD	NAD	NAD	NAD	NAD	NAD		A-T-045
Asbestos ACM - Suitable for Water Absorption Test?	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		

Envirolab Job Number: 18/07504

Client Project Name: Swan House, Manchester

Client Project Ref: B067266.201

Lab Sample ID	18/07504/2	18/07504/3	18/07504/4	18/07504/5	18/07504/6	18/07504/7	18/07504/8	18/07504/9	Units	Method ref
Client Sample No	2	3	4	5	1	1	2	3		
Client Sample ID	WS04	WS04	WS04	WS04	WS01	WS03	WS03	WS03		
Depth to Top	0.70	1.40	2.40	2.70	0.55	0.40	1.70	3.00		
Depth To Bottom		1.70	2.70	3.00	0.65					
Date Sampled	13-Sep-18	13-Sep-18	13-Sep-18	13-Sep-18	13-Sep-18	13-Sep-18	13-Sep-18	13-Sep-18		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	5AB	4AB	6	3	6	4A	6A	6		
PAH-16MS										
Naphthalene$_A^{M\#}$	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	mg/kg	A-T-019s
Acenaphthylene$_A^{M\#}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-019s
Acenaphthene$_A^{M\#}$	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.02	mg/kg	A-T-019s
Fluorene$_A^{M\#}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	mg/kg	A-T-019s
Phenanthrene$_A^{M\#}$	<0.03	<0.03	<0.03	<0.03	<0.03	0.08	<0.03	0.15	mg/kg	A-T-019s
Anthracene$_A^{M\#}$	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.04	mg/kg	A-T-019s
Fluoranthene$_A^{M\#}$	<0.08	<0.08	<0.08	<0.08	<0.08	0.12	<0.08	0.25	mg/kg	A-T-019s
Pyrene$_A^{M\#}$	<0.07	<0.07	<0.07	<0.07	<0.07	0.10	<0.07	0.19	mg/kg	A-T-019s
Benzo(a)anthracene$_A^{M\#}$	<0.04	<0.04	<0.04	<0.04	<0.04	0.06	<0.04	0.09	mg/kg	A-T-019s
Chrysene$_A^{M\#}$	<0.06	<0.06	<0.06	<0.06	<0.06	0.08	<0.06	0.12	mg/kg	A-T-019s
Benzo(b)fluoranthene$_A^{M\#}$	<0.05	<0.05	<0.05	<0.05	<0.05	0.08	<0.05	0.11	mg/kg	A-T-019s
Benzo(k)fluoranthene$_A^{M\#}$	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	mg/kg	A-T-019s
Benzo(a)pyrene$_A^{M\#}$	<0.04	<0.04	<0.04	<0.04	<0.04	0.06	<0.04	0.06	mg/kg	A-T-019s
Indeno(123-cd)pyrene$_A^{M\#}$	<0.03	<0.03	<0.03	<0.03	<0.03	0.03	<0.03	0.04	mg/kg	A-T-019s
Dibenzo(ah)anthracene$_A^{M\#}$	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	mg/kg	A-T-019s
Benzo(ghi)perylene$_A^{M\#}$	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	mg/kg	A-T-019s
Total PAH-16MS$_A^{M\#}$	<0.08	<0.08	<0.08	<0.08	<0.08	0.62	<0.08	1.08	mg/kg	A-T-019s

Envirolab Job Number: 18/07504

Client Project Name: Swan House, Manchester

Client Project Ref: B067266.201

Lab Sample ID	18/07504/2	18/07504/3	18/07504/4	18/07504/5	18/07504/6	18/07504/7	18/07504/8	18/07504/9	Units	Method ref
Client Sample No	2	3	4	5	1	1	2	3		
Client Sample ID	WS04	WS04	WS04	WS04	WS01	WS03	WS03	WS03		
Depth to Top	0.70	1.40	2.40	2.70	0.55	0.40	1.70	3.00		
Depth To Bottom		1.70	2.70	3.00	0.65					
Date Sampled	13-Sep-18	13-Sep-18	13-Sep-18	13-Sep-18	13-Sep-18	13-Sep-18	13-Sep-18	13-Sep-18		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	5AB	4AB	6	3	6	4A	6A	6		
TPH CWG										
Ali >C5-C6$_A^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
Ali >C6-C8$_A^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	mg/kg	A-T-022s
Ali >C8-C10$_A^{M\#}$	<1	<1	<1	<1	<1	<1	<1	<1	mg/kg	A-T-055s
Ali >C10-C12$_A^{M\#}$	<1	<1	<1	<1	<1	<1	<1	<1	mg/kg	A-T-055s
Ali >C12-C16$_A^{M\#}$	<1	<1	<1	<1	<1	<1	<1	<1	mg/kg	A-T-055s
Ali >C16-C21$_A^{M\#}$	<1	<1	<1	1	<1	<1	<1	<1	mg/kg	A-T-055s
Ali >C21-C35$_A$	1	<1	3	22	5	2	1	5	mg/kg	A-T-055s
Total Aliphatics >C5-C35$_A$	1	<1	3	25	5	2	1	5	mg/kg	A-T-055s
Aro >C5-C7$_A^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
Aro >C7-C8$_A^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
Aro >C8-C10$_A^{M\#}$	2	<1	1	3	1	2	1	2	mg/kg	A-T-055s
Aro >C10-C12$_A^{M\#}$	1	<1	<1	1	<1	1	<1	1	mg/kg	A-T-055s
Aro >C12-C16$_A$	2	<1	1	4	1	3	2	2	mg/kg	A-T-055s
Aro >C16-C21$_A^{M\#}$	3	<1	1	4	1	3	2	2	mg/kg	A-T-055s
Aro >C21-C35$_A^{M\#}$	12	<1	8	67	8	11	6	10	mg/kg	A-T-055s
Total Aromatics >C5-C35$_A$	21	<1	13	80	11	21	12	19	mg/kg	A-T-055s
TPH (Ali & Aro >C5-C35)$_A$	23	<1	15	105	16	24	13	24	mg/kg	A-T-055s
BTEX - Benzene$_A^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
BTEX - Toluene$_A^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
BTEX - Ethyl Benzene$_A^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
BTEX - m & p Xylene$_A^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
BTEX - o Xylene$_A^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
MTBE$_A^{\#}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s

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Client Project Name: Swan House, Manchester

Client Project Ref: B067266.201

Lab Sample ID	18/07504/10	18/07504/11	18/07504/12						Units	Method ref
Client Sample No	1	2	3							
Client Sample ID	WS02	WS02	WS02							
Depth to Top	0.35	0.70	1.05							
Depth To Bottom			1.30							
Date Sampled	14-Sep-18	14-Sep-18	14-Sep-18							
Sample Type	Soil - ES	Soil - ES	Soil - ES							
Sample Matrix Code	4	4A	5							
% Stones >10mm$_A$	<0.1	<0.1	<0.1						% w/w	A-T-044
pH$_D$$^{M\#}$	8.95	8.77	8.05						pH	A-T-031s
Sulphate (water sol 2:1)$_D$$^{M\#}$	0.02	0.06	0.12						g/l	A-T-026s
Cyanide (total)$_A$$^{M\#}$	<1	<1	<1						mg/kg	A-T-042sTCN
Phenols - Total by HPLC$_A$	<0.2	<0.2	<0.2						mg/kg	A-T-050s
Organic matter$_D$$^{M\#}$	3.5	2.7	1.1						% w/w	A-T-032 OM
Arsenic$_D$$^{M\#}$	2	2	4						mg/kg	A-T-024s
Boron (water soluble)$_D$$^{M\#}$	1.8	1.2	<1.0						mg/kg	A-T-027s
Cadmium$_D$$^{M\#}$	0.6	0.5	1.1						mg/kg	A-T-024s
Copper$_D$$^{M\#}$	13	7	21						mg/kg	A-T-024s
Chromium$_D$$^{M\#}$	7	9	31						mg/kg	A-T-024s
Chromium (hexavalent)$_D$	<1	<1	<1						mg/kg	A-T-040s
Lead$_D$$^{M\#}$	18	76	19						mg/kg	A-T-024s
Mercury$_D$	<0.17	<0.17	<0.17						mg/kg	A-T-024s
Nickel$_D$$^{M\#}$	12	8	39						mg/kg	A-T-024s
Selenium$_D$$^{\#}$	<1	<1	<1						mg/kg	A-T-024s
Zinc$_D$$^{M\#}$	46	21	56						mg/kg	A-T-024s

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Lab Sample ID	18/07504/10	18/07504/11	18/07504/12						Units	Method ref
Client Sample No	1	2	3							
Client Sample ID	WS02	WS02	WS02							
Depth to Top	0.35	0.70	1.05							
Depth To Bottom			1.30							
Date Sampled	14-Sep-18	14-Sep-18	14-Sep-18							
Sample Type	Soil - ES	Soil - ES	Soil - ES							
Sample Matrix Code	4	4A	5							
Asbestos in Soil (inc. matrix)										
Asbestos in soil$_A^{\#}$	NAD	NAD	NAD							A-T-045
Asbestos ACM - Suitable for Water Absorption Test?	N/A	N/A	N/A							

Envirolab Job Number: 18/07504

Client Project Name: Swan House, Manchester

Client Project Ref: B067266.201

Lab Sample ID	18/07504/10	18/07504/11	18/07504/12						Units	Method ref
Client Sample No	1	2	3							
Client Sample ID	WS02	WS02	WS02							
Depth to Top	0.35	0.70	1.05							
Depth To Bottom			1.30							
Date Sampled	14-Sep-18	14-Sep-18	14-Sep-18							
Sample Type	Soil - ES	Soil - ES	Soil - ES							
Sample Matrix Code	4	4A	5							
PAH-16MS										
Naphthalene$_A^{M\#}$	2.51	<0.03	<0.03						mg/kg	A-T-019s
Acenaphthylene$_A^{M\#}$	<0.10	<0.01	<0.01						mg/kg	A-T-019s
Acenaphthene$_A^{M\#}$	8.93	0.07	<0.01						mg/kg	A-T-019s
Fluorene$_A^{M\#}$	4.39	0.03	<0.01						mg/kg	A-T-019s
Phenanthrene$_A^{M\#}$	27.7	0.23	<0.03						mg/kg	A-T-019s
Anthracene$_A^{M\#}$	7.26	0.07	<0.02						mg/kg	A-T-019s
Fluoranthene$_A^{M\#}$	28.6	0.31	<0.08						mg/kg	A-T-019s
Pyrene$_A^{M\#}$	22.6	0.24	<0.07						mg/kg	A-T-019s
Benzo(a)anthracene$_A^{M\#}$	11.5	0.12	<0.04						mg/kg	A-T-019s
Chrysene$_A^{M\#}$	13.2	0.13	<0.06						mg/kg	A-T-019s
Benzo(b)fluoranthene$_A^{M\#}$	11.7	0.11	<0.05						mg/kg	A-T-019s
Benzo(k)fluoranthene$_A^{M\#}$	4.71	<0.07	<0.07						mg/kg	A-T-019s
Benzo(a)pyrene$_A^{M\#}$	9.05	0.10	<0.04						mg/kg	A-T-019s
Indeno(123-cd)pyrene$_A^{M\#}$	4.62	0.07	<0.03						mg/kg	A-T-019s
Dibenzo(ah)anthracene$_A^{M\#}$	0.98	<0.04	<0.04						mg/kg	A-T-019s
Benzo(ghi)perylene$_A^{M\#}$	3.63	0.06	<0.05						mg/kg	A-T-019s
Total PAH-16MS$_A^{M\#}$	161	1.54	<0.08						mg/kg	A-T-019s

Envirolab Job Number: 18/07504

Client Project Name: Swan House, Manchester

Client Project Ref: B067266.201

Lab Sample ID	18/07504/10	18/07504/11	18/07504/12						Units	Method ref
Client Sample No	1	2	3							
Client Sample ID	WS02	WS02	WS02							
Depth to Top	0.35	0.70	1.05							
Depth To Bottom			1.30							
Date Sampled	14-Sep-18	14-Sep-18	14-Sep-18							
Sample Type	Soil - ES	Soil - ES	Soil - ES							
Sample Matrix Code	4	4A	5							
TPH CWG										
Ali >C5-C6$_A^{\#}$	<0.01	<0.01	<0.01						mg/kg	A-T-022s
Ali >C6-C8$_A^{\#}$	<0.01	<0.01	<0.01						mg/kg	A-T-022s
Ali >C8-C10$_A^{M\#}$	<1	<1	<1						mg/kg	A-T-055s
Ali >C10-C12$_A^{M\#}$	1	<1	<1						mg/kg	A-T-055s
Ali >C12-C16$_A^{M\#}$	2	<1	<1						mg/kg	A-T-055s
Ali >C16-C21$_A^{M\#}$	6	<1	<1						mg/kg	A-T-055s
Ali >C21-C35$_A$	411	2	<1						mg/kg	A-T-055s
Total Aliphatics >C5-C35$_A$	420	2	<1						mg/kg	A-T-055s
Aro >C5-C7$_A^{\#}$	<0.01	<0.01	<0.01						mg/kg	A-T-022s
Aro >C7-C8$_A^{\#}$	<0.01	<0.01	<0.01						mg/kg	A-T-022s
Aro >C8-C10$_A^{M\#}$	4	2	<1						mg/kg	A-T-055s
Aro >C10-C12$_A^{M\#}$	10	1	<1						mg/kg	A-T-055s
Aro >C12-C16$_A$	60	2	<1						mg/kg	A-T-055s
Aro >C16-C21$_A^{M\#}$	126	3	<1						mg/kg	A-T-055s
Aro >C21-C35$_A^{M\#}$	540	8	2						mg/kg	A-T-055s
Total Aromatics >C5-C35$_A$	741	17	2						mg/kg	A-T-055s
TPH (Ali & Aro >C5-C35)$_A$	1160	19	2						mg/kg	A-T-055s
BTEX - Benzene$_A^{\#}$	<0.01	<0.01	<0.01						mg/kg	A-T-022s
BTEX - Toluene$_A^{\#}$	<0.01	<0.01	<0.01						mg/kg	A-T-022s
BTEX - Ethyl Benzene$_A^{\#}$	<0.01	<0.01	<0.01						mg/kg	A-T-022s
BTEX - m & p Xylene$_A^{\#}$	<0.01	<0.01	<0.01						mg/kg	A-T-022s
BTEX - o Xylene$_A^{\#}$	<0.01	<0.01	<0.01						mg/kg	A-T-022s
MTBE$_A^{\#}$	<0.01	<0.01	<0.01						mg/kg	A-T-022s

REPORT NOTES

General:
This report shall not be reproduced, except in full, without written approval from Envirolab.
All samples contained within this report, and any received with the same delivery, will be disposed of one month after the date of this report.
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.

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Units 7 & 8, Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

Final Test Report

Envirolab Job Number:	21/00959
Issue Number:	1
Date:	9-Feb-21
Client:	Curtins Consulting (Manchester) Merchant Exchange 17-19 Whitworth Street Manchester UK M1 5WG
Project Manager:	EBMA/Philippa Neesham/Siobhán Hyde
Project Name:	Swan House
Project Ref:	B077409
Order No:	EBMA2678
Date Samples Received:	28-Jan-21
Date Instructions Received:	2-Feb-21
Date Analysis Completed:	9-Feb-21

Notes - Soil analysis

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

For samples with Matrix Codes 1 - 6 natural stones >10mm are removed or excluded from the sample prior to analysis and reported results corrected to a whole sample basis.

For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis.

Notes - General

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

Subscript "A" indicates analysis performed on the sample as received. "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve, unless asbestos is found to be present in which case all analysis is performed on the sample as received.

All analysis is performed on the dried and crushed sample for samples with Matrix Code 7 and this supercedes any "A" subscripts.

All analysis is performed on the sample as received for soil samples from outside the European Union and this supercedes any "D" subscripts

For complex, multi-compound analysis, quality control results do not always fall within chart limits for every compound and we have criteria for reporting in these situations.

If results are in italic font they are associated with such quality control failures and may be 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

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

Secondary Matrix Codes: A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal, E = contains roots/twigs.

IS indicates Insufficient sample for analysis, NDP indicates No Determination Possible and NAD indicates No Asbestos Detected.

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.

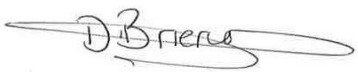
Please contact us if you need any further information.

Prepared by:



Melanie Marshall
Laboratory Coordinator

Approved by:



Danielle Brierley
Client Manager

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Landfill WAC analysis must not be used for hazardous waste classification purposes. This analysis is only applicable for landfill acceptance and does not give any indication as to whether a waste may be hazardous or non-hazardous.

Sample Details								Landfill Waste Acceptance Criteria Limits		
Lab Sample ID	Method	ISO17025	MCERTS	21/00959/1						
Client Sample Number				1				Inert Waste Landfill	Stable Non-reactive Hazardous Waste in Non-Hazardous Landfill	Hazardous Waste Landfill
Client Sample ID				BH102						
Depth to Top				0.45						
Depth to Bottom				0.60						
Date Sampled				22/01/2021						
Sample Type				Soil - ES						
Sample Matrix Code				6A						
Solid Waste Analysis										
pH (pH Units)$_D$	A-T-031	N	N	**8.83**				-	>6	-
ANC to pH 4 (mol/kg)$_D$	A-T-ANC	N	N	**0.02**				-	to be evaluated	to be evaluated
ANC to pH 6 (mol/kg)$_D$	A-T-ANC	N	N	**0.02**				-	to be evaluated	to be evaluated
Loss on Ignition (%)$_D$	A-T-030	N	N	**4.5**				-	-	10
Total Organic Carbon (%)$_D$	A-T-032	N	N	**0.58**				3	5	6
PAH Sum of 17 (mg/kg) $_A$	A-T-019	N	N	**2.02**				100	-	-
Mineral Oil (mg/kg)$_A$	A-T-007	N	N	**<10**				500	-	-
Sum of 7 PCBs (mg/kg)$_A$	A-T-004	N	N	**<0.007**				1	-	-
Sum of BTEX (mg/kg)$_A$	A-T-022	N	N	**<0.01**				6	-	-
Eluate Analysis				**2:1**	**8:1**	**2:1**	**Cumulative 10:1**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg (mg/kg)**		
				mg/l		**mg/kg**				
Arsenic	A-T-025	N	N	<0.001	<0.001	<0.002	**<0.01**	0.5	2	25
Barium	A-T-025	N	N	0.014	0.029	0.032	**0.280**	20	100	300
Cadmium	A-T-025	N	N	<0.001	<0.001	<0.002	**<0.01**	0.04	1	5
Chromium	A-T-025	N	N	0.005	0.002	0.011	**0.020**	0.5	10	70
Copper	A-T-025	N	N	<0.001	0.002	<0.002	**<0.01**	2	50	100
Mercury	A-T-025	N	N	<0.0005	<0.0005	<0.001	**<0.005**	0.01	0.2	2
Molybdenum	A-T-025	N	N	0.011	0.003	0.025	**0.040**	0.5	10	30
Nickel	A-T-025	N	N	0.001	<0.001	0.002	**<0.01**	0.4	10	40
Lead	A-T-025	N	N	<0.001	0.002	<0.002	**<0.01**	0.5	10	50
Antimony	A-T-025	N	N	<0.001	<0.001	<0.002	**<0.01**	0.06	0.7	5
Selenium	A-T-025	N	N	0.002	<0.001	0.005	**<0.01**	0.1	0.5	7
Zinc	A-T-025	N	N	0.002	0.003	0.005	**0.030**	4	50	200
Chloride	A-T-026	N	N	32	3	73	**65**	800	15000	25000
Fluoride	A-T-026	N	N	1.8	0.9	4.1	**10.0**	10	150	500
Sulphate as SO_4	A-T-026	N	N	107	13	245	**241**	1000	20000	50000
Total Dissolved Solids	A-T-035	N	N	264	56	605	**814**	4000	60000	100000
Phenol Index	A-T-050	N	N	<0.01	<0.01	<0.02	**<0.1**	1	-	-
Dissolved Organic Carbon	A-T-032	N	N	<20.0	<20.0	<40	**<200**	500	800	1000
Leach Test Information										
pH (pH Units)	A-T-031	N	N	7.7	7.6					
Conductivity (µS/cm)	A-T-037	N	N	527	111					
Mass Sample (kg)				0.226						
Dry Matter (%)	A-T-044	N	N	77.4						
Stage 1										
Volume Leachant, L_2 (l)	A-T-046			0.350						
Filtered Eluate Volume, VE_1 (l)	A-T-046			0.200						
Stage 2										
Volume Leachant, L_8 (l)	A-T-046			1.400						

Stated acceptance limits are for guidance only and Envirolab cannot be held responsible for any discrepancies with current legislation

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Landfill WAC analysis must not be used for hazardous waste classification purposes. This analysis is only applicable for landfill acceptance and does not give any indication as to whether a waste may be hazardous or non-hazardous.

Sample Details								Landfill Waste Acceptance Criteria Limits		
Lab Sample ID	Method	ISO17025	MCERTS	21/00959/2						
Client Sample Number				1				Inert Waste Landfill	Stable Non-reactive Hazardous Waste in Non-Hazardous Landfill	Hazardous Waste Landfill
Client Sample ID				BH103						
Depth to Top				1.4						
Depth to Bottom				1.60						
Date Sampled				22/01/2021						
Sample Type				Soil - ES						
Sample Matrix Code				6A						
Solid Waste Analysis										
pH (pH Units)$_D$	A-T-031	N	N	**8.82**				-	>6	-
ANC to pH 4 (mol/kg)$_D$	A-T-ANC	N	N	**0.07**				-	to be evaluated	to be evaluated
ANC to pH 6 (mol/kg)$_D$	A-T-ANC	N	N	**0.02**				-	to be evaluated	to be evaluated
Loss on Ignition (%)$_D$	A-T-030	N	N	**5.2**				-	-	10
Total Organic Carbon (%)$_D$	A-T-032	N	N	**2.32**				3	5	6
PAH Sum of 17 (mg/kg) $_A$	A-T-019	N	N	**0.11**				100	-	-
Mineral Oil (mg/kg)$_A$	A-T-007	N	N	**<10**				500	-	-
Sum of 7 PCBs (mg/kg)$_A$	A-T-004	N	N	**<0.007**				1	-	-
Sum of BTEX (mg/kg)$_A$	A-T-022	N	N	**<0.01**				6	-	-
Eluate Analysis				**2:1**	**8:1**	**2:1**	**Cumulative 10:1**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg (mg/kg)**		
				mg/l		**mg/kg**				
Arsenic	A-T-025	N	N	0.016	0.013	0.035	**0.140**	0.5	2	25
Barium	A-T-025	N	N	0.004	0.004	0.009	**0.040**	20	100	300
Cadmium	A-T-025	N	N	<0.001	<0.001	<0.002	**<0.01**	0.04	1	5
Chromium	A-T-025	N	N	0.004	0.001	0.009	**0.010**	0.5	10	70
Copper	A-T-025	N	N	0.010	0.006	0.022	**0.070**	2	50	100
Mercury	A-T-025	N	N	<0.0005	<0.0005	<0.001	**<0.005**	0.01	0.2	2
Molybdenum	A-T-025	N	N	0.035	0.004	0.077	**0.080**	0.5	10	30
Nickel	A-T-025	N	N	<0.001	<0.001	<0.002	**<0.01**	0.4	10	40
Lead	A-T-025	N	N	<0.001	0.018	<0.002	**<0.01**	0.5	10	50
Antimony	A-T-025	N	N	0.002	<0.001	0.004	**<0.01**	0.06	0.7	5
Selenium	A-T-025	N	N	0.003	<0.001	0.007	**<0.01**	0.1	0.5	7
Zinc	A-T-025	N	N	<0.001	0.006	<0.002	**<0.01**	4	50	200
Chloride	A-T-026	N	N	19	2	43	**36**	800	15000	25000
Fluoride	A-T-026	N	N	1.2	0.4	2.7	**5.0**	10	150	500
Sulphate as SO_4	A-T-026	N	N	147	15	324	**301**	1000	20000	50000
Total Dissolved Solids	A-T-035	N	N	253	55	559	**788**	4000	60000	100000
Phenol Index	A-T-050	N	N	<0.01	<0.01	<0.02	**<0.1**	1	-	-
Dissolved Organic Carbon	A-T-032	N	N	<20.0	<20.0	<40	**<200**	500	800	1000
Leach Test Information										
pH (pH Units)	A-T-031	N	N	8.1	8.1					
Conductivity (µS/cm)	A-T-037	N	N	506	109					
Mass Sample (kg)				0.212						
Dry Matter (%)	A-T-044	N	N	82.7						
Stage 1										
Volume Leachant, L_2 (l)	A-T-046			0.350						
Filtered Eluate Volume, VE_1 (l)	A-T-046			0.200						
Stage 2										
Volume Leachant, L_8 (l)	A-T-046			1.400						

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Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 21/00959
Issue Number: 1 **Date:** 09 February, 2021

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

Project Manager: EBMA/Philippa Neesham/Siobhán Hyde
Project Name: Swan House
Project Ref: B077409
Order No: EBMA2678
Date Samples Received: 28/01/21
Date Instructions Received: 02/02/21
Date Analysis Completed: 09/02/21

Prepared by:

Melanie Marshall
Laboratory Coordinator

Approved by:

Danielle Brierley
Client Manager

Envirolab Job Number: 21/00959

Client Project Name: Swan House

Client Project Ref: B077409

Lab Sample ID	21/00959/1	21/00959/2						Units	Limit of Detection	Method ref
Client Sample No	1	1								
Client Sample ID	BH102	BH103								
Depth to Top	0.45	1.4								
Depth To Bottom	0.6	1.6								
Date Sampled	22-Jan-21	22-Jan-21								
Sample Type	Soil - ES	Soil - ES								
Sample Matrix Code	6A	6A								
% Stones >10mm$_A$	2.7	20.0						% w/w	0.1	A-T-044
pH$_D$$^{M\#}$	8.83	8.82						pH	0.01	A-T-031s
Sulphate (water sol 2:1)$_D$$^{M\#}$	0.18	0.17						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\#}$	1.0	4.0						% w/w	0.1	A-T-032 OM
Arsenic$_D$$^{M\#}$	<1	8						mg/kg	1	A-T-024s
Boron (water soluble)$_D$	1.4	<1.0						mg/kg	1	A-T-027s
Cadmium$_D$$^{M\#}$	1.3	0.9						mg/kg	0.5	A-T-024s
Copper$_D$$^{M\#}$	29	46						mg/kg	1	A-T-024s
Chromium$_D$$^{M\#}$	59	17						mg/kg	1	A-T-024s
Chromium (hexavalent)$_D$	<1	<1						mg/kg	1	A-T-040s
Lead$_D$$^{M\#}$	18	268						mg/kg	1	A-T-024s
Mercury$_D$	<0.17	0.27						mg/kg	0.17	A-T-024s
Nickel$_D$$^{M\#}$	37	20						mg/kg	1	A-T-024s
Selenium$_D$$^{M\#}$	<1	2						mg/kg	1	A-T-024s
Zinc$_D$$^{M\#}$	54	37						mg/kg	5	A-T-024s

Envirolab Job Number: 21/00959

Client Project Name: Swan House

Client Project Ref: B077409

Lab Sample ID	21/00959/1	21/00959/2						Units	Limit of Detection	Method ref
Client Sample No	1	1								
Client Sample ID	BH102	BH103								
Depth to Top	0.45	1.4								
Depth To Bottom	0.6	1.6								
Date Sampled	22-Jan-21	22-Jan-21								
Sample Type	Soil - ES	Soil - ES								
Sample Matrix Code	6A	6A								
Asbestos in Soil (inc. matrix)										
Asbestos in soil$_{D}^{\#}$	NAD	NAD								A-T-045
Asbestos ACM - Suitable for Water Absorption Test?$_{D}$	N/A	N/A								A-T-045

Envirolab Job Number: 21/00959

Client Project Name: Swan House

Client Project Ref: B077409

Lab Sample ID	21/00959/1	21/00959/2						Units	Limit of Detection	Method ref
Client Sample No	1	1								
Client Sample ID	BH102	BH103								
Depth to Top	0.45	1.4								
Depth To Bottom	0.6	1.6								
Date Sampled	22-Jan-21	22-Jan-21								
Sample Type	Soil - ES	Soil - ES								
Sample Matrix Code	6A	6A								
PAH-16MS (MSD order)										
Naphthalene$_A^{M\#}$	0.16	<0.03						mg/kg	0.03	A-T-019s
Acenaphthylene$_A^{M\#}$	<0.01	<0.01						mg/kg	0.01	A-T-019s
Acenaphthene$_A^{M\#}$	0.13	0.02						mg/kg	0.01	A-T-019s
Fluorene$_A^{M\#}$	0.08	<0.01						mg/kg	0.01	A-T-019s
Phenanthrene$_A^{M\#}$	0.40	0.07						mg/kg	0.03	A-T-019s
Anthracene$_A^{M\#}$	0.08	<0.02						mg/kg	0.02	A-T-019s
Fluoranthene$_A^{M\#}$	0.35	<0.08						mg/kg	0.08	A-T-019s
Pyrene$_A^{M\#}$	0.26	<0.07						mg/kg	0.07	A-T-019s
Benzo(a)anthracene$_A^{M\#}$	0.13	<0.04						mg/kg	0.04	A-T-019s
Chrysene$_A^{M\#}$	0.14	<0.06						mg/kg	0.06	A-T-019s
Benzo(b)fluoranthene$_A^{M\#}$	0.12	<0.05						mg/kg	0.05	A-T-019s
Benzo(k)fluoranthene$_A^{M\#}$	<0.07	<0.07						mg/kg	0.07	A-T-019s
Benzo(a)pyrene$_A^{M\#}$	0.11	<0.04						mg/kg	0.04	A-T-019s
Indeno(123-cd)pyrene$_A^{M\#}$	0.06	<0.03						mg/kg	0.03	A-T-019s
Dibenzo(ah)anthracene$_A^{M\#}$	<0.04	<0.04						mg/kg	0.04	A-T-019s
Benzo(ghi)perylene$_A^{M\#}$	<0.05	<0.05						mg/kg	0.05	A-T-019s
Total PAH-16MS (MSD order)$_A^{M\#}$	2.02	0.09						mg/kg	0.03	A-T-019s

Envirolab Job Number: 21/00959

Client Project Name: Swan House

Client Project Ref: B077409

Lab Sample ID	21/00959/1	21/00959/2						Units	Limit of Detection	Method ref
Client Sample No	1	1								
Client Sample ID	BH102	BH103								
Depth to Top	0.45	1.4								
Depth To Bottom	0.6	1.6								
Date Sampled	22-Jan-21	22-Jan-21								
Sample Type	Soil - ES	Soil - ES								
Sample Matrix Code	6A	6A								
TPH CWG										
Ali >C5-C6$_A^{\#}$	<0.01	<0.01						mg/kg	0.01	A-T-022s
Ali >C6-C8$_A^{\#}$	<0.01	<0.01						mg/kg	0.01	A-T-022s
Ali >C8-C10$_A$	<1	<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	<1						mg/kg	1	A-T-055s
Ali >C16-C21$_A^{M\#}$	<1	<1						mg/kg	1	A-T-055s
Ali >C21-C35$_A^{M\#}$	<1	<1						mg/kg	1	A-T-055s
Total Aliphatics$_A$	<1	<1						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$_A$	<1	<1						mg/kg	1	A-T-055s
Aro >C10-C12$_A$	<1	<1						mg/kg	1	A-T-055s
Aro >C12-C16$_A$	<1	<1						mg/kg	1	A-T-055s
Aro >C16-C21$_A^{M\#}$	<1	<1						mg/kg	1	A-T-055s
Aro >C21-C35$_A^{M\#}$	1	4						mg/kg	1	A-T-055s
Total Aromatics$_A$	1	6						mg/kg	1	A-T-055s
TPH (Ali & Aro >C5-C35)$_A$	1	7						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.
The Client Sample No, Client Sample ID, Depth to Top, Depth to Bottom and Date Sampled were all provided by the client.

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 (Manchester), Merchant Exchange, 17-19 Whitworth Street , Manchester, UK, M1 5WG

Project: Swan House

Clients Project No: B077409

Project No: 21/00959

Date Received: 02/02/2021 (am)

Cool Box Temperatures (°C): 5.5

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.

envirolab
Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 21/01742
Issue Number: 1 **Date:** 01 March, 2021

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

Project Manager: EBMA/Matthew Holroyd
Project Name: Swan House
Project Ref: B077409
Order No: EBMA2701
Date Samples Received: 19/02/21
Date Instructions Received: 22/02/21
Date Analysis Completed: 01/03/21

Prepared by:

Melanie Marshall
Laboratory Coordinator

Approved by:

Sophie France
Client Service Manager

UKAS TESTING
1247

Envirolab Job Number: 21/01742

Client Project Name: Swan House

Client Project Ref: B077409

Lab Sample ID	21/01742/1	21/01742/2						Units	Limit of Detection	Method ref
Client Sample No	1	1								
Client Sample ID	BH102	BH103								
Depth to Top	24.29	3.34								
Depth To Bottom	25.23	4.91								
Date Sampled	18-Feb-21	18-Feb-21								
Sample Type	Water - EW	Water - EW								
Sample Matrix Code	N/A	N/A								
pH (w)$_A^\#$	7.39	7.85						pH	0.01	A-T-031w
Hardness Total$_A^\#$	577	464						mg/l Ca CO3	2	A-T-049w
Sulphate (w)$_A^\#$	202	250						mg/l	1	A-T-026w
Cyanide (total) (w)$_A^\#$	<0.005	<0.005						mg/l	0.005	A-T-042wTCN
Phenols - Total by HPLC (w)$_A$	<0.01	<0.01						mg/l	0.01	A-T-050w
Sulphide (w)$_A$	0.8	<0.1						mg/l	0.1	A-T-S2-w
DOC (w)$_A^\#$	8.1	56.7						mg/l	0.2	A-T-032w
Arsenic (dissolved)$_A^\#$	<1	2						µg/l	1	A-T-025w
Boron (dissolved)$_A^\#$	128	134						µg/l	10	A-T-025w
Cadmium (dissolved)$_A^\#$	<0.2	<0.2						µg/l	0.2	A-T-025w
Calcium (dissolved)$_A^\#$	140	108						mg/l	1	A-T-049w
Copper (dissolved)$_A^\#$	3	5						µg/l	1	A-T-025w
Chromium (dissolved)$_A^\#$	<1	<1						µg/l	1	A-T-025w
Lead (dissolved)$_A^\#$	<1	<1						µg/l	1	A-T-025w
Mercury (dissolved)$_A^\#$	<0.1	<0.1						µg/l	0.1	A-T-025w
Nickel (dissolved)$_A^\#$	10	21						µg/l	1	A-T-025w
Selenium (dissolved)$_A^\#$	<1	<1						µg/l	1	A-T-025w
Zinc (dissolved)$_A^\#$	6	4						µg/l	1	A-T-025w

Envirolab Job Number: 21/01742

Client Project Name: Swan House

Client Project Ref: B077409

Lab Sample ID	21/01742/1	21/01742/2						Units	Limit of Detection	Method ref
Client Sample No	1	1								
Client Sample ID	BH102	BH103								
Depth to Top	24.29	3.34								
Depth To Bottom	25.23	4.91								
Date Sampled	18-Feb-21	18-Feb-21								
Sample Type	Water - EW	Water - EW								
Sample Matrix Code	N/A	N/A								
PAH 16MS (w)										
Acenaphthene (w)$_A^\#$	0.04	0.16						µg/l	0.01	A-T-019w
Acenaphthylene (w)$_A^\#$	<0.01	<0.01						µg/l	0.01	A-T-019w
Anthracene (w)$_A^\#$	0.01	0.02						µg/l	0.01	A-T-019w
Benzo(a)anthracene (w)$_A^\#$	0.02	<0.01						µg/l	0.01	A-T-019w
Benzo(a)pyrene (w)$_A^\#$	0.02	<0.01						µg/l	0.01	A-T-019w
Benzo(b)fluoranthene (w)$_A^\#$	0.04	<0.01						µg/l	0.01	A-T-019w
Benzo(ghi)perylene (w)$_A^\#$	0.01	<0.01						µg/l	0.01	A-T-019w
Benzo(k)fluoranthene (w)$_A^\#$	0.01	<0.01						µg/l	0.01	A-T-019w
Chrysene (w)$_A^\#$	0.02	<0.01						µg/l	0.01	A-T-019w
Dibenzo(ah)anthracene (w)$_A^\#$	<0.01	<0.01						µg/l	0.01	A-T-019w
Fluoranthene (w)$_A^\#$	0.11	0.04						µg/l	0.01	A-T-019w
Fluorene (w)$_A^\#$	0.02	0.04						µg/l	0.01	A-T-019w
Indeno(123-cd)pyrene (w)$_A^\#$	0.01	<0.01						µg/l	0.01	A-T-019w
Naphthalene (w)$_A^\#$	<0.01	0.32						µg/l	0.01	A-T-019w
Phenanthrene (w)$_A^\#$	0.05	0.06						µg/l	0.01	A-T-019w
Pyrene (w)$_A^\#$	0.12	0.04						µg/l	0.01	A-T-019w
Total PAH 16MS (w)$_A^\#$	0.48	0.68						µg/l	0.01	A-T-019w

Envirolab Job Number: 21/01742

Client Project Name: Swan House

Client Project Ref: B077409

Lab Sample ID	21/01742/1	21/01742/2						Units	Limit of Detection	Method ref
Client Sample No	1	1								
Client Sample ID	BH102	BH103								
Depth to Top	24.29	3.34								
Depth To Bottom	25.23	4.91								
Date Sampled	18-Feb-21	18-Feb-21								
Sample Type	Water - EW	Water - EW								
Sample Matrix Code	N/A	N/A								
TPH CWG (w)										
Ali >C5-C6 $(w)_A^{\#}$	<1	10						µg/l	1	A-T-022w
Ali >C6-C8 $(w)_A^{\#}$	<1	19						µg/l	1	A-T-022w
Ali >C8-C10 $(w)_A^{\#}$	<5	172						µg/l	5	A-T-055w
Ali >C10-C12 $(w)_A^{\#}$	<5	564						µg/l	5	A-T-055w
Ali >C12-C16 $(w)_A^{\#}$	<5	1236						µg/l	5	A-T-055w
Ali >C16-C21 $(w)_A^{\#}$	7	1531						µg/l	5	A-T-055w
Ali >C21-C35 $(w)_A^{\#}$	172	14173						µg/l	5	A-T-055w
Total Aliphatics $(w)_A^{\#}$	179	17700						µg/l	5	A-T-055w
Aro >C5-C7 $(w)_A^{\#}$	<1	<1						µg/l	1	A-T-022w
Aro >C7-C8 $(w)_A^{\#}$	<1	2						µg/l	1	A-T-022w
Aro >C8-C10 $(w)_A$	8	<5						µg/l	5	A-T-055w
Aro >C10-C12 $(w)_A^{\#}$	<5	260						µg/l	5	A-T-055w
Aro >C12-C16 $(w)_A^{\#}$	17	445						µg/l	5	A-T-055w
Aro >C16-C21 $(w)_A^{\#}$	19	818						µg/l	5	A-T-055w
Aro >C21-C35 $(w)_A^{\#}$	40	1012						µg/l	10	A-T-055w
Total Aromatics $(w)_A$	84	2540						µg/l	10	A-T-055w
TPH (Ali & Aro >C5-C35) $(w)_A$	263	20200						µg/l	10	A-T-055w
BTEX - Benzene $(w)_A^{\#}$	<1	<1						µg/l	1	A-T-022w
BTEX - Toluene $(w)_A^{\#}$	<1	2						µg/l	1	A-T-022w
BTEX - Ethyl Benzene $(w)_A^{\#}$	<1	<1						µg/l	1	A-T-022w
BTEX - m & p Xylene $(w)_A^{\#}$	<1	<1						µg/l	1	A-T-022w
BTEX - o Xylene $(w)_A^{\#}$	<1	<1						µg/l	1	A-T-022w
MTBE $(w)_A^{\#}$	<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.
The Client Sample No, Client Sample ID, Depth to Top, Depth to Bottom and Date Sampled were all provided by the client.

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 (Manchester), Merchant Exchange, 17-19 Whitworth Street , Manchester, UK, M1 5WG

Project: Swan House

Clients Project No: B077409

Project No: 21/01742

Date Received: 22/02/2021 (am)

Cool Box Temperatures (°C): 6.0

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

- 2018 Investigation
  - Envirolab, Final Analytical Test Report 18-07336-1
  - Envirolab, Final Analytical Test Report 18-07505-1
- 2021 Investigation
  - Envirolab, Final Analytical Test Report 21-01179-1

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envirolab
Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 18/07336
Issue Number: 1 **Date:** 27 September, 2018

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

Project Manager: Matthew Holroyd/Siobhán Hyde
Project Name: Swan House Manchester
Project Ref: B067266.201
Order No: EBMA1394
Date Samples Received: 12/09/18
Date Instructions Received: 13/09/18
Date Analysis Completed: 26/09/18

Prepared by:

Melanie Marshall
Laboratory Coordinator

Approved by:

Georgia King
Admin & Client Services Supervisor

Envirolab Job Number: 18/07336

Client Project Name: Swan House Manchester

Client Project Ref: B067266.201

Lab Sample ID	18/07336/1	18/07336/2	18/07336/3	18/07336/4					Units	Method ref
Client Sample No	D1	D2	D1	D2						
Client Sample ID	WS06	WS06	WS07	WS07						
Depth to Top	3.00	4.70	1.90	3.80						
Depth To Bottom	3.25	4.90	2.00	4.00						
Date Sampled	10-Sep-18	11-Sep-18	11-Sep-18	11-Sep-18						
Sample Type	Soil - D	Soil - D	Soil - D	Soil - D						
Sample Matrix Code	3	3	3	5						
% Stones >10mm$_A$	<0.1	<0.1	<0.1	<0.1					% w/w	A-T-044
pH BRE$_D^{M\#}$	8.42	8.49	8.46	8.56					pH	A-T-031s
Sulphate BRE (water sol 2:1)$_D^{M\#}$	41	47	62	36					mg/l	A-T-026s
1.01 % Moisture BS1377 1990 pt2 cl3.2$_A^{\#}$	-	Appended	Appended	-						Subcon SS
1.02 Atterburg 4Pt BS1377 1990 pt2 cl4.4,5.3+5.4$_A^{\#}$	-	Appended	Appended	-						Subcon SS

REPORT NOTES

General:
This report shall not be reproduced, except in full, without written approval from Envirolab.
All samples contained within this report, and any received with the same delivery, will be disposed of one month after the date of this report.
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.

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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.

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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.

STRUCTURAL SOILS LTD

TEST REPORT

Report No. 783379 R1a

1774

Date 01-October-2018 Contract 18/07336

Client Envirolab Ltd
Address Units 7 & 8 Sandpits Business Park
Mottram Road
Hyde
SK14 3AR

For the Attention of Iain Haslock

Samples submitted by client	14/09/2018	Client Reference	18/07336
Testing Started	14/09/2018	Client Order No.	P0739027
Testing Completed	26/09/2018	Instruction Type	Written

Tests marked 'Not UKAS Accredited' in this report are not included in the UKAS Accreditation Schedule for our Laboratory.

UKAS Accredited Tests Undertaken

Moisture Content (oven drying method) BS1377:Part 2:1990,clause 3.2 (superseded)**
Liquid Limit (definitive method) BS1377:Part 2:1990,clause 4.3
Plastic Limit BS1377:Part 2:1990,clause 5.3
Plasticity Index Derivation BS1377:Part 2:1990,clause 5.4

* This clause of BS1377 is no longer the most up to date method due to the publication of ISO17892

Please Note: Remaining samples will be retained for a period of one month from today and will then be disposed of.
Test were undertaken on samples 'as received' unless otherwise stated.
Opinions and interpretations expressed in this report are outside the scope of accreditation for this laboratory.

Structural Soils Ltd, The Potteries, Pottery Street, Castleford, WF10 1NJ Tel.01977 552255. E-mail mark.athorne@soils.co.uk

SUMMARY OF SOIL CLASSIFICATION TESTS

In accordance with clauses 3.2,4.3,4.4,5.3,5.4,7.2,8.2,8.3 of BS1377:Part 2:1990

Exploratory Position ID	Sample Ref	Sample Type	Depth (m)	Moisture Content %	Liquid Limit %	Plastic Limit %	Plasticity Index	% <425um	Description of Sample
WS06	18/07336/2	B	4.70	19	40	18	22	97	Brown slightly gravelly CLAY
WS07	18/07336/3	B	1.90	19	39	16	23	97	Brown slightly gravelly CLAY

STRUCTURAL SOILS LTD

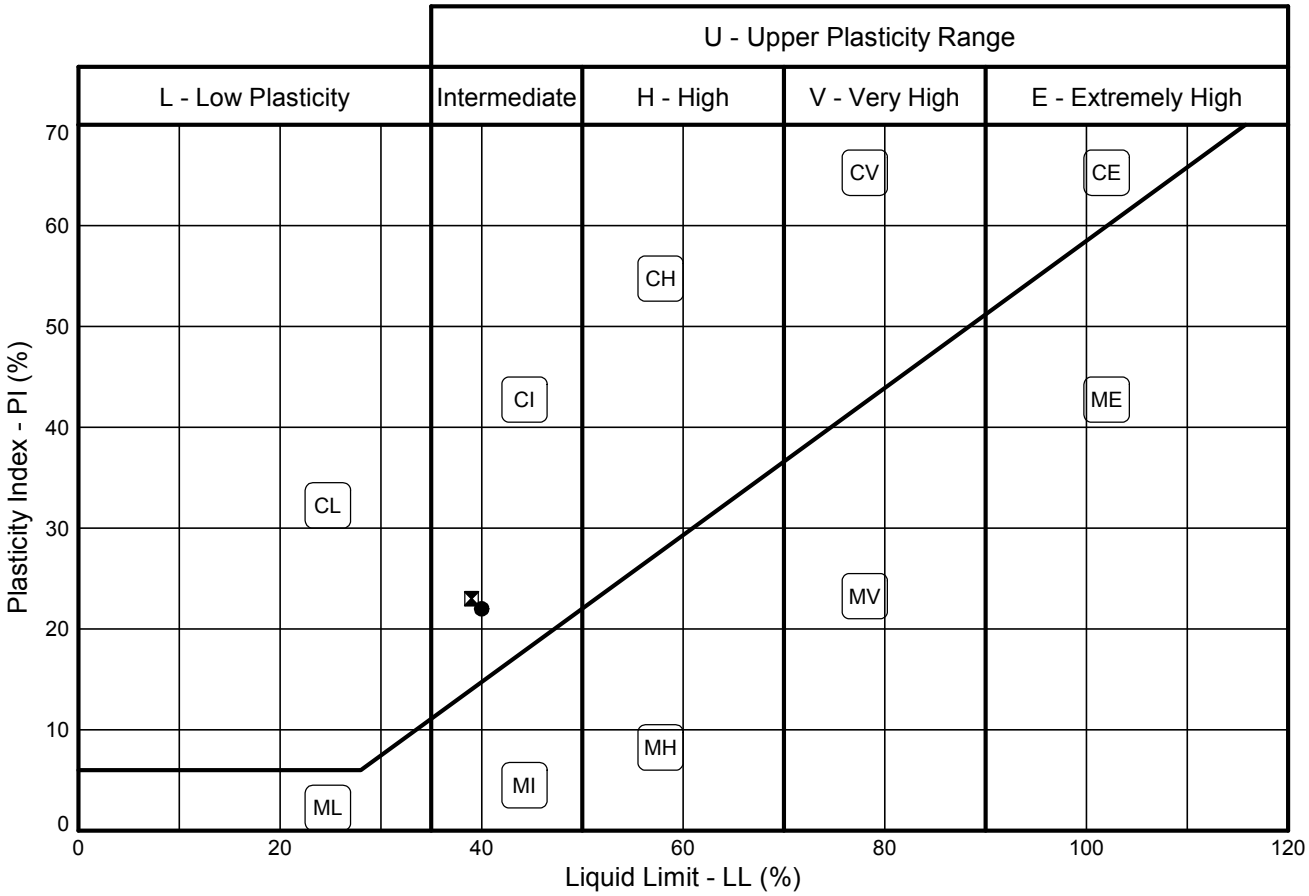
Contract: **18/07336**

Contract Ref: **783379**

AGS

PLASTICITY CHART - PI Vs LL

In accordance with BS5930:2015
Testing in accordance with BS1377-2:1990



Sample Identification				BS Test Method #	Preparation Method +	MC %	LL %	PL %	PI %	<425um %	Lab location
Exploratory Position ID	Sample		Depth (m)								
● WS06	18/07336/2B		4.70	3.2/4.3/5.3/5.4	4.2.4	19	40	18	22	97	C
⊠ WS07	18/07336/3B		1.90	3.2/4.3/5.3/5.4	4.2.4	19	39	16	23	97	C

Tested in accordance with the following clauses of BS1377-2:1990.

3.2 - Moisture Content
4.3 - Cone Penetrometer Method
4.4 - One Point Cone Penetrometer Method
4.6 - One Point Casagrande Method
5.3 - Plastic Limit Method
5.4 - Plasticity Index

+ Tested in accordance with the following clauses of BS1377-2:1990.

4.2.3 - Natural State
4.2.4 - Wet Sieved

Key: * = Non-standard test, NP = Non plastic.

Lab location: B = Bristol (BS3 4AG), C = Castleford (WF10 1NJ), H = Hemel Hempstead (HP3 9RT), T = Tonbridge (TN11 9HU)

STRUCTURAL SOILS
The Potteries
Pottery Street
Castleford
W. Yorkshire WF10 1NJ

Compiled By		Date
M. Athorne	MARK ATHORNE	01/10/18

Contract	Contract Ref:
18/07336	783379

AGS

GINT_LIBRARY_V8_06.GLB LibVersion: v8_06_018 PrjVersion: v8_06 - Core+Geotech Lab-Castleford - 009 | Graph L - ALINE STANDARD - A4P | 783379 - 18-07336.GPJ - v8_06_
Structural Soils Ltd, Branch Office - Castleford: The Potteries, Pottery Street, Castleford, West Yorkshire, WF10 1NJ. Tel: 01977-552255, Fax: 01977-552299, Web: www.soils.co.uk, Email: ask@soils.co.uk, | 01/10/18 - 17:22 | MAA1 |

TESTING VERIFICATION CERTIFICATE

UKAS TESTING
1774

The test results included in this report are certified as:-

ISSUE STATUS: **FINAL**

In accordance with the Structural Soils Ltd Laboratory Quality Management System, results sheets and summaries of results issued by the laboratory are checked by an approved signatory. The integrity of the test data and results are ensured by control of the computer system employed by the laboratory as part of the Software Verification Program as detailed in the Laboratory Quality Manual.

This testing verification certificate covers all testing compiled on or before the following datetime: **01/10/2018 17:23:23**.

Testing reported after this date is not covered by this Verification Certificate.



Approved Signatory
Mark Athorne (Laboratory Manager)

(Head Office)
Bristol Laboratory
Unit 1A, Princess Street
Bedminster
Bristol
BS3 4AG

Castleford Laboratory
The Potteries, Pottery Street
Castleford
West Yorkshire
WF10 1NJ

Hemel Laboratory
18 Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT

Tonbridge Laboratory
Anerley Court, Half Moon Lane
Hildenborough
Tonbridge
TN11 9HU

STRUCTURAL SOILS LTD	Contract: **18/07336**	Job No: **783379**

AGS

GINT_LIBRARY_V8_06.GLB LibVersion: v8_06_018 PrjVersion: v8_06 - Core+Geotech Lab-Castleford - 009 | GrfcText L - LAB VERIFICATION REPORT - V02 - A4P | 783379 - 18-07336.GPJ - v8_06.
Structural Soils Ltd, Branch Office - Castleford: The Potteries, Pottery Street, Castleford, West Yorkshire, WF10 1NJ. Tel: 01977-552255, Fax: 01977-552299, Web: www.soils.co.uk, Email: ask@soils.co.uk. | 01/10/18 - 17:23 | MAA1 |

envirolab
Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 18/07505
Issue Number: 1 **Date:** 02 October, 2018

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

Project Manager: Matthew Holroyd/Siobhán Hyde
Project Name: Swan House, Manchester
Project Ref: B067266.201
Order No: EBMA1405
Date Samples Received: 14/09/18
Date Instructions Received: 18/09/18
Date Analysis Completed: 02/10/18

Prepared by:

Melanie Marshall
Laboratory Coordinator

Approved by:

Danielle Brierley
Client Manager

Envirolab Job Number: 18/07505

Client Project Name: Swan House, Manchester

Client Project Ref: B067266.201

Lab Sample ID	18/07505/1	18/07505/2	18/07505/3	18/07505/4	18/07505/5	18/07505/6			Units	Method ref
Client Sample No	1	2	2	3	1	2				
Client Sample ID	WS01	WS01	WS01	WS03	WS02	WS02				
Depth to Top	1.90	3.50	4.70	4.80	1.80	3.80				
Depth To Bottom	2.00		5.00	5.00	2.00	4.00				
Date Sampled	13-Sep-18	13-Sep-18	13-Sep-18	13-Sep-18	14-Sep-18	14-Sep-18				
Sample Type	Soil - D	Soil - D	Soil - D	Soil - D	Soil - D	Soil - D				
Sample Matrix Code	3	3	5	6	5A	5				
% Stones >10mm$_A$	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1			% w/w	A-T-044
pH BRE$_D^{M\#}$	8.18	8.57	8.62	8.42	8.37	8.43			pH	A-T-031s
Sulphate BRE (water sol 2:1)$_D^{M\#}$	81	47	48	102	87	66			mg/l	A-T-026s
1.01 % Moisture BS1377 1990 pt2 cl3.2$_A^{\#}$	-	Appended	-	Appended	-	Appended				Subcon SS
1.02 Atterburg 4Pt BS1377 1990 pt2 cl4.4,5.3+5.4$_A^{\#}$	-	Appended	-	Appended	-	Appended				Subcon SS

REPORT NOTES

General:
This report shall not be reproduced, except in full, without written approval from Envirolab.
All samples contained within this report, and any received with the same delivery, will be disposed of one month after the date of this report.
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.

STRUCTURAL SOILS LTD

TEST REPORT

Report No. 783389 R1

1774

Date 02-October-2018 Contract 18/07505

Client Envirolab Ltd
Address Units 7 & 8 Sandpits Business Park
Mottram Road
Hyde
SK14 3AR

For the Attention of Iain Haslock

Samples submitted by client	19/09/2018	Client Reference	18/07505
Testing Started	21/09/2018	Client Order No.	P0739062
Testing Completed	02/10/2018	Instruction Type	Written

Tests marked 'Not UKAS Accredited' in this report are not included in the UKAS Accreditation Schedule for our Laboratory.

UKAS Accredited Tests Undertaken

Moisture Content (oven drying method) BS1377:Part 2:1990,clause 3.2 (superseded)**
Liquid Limit (definitive method) BS1377:Part 2:1990,clause 4.3
Plastic Limit BS1377:Part 2:1990,clause 5.3
Plasticity Index Derivation BS1377:Part 2:1990,clause 5.4

* This clause of BS1377 is no longer the most up to date method due to the publication of ISO17892

Please Note: Remaining samples will be retained for a period of one month from today and will then be disposed of.
Test were undertaken on samples 'as received' unless otherwise stated.
Opinions and interpretations expressed in this report are outside the scope of accreditation for this laboratory.

Structural Soils Ltd, The Potteries, Pottery Street, Castleford, WF10 1NJ Tel.01977 552255. E-mail mark.athorne@soils.co.uk

SUMMARY OF SOIL CLASSIFICATION TESTS

In accordance with clauses 3.2,4.3,4.4,5.3,5.4,7.2,8.2,8.3 of BS1377:Part 2:1990

Exploratory Position ID	Sample Ref	Sample Type	Depth (m)	Moisture Content %	Liquid Limit %	Plastic Limit %	Plasticity Index	% <425um	Description of Sample
WS01	18/07505/2	B	3.50	18	41	20	21	96	Brwon slightly gravelly CLAY
WS02	18/07505/6	B	3.80	19	39	20	19	98	Brown slightly gravelly CLAY
WS03	18/07505/4	B	4.80	18	35	18	17	93	Brown slightly gravelly CLAY

STRUCTURAL SOILS LTD

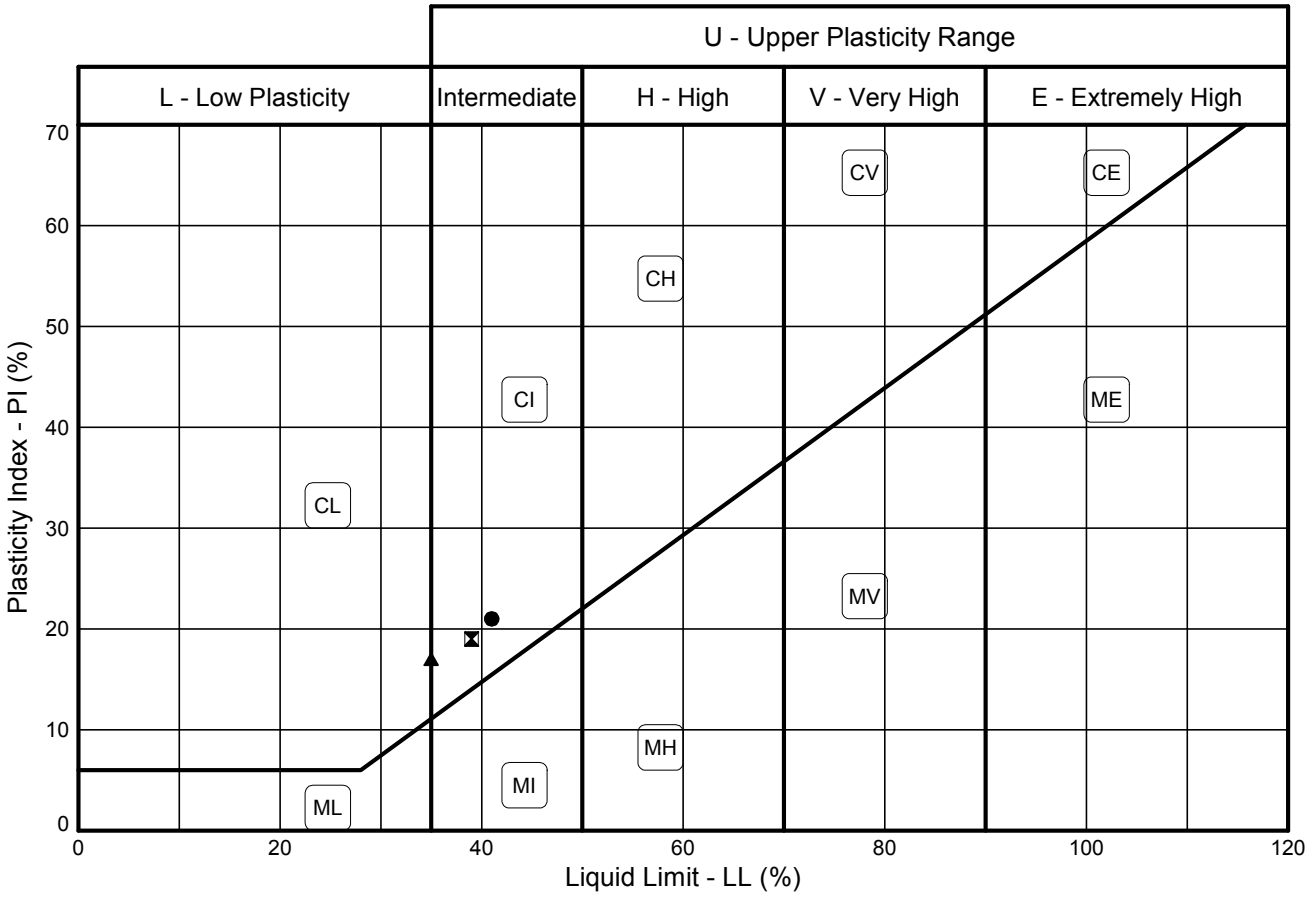
Contract: **18/07505**

Contract Ref: **783389**

AGS

PLASTICITY CHART - PI Vs LL

In accordance with BS5930:2015
Testing in accordance with BS1377-2:1990



Sample Identification				BS Test Method #	Preparation Method +	MC	LL	PL	PI	<425um	Lab location
	Exploratory Position ID	Sample	Depth (m)			%	%	%	%	%	
●	WS01	18/07505/2B	3.50	3.2/4.3/5.3/5.4	4.2.4	18	41	20	21	96	C
⊠	WS02	18/07505/6B	3.80	3.2/4.3/5.3/5.4	4.2.4	19	39	20	19	98	C
▲	WS03	18/07505/4B	4.80	3.2/4.3/5.3/5.4	4.2.4	18	35	18	17	93	C

Tested in accordance with the following clauses of BS1377-2:1990.

3.2 - Moisture Content
4.3 - Cone Penetrometer Method
4.4 - One Point Cone Penetrometer Method
4.6 - One Point Casagrande Method
5.3 - Plastic Limit Method
5.4 - Plasticity Index

+ Tested in accordance with the following clauses of BS1377-2:1990.

4.2.3 - Natural State
4.2.4 - Wet Sieved

Key: * = Non-standard test, NP = Non plastic.

Lab location: B = Bristol (BS3 4AG), C = Castleford (WF10 1NJ), H = Hemel Hempstead (HP3 9RT), T = Tonbridge (TN11 9HU)

STRUCTURAL SOILS
The Potteries
Pottery Street
Castleford
W. Yorkshire WF10 1NJ

Compiled By		Date
M. Fisher.	**MAUREEN FISHER**	**02/10/18**
Contract: **18/07505**	Contract Ref: **783389**	

GINT_LIBRARY_V8_06.GLB LibVersion: v8_06_018 PrjVersion: v8_06 - Core+Geotech Lab-Castleford - 009 | Graph L - ALINE STANDARD - A4P | 783389 - 18-07505.GPJ - v8_06
Structural Soils Ltd, Branch Office - Castleford: The Potteries, Pottery Street, Castleford, West Yorkshire, WF10 1NJ. Tel: 01977-552255, Fax: 01977-552299, Web: www.soils.co.uk, Email: ask@soils.co.uk | 02/10/18 - 10:04 | MF1 |

TESTING VERIFICATION CERTIFICATE

1774

The test results included in this report are certified as:-

ISSUE STATUS: **FINAL**

In accordance with the Structural Soils Ltd Laboratory Quality Management System, results sheets and summaries of results issued by the laboratory are checked by an approved signatory. The integrity of the test data and results are ensured by control of the computer system employed by the laboratory as part of the Software Verification Program as detailed in the Laboratory Quality Manual.

This testing verification certificate covers all testing compiled on or before the following datetime: **02/10/2018 12:19:37**.

Testing reported after this date is not covered by this Verification Certificate.



Approved Signatory
Mark Athorne (Laboratory Manager)

(Head Office)
Bristol Laboratory
Unit 1A, Princess Street
Bedminster
Bristol
BS3 4AG

Castleford Laboratory
The Potteries, Pottery Street
Castleford
West Yorkshire
WF10 1NJ

Hemel Laboratory
18 Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT

Tonbridge Laboratory
Anerley Court, Half Moon Lane
Hildenborough
Tonbridge
TN11 9HU

STRUCTURAL SOILS LTD	Contract: **18/07505**	Job No: **783389**

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Structural Soils Ltd, Branch Office - Castleford: The Potteries, Pottery Street, Castleford, West Yorkshire, WF10 1NJ. Tel: 01977-552255, Fax: 01977-552299, Web: www.soils.co.uk, Email: ask@soils.co.uk. | 02/10/18 - 12:19 | MAA1 |

envirolab
Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 21/01179
Issue Number: 1 **Date:** 25 February, 2021

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

Project Manager: EBMA/Phil Winterburn/Philippa Neesham
Project Name: Swan House
Project Ref: B077409
Order No: EBMA2690
Date Samples Received: 05/02/21
Date Instructions Received: 08/02/21
Date Analysis Completed: 25/02/21

Prepared by:

Melanie Marshall
Laboratory Coordinator

Approved by:

Sophie France
Client Service Manager

Envirolab Job Number: 21/01179

Client Project Name: Swan House

Client Project Ref: B077409

Lab Sample ID	21/01179/1	21/01179/2	21/01179/3	21/01179/4	21/01179/5	21/01179/6	21/01179/7	Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	BH101A	BH101A	BH101A	BH101A	BH101A	BH101A	BH101A			
Depth to Top	24.1	26.14	26.93	29.84	30.66	32.86	36.93			
Depth To Bottom	24.32	26.27	27.17	30	31.01	33.27	37.15			
Date Sampled	27-Jan-21	27-Jan-21	27-Jan-21	27-Jan-21	27-Jan-21	27-Jan-21	27-Jan-21			
Sample Type	Solid	Solid	Solid	Solid	Solid	Solid	Solid			
Sample Matrix Code	7	7	7	7	7	7	7			
% Stones >10mm$_A$	-	-	-	<0.1	-	-	-	% w/w	0.1	A-T-044
pH$_D$$^{M\#}$	-	-	-	8.34	-	-	-	pH	0.01	A-T-031s
Sulphate (water sol 2:1)$_D$$^{M\#}$	-	-	-	0.03	-	-	-	g/l	0.01	A-T-026s
10.03a Point Load (PL) Index of a Single Specimen (Rock Sample) ISRM SM 1974-2006$_A$$^{\#}$	-	Appended	Appended	Appended	-	-	Appended	N/A		Subcon SS
10.04 Uniaxial / Unconfined Compressive Strength (Rock Sample) ISRM SM 1974-2006$_A$$^{\#}$	Appended	-	-	-	Appended	Appended	-	N/A		Subcon SS

Envirolab Job Number: 21/01179

Client Project Name: Swan House

Client Project Ref: B077409

Lab Sample ID	21/01179/8	21/01179/9	21/01179/10	21/01179/11	21/01179/12	21/01179/13	21/01179/14	Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	BH101A	BH101A	BH103	BH103	BH103	BH103	BH103			
Depth to Top	38.73	35.85	25.78	28.2	30.12	32.29	34.28			
Depth To Bottom	38.97	35.99	26	28.38	30.33	32.46	34.46			
Date Sampled	27-Jan-21	27-Jan-21	27-Jan-21	27-Jan-21	27-Jan-21	27-Jan-21	27-Jan-21			
Sample Type	Solid	Solid	Solid	Solid	Solid	Solid	Solid			
Sample Matrix Code	7	7	7	7	7	7	7			
% Stones >10mm$_A$	-	<0.1	-	-	<0.1	-	<0.1	% w/w	0.1	A-T-044
pH$_D$$^{M\#}$	-	8.30	-	-	8.01	-	7.67	pH	0.01	A-T-031s
Sulphate (water sol 2:1)$_D$$^{M\#}$	-	0.02	-	-	0.01	-	0.02	g/l	0.01	A-T-026s
10.03a Point Load (PL) Index of a Single Specimen (Rock Sample) ISRM SM 1974-2006$_A$$^{\#}$	Appended	-	Appended	-	Appended	-	Appended	N/A		Subcon SS
10.04 Uniaxial / Unconfined Compressive Strength (Rock Sample) ISRM SM 1974-2006$_A$$^{\#}$	-	Appended	-	Appended	-	Appended	-	N/A		Subcon SS

Envirolab Job Number: 21/01179

Client Project Name: Swan House

Client Project Ref: B077409

Lab Sample ID	21/01179/15	21/01179/16	21/01179/17	21/01179/18	21/01179/19	21/01179/20	21/01179/21	Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	BH103	BH103	BH102	BH102	BH102	BH102	BH102			
Depth to Top	37.28	39.08	27.78	29	31.52	33.06	34.34			
Depth To Bottom	37.6	39.25	27.96	29.16	31.77	33.44	34.5			
Date Sampled	27-Jan-21	27-Jan-21	01-Feb-21	01-Feb-21	01-Feb-21	01-Feb-21	01-Feb-21			
Sample Type	Solid	Solid	Solid	Solid	Solid	Solid	Solid			
Sample Matrix Code	7	7	7	7	7	7	7			
% Stones >10mm$_A$	-	-	<0.1	-	-	-	-	% w/w	0.1	A-T-044
pH$_D$$^{M\#}$	-	-	7.48	-	-	-	-	pH	0.01	A-T-031s
Sulphate (water sol 2:1)$_D$$^{M\#}$	-	-	<0.01	-	-	-	-	g/l	0.01	A-T-026s
10.03a Point Load (PL) Index of a Single Specimen (Rock Sample) ISRM SM 1974-2006$_A$$^{\#}$	-	Appended	-	Appended	-	Appended	-	N/A		Subcon SS
10.04 Uniaxial / Unconfined Compressive Strength (Rock Sample) ISRM SM 1974-2006$_A$$^{\#}$	Appended	-	Appended	-	Appended	-	Appended	N/A		Subcon SS

Envirolab Job Number: 21/01179

Client Project Name: Swan House

Client Project Ref: B077409

Lab Sample ID	21/01179/22	21/01179/23	21/01179/24	21/01179/25	21/01179/26	21/01179/27	21/01179/28	Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	BH102	BH102	BH101A	BH101A	BH101A	BH101A	BH101A			
Depth to Top	35.83	39.68	1	5	12	9	8.5			
Depth To Bottom	36.09	39.88	1.1	5.45	12.45	9.45	8.6			
Date Sampled	01-Feb-21	01-Feb-21	19-Jan-21	19-Jan-21	20-Jan-21	20-Jan-21	20-Jan-21			
Sample Type	Solid	Solid	Soil - D	Soil - U	Soil - U	Soil - D	Soil - D			
Sample Matrix Code	7	7		5A	5A		5A			
% Stones >10mm$_A$	-	<0.1	-	<0.1	<0.1	-	2.6	% w/w	0.1	A-T-044
pH$_D^{M\#}$	-	8.09	-	8.93	9.14	-	9.18	pH	0.01	A-T-031s
Sulphate (water sol 2:1)$_D^{M\#}$	-	0.02	-	0.06	0.04	-	0.07	g/l	0.01	A-T-026s
1.02 Atterburg 4Pt BS1377 1990 pt2 cl4.4,5.3+5.4$_A^{\#}$	-	-	Appended	Appended	-	Appended	-	%	1	Subcon SS
1.01 % Moisture BS1377 1990 pt2 cl3.2$_A^{\#}$	-	-	Appended	Appended	Appended	Appended	-	%	0.1	Subcon SS
4.01 Dimensional Consolidation (5 stages) (75mm) BS1377-5:3$_A^{\#}$	-	-	-	-	Appended	-	-	N/A		Subcon SS
4.06a potential remoulding charge at as received moisture$_A$	-	-	-	-	Appended	-	-	N/A		Subcon SS
4.06b potential remoulding charge at specified moisture / density$_A$	-	-	-	-	Appended	-	-	N/A		Subcon SS
5.02c QUT Multistage (mm supplied) BS1377 1990 pt7 cl9$_A^{\#}$	-	-	-	Appended	Appended	-	-	N/A		Subcon SS
10.03a Point Load (PL) Index of a Single Specimen (Rock Sample) ISRM SM 1974-2006$_A^{\#}$	-	Appended	-	-	-	-	-	N/A		Subcon SS
10.04 Uniaxial / Unconfined Compressive Strength (Rock Sample) ISRM SM 1974-2006$_A^{\#}$	Appended	-	-	-	-	-	-	N/A		Subcon SS

Envirolab Job Number: 21/01179

Client Project Name: Swan House

Client Project Ref: B077409

Lab Sample ID	21/01179/29	21/01179/30	21/01179/31	21/01179/32	21/01179/33	21/01179/34	21/01179/35	Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	BH102	BH102	BH102	BH102	BH102	BH102	BH102			
Depth to Top	2	3	4.5	7	11.5	17.5	13			
Depth To Bottom	2.6	3.45	4.6	7.1	11.6	17.6	13.1			
Date Sampled	25-Jan-21	25-Jan-21	25-Jan-21	25-Jan-21	25-Jan-21	25-Jan-21	25-Jan-21			
Sample Type	Soil - D	Soil - U	Soil - D	Soil - D	Soil - D	Soil - B	Soil - B			
Sample Matrix Code				5A		4A	4A			
% Stones >10mm$_A$	-	-	-	<0.1	-	<0.1	<0.1	% w/w	0.1	A-T-044
pH$_D$$^{M\#}$	-	-	-	9.24	-	9.14	9.19	pH	0.01	A-T-031s
Sulphate (water sol 2:1)$_D$$^{M\#}$	-	-	-	0.03	-	<0.01	<0.01	g/l	0.01	A-T-026s
1.02 Atterburg 4Pt BS1377 1990 pt2 cl4.4,5.3+5.4$_A$$^{\#}$	Appended	-	Appended	Appended	Appended	-	-	%	1	Subcon SS
1.01 % Moisture BS1377 1990 pt2 cl3.2$_A$$^{\#}$	Appended	-	Appended	Appended	Appended	-	-	%	0.1	Subcon SS
5.02c QUT Multistage (mm supplied) BS1377 1990 pt7 cl9$_A$$^{\#}$	-	Appended	-	-	-	-	-	N/A		Subcon SS

Envirolab Job Number: 21/01179

Client Project Name: Swan House

Client Project Ref: B077409

Lab Sample ID	21/01179/36	21/01179/37	21/01179/38					Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	BH103	BH103	BH103							
Depth to Top	5	19	10.5							
Depth To Bottom	5.45	19.1	10.95							
Date Sampled	22-Jan-21	22-Jan-21	22-Jan-21							
Sample Type	Soil - U	Soil - B	Soil - D							
Sample Matrix Code		4A								
% Stones >10mm$_A$	-	1.2	-					% w/w	0.1	A-T-044
pH$_D^{M\#}$	-	9.38	-					pH	0.01	A-T-031s
Sulphate (water sol 2:1)$_D^{M\#}$	-	<0.01	-					g/l	0.01	A-T-026s
1.02 Atterburg 4Pt BS1377 1990 pt2 cl4.4,5.3+5.4$_A^{\#}$	-	-	Appended					%	1	Subcon SS
1.01 % Moisture BS1377 1990 pt2 cl3.2$_A^{\#}$	Appended	-	Appended					%	0.1	Subcon SS
1.10a PSD (Grading/63um/sand fraction/wet sieve) BS1377 pt 2 1990 cl 9.2$_A^{\#}$	-	Appended	-					%	0.1	Subcon SS
4.01 Dimensional Consolidation (5 stages) (75mm) BS1377-5:3$_A^{\#}$	Appended	-	-					N/A		Subcon SS
4.06a potential remoulding charge at as received moisture$_A$	Appended	-	-					N/A		Subcon SS
4.06b potential remoulding charge at specified moisture / density$_A$	Appended	-	-					N/A		Subcon SS
5.02c QUT Multistage (mm supplied) BS1377 1990 pt7 cl9$_A^{\#}$	Appended	-	-					N/A		Subcon SS

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.
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The Client Sample No, Client Sample ID, Depth to Top, Depth to Bottom and Date Sampled were all provided by the client.

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.
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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 (Manchester), Merchant Exchange, 17-19 Whitworth Street , Manchester, UK, M1 5WG

Project: Swan House

Clients Project No: B077409

Project No: 21/01179

Date Received: 08/02/2021 (am)

Cool Box Temperatures (°C): 5.5 & 6.2

Lab Sample ID	21/01179/25	21/01179/26
Client Sample No		
Client Sample ID/Depth	BH101A 5-5.45m	BH101A 12-12.45m
Date Sampled	19/01/21	20/01/21
Deviation Code		
F	✓	✓

Key
F *Maximum holding time exceeded between sampling date and analysis for analytes listed below*

HOLDING TIME EXCEEDANCES

Lab Sample ID	21/01179/25	21/01179/26
Client Sample No		
Client Sample ID/Depth	BH101A 5-5.45m	BH101A 12-12.45m
Date Sampled	19/01/21	20/01/21
Sulphate (water sol 2:1)	✓	✓

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.

IAN FARMER ASSOCIATES

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washington@ianfarmer.co.uk www.ianfarmer.co.uk

F.A.O.

Final Test Report - 2280408 / 1

Site:	Swan House
Job Number:	2280408
Originating Client:	Envirolab Ltd
Originating Reference:	2280408
Date Sampled:	19/01/2021
Date Scheduled:	10/02/2021
Date Testing Started:	12/02/2021
Date Testing Finished:	24/02/2021

Previous Reports		Amendments	Date Issued

Amendments:

Authorised By:

Tim Robinson
Quality Supervisor

Report Issue Date: 25/02/2021

Constructionline
Part of Capita plc

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Registered Office: Spring Lodge 172 Chester Road, Helsby, Frodsham, England, WA6 0AR.
Offices in: **Cornwall** (01872) 261775. **Coventry** (024) 7630 3422. **Harpenden** (01582) 460018. **Llanelli** (01554) 566566.
Newcastle upon Tyne (0191) 482 8500. **Motherwell** (01698) 230231. **Warrington** (01925) 855440. **Washington** (0191) 482 8500.

AGS

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Laboratory Test Report 2280408 / 1

Site: Swan House **Job Number:** 2280408

Client: Envirolab Ltd **Page:** 2

Determination of Water Content, Liquid Limit and Plastic Limit and Derivation of Plasticity and Liquidity Index

Borehole / Trial Pit	Depth (m)	Sample	Natural Moisture Content %	Natural - Stones removed by hand Sieved - Washed on 425 µm sieve			Liquid Limit %	Plastic Limit %	Plasticity Index %	Liquidity Index	Class	Description / Remarks
				Natural / Sieved	Percentage Passing %	Moisture Content %						
BH101A	1.00	D	34	Natural	100	34	54	25	29	0.31	CH	Brown silty CLAY
BH101A	5.00	U	22	Natural	98	22	40	20	20	0.11	CI	Brown slightly silty, gravelly CLAY
BH101A	9.00	D	15	Natural	96	15	33	16	17	-0.03	CL	Brown slightly gravelly, silty CLAY
BH101A	12.00	U	14									Brown silty CLAY
BH102	2.00	D	18	Natural	99	18	42	19	23	-0.04	CI	Brown silty CLAY
BH102	4.50	D	18	Natural	97	18	39	18	21	0.02	CI	Brown slightly gravelly, silty CLAY
BH102	7.00	D	16	Natural	96	16	32	14	18	0.13	CL	Brown silty CLAY
BH102	11.50	D	18	Natural	97	18	40	20	20	-0.08	CI	Brown slightly gravelly, silty CLAY
BH103	5.00	U	20									Brown silty CLAY
BH103	10.50	D	15	Natural	100	15	33	17	16	-0.13	CL	Brown silty CLAY

Method of Preparation: BS 1377 : Part 1 : 1990 : Clause 7 Preparation of disturbed samples for testing
BS 1377 : Part 1 : 2016 : Clause 8.4.3 Preparation of samples for plasticity tests
BS 1377 : Part 2 : 1990 : Clause 4.2 Preparation of samples for plastic limit tests

Method of Test: BS 1377 : Part 2 : 1990 : Clause 3.2 Determination of moisture content
BS 1377 : Part 2 : 1990 : Clause 4.3 or 4.4 Determination of the liquid limit
BS 1377 : Part 2 : 1990 : Clause 5.3 Determination of the plastic limit and plasticity index

UKAS TESTING 1464

Results reported relate only to the samples tested.

IAN FARMER ASSOCIATES

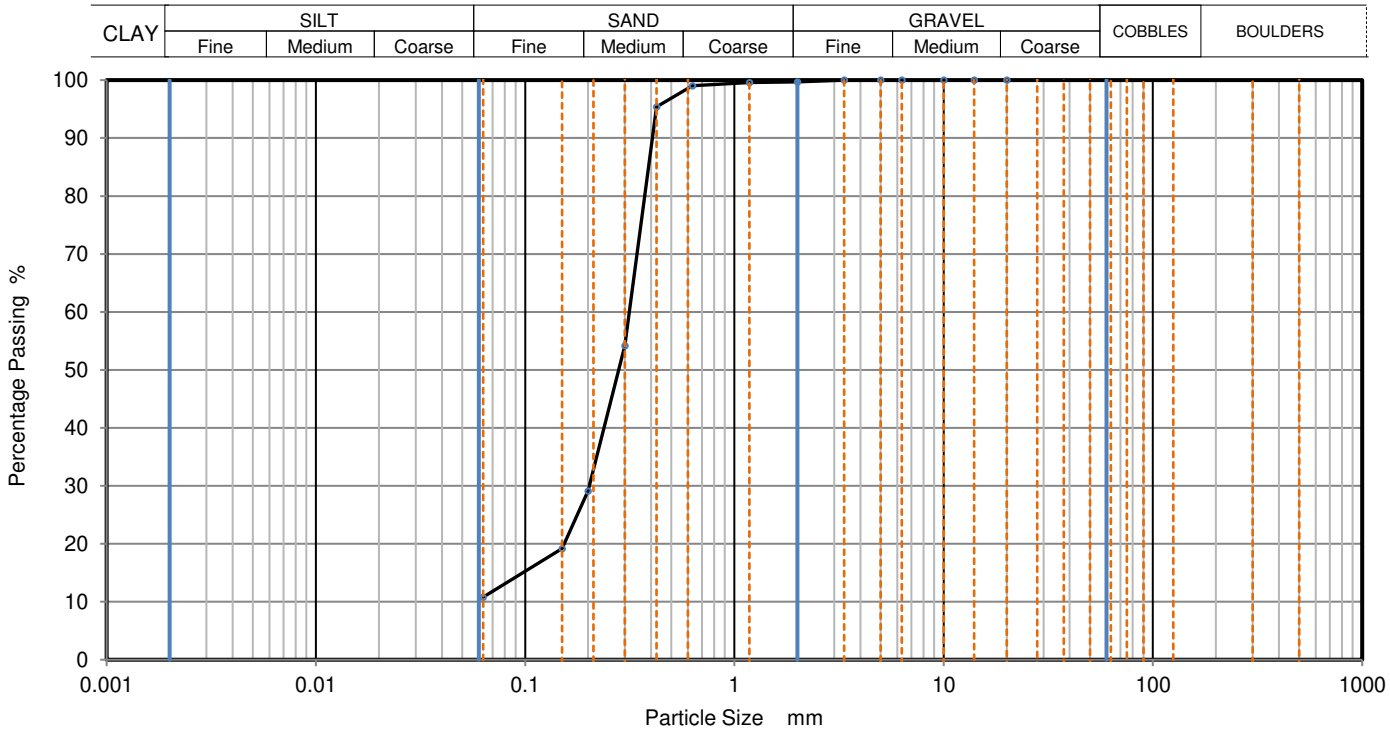
Laboratory Test Report 2280408 / 1

Site: Swan House **Job Number:** 2280408

Client: Envirolab Ltd **Page:** 3

DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Testing Type	Description
BH103	19.00	D	Wet Sieve	Brown silty SAND



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	100		
0.63	99		
0.425	95		
0.3	54		
0.2	29		
0.15	19		
0.063	11		

Dry Mass of sample, g: 114

Sample Proportions	% dry mass
Very coarse	0
Gravel	0
Sand	89
Fines <0.063mm	11

Grading Analysis		
D100	mm	3.35
D60	mm	0.315
D30	mm	0.203
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS17892 unless noted below

Method of Preparation: BS EN 17892:Part4:2016, clause 5.2.2 Preparation of samples for wet sieving test

Method of Test: BS EN 17892:Part4:2016, clause 5.2.3 Determination of particle size distribution by wet sieving method

UKAS TESTING 1464

Result reported relates only to the sample tested.

IAN FARMER ASSOCIATES

Laboratory Test Report 2280408 / 1

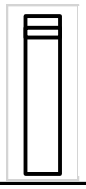
Site: Swan House **Job Number:** 2280408

Client: Envirolab Ltd **Page:** 4

DETERMINATION OF THE ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

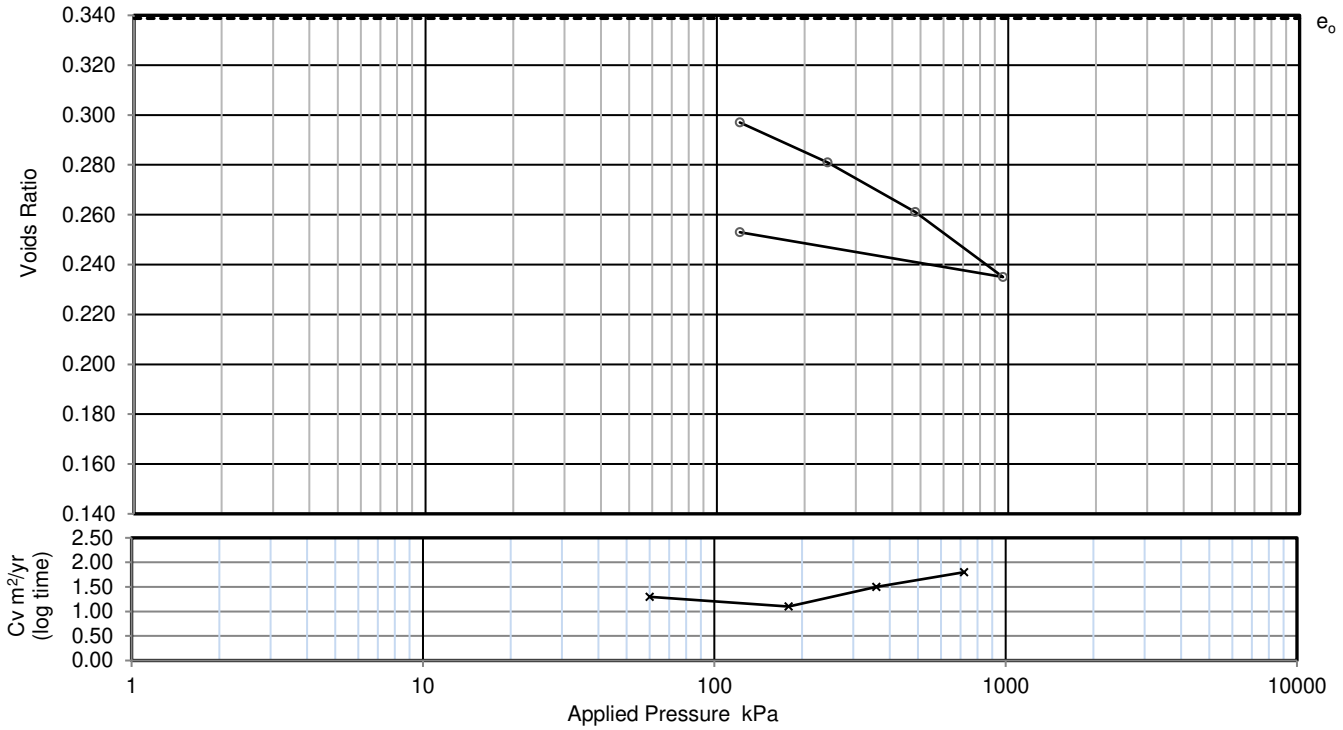
Borehole / Trial Pit	Depth (m)	Sample	Description
BH101A	12.00	U	Brown silty CLAY

Initial Specimen



Length of Sample (mm)	357.15
Depth from top of specimen (mm)	41.61
Condition of Sample:	Undisturbed
Orientation:	Vertical

Diameter (mm)	74.94
Particle density (Mg/m³)	2.65 assumed
Swelling Pressure (kPa)	
Lab Temp. (°C)	20



Applied Pressure kPa	Mv m2/MN	Cv (t50, log) m2/yr	Cv (t90, root) m2/yr	Csec	Voids ratio
0.0	-	-	-	-	0.339
120	0.26	1.3	15	0.00041	0.297
240	0.1	1.1	2.8	0.00065	0.281
480	0.067	1.5	2.6	0.0013	0.261
960	0.043	1.8	2.3	0.0019	0.235
120	0.017				0.253

	Initial	Final
Height (mm)	19.91	18.63
Moisture Content (%)	15	14
Bulk density (Mg/m³)	2.28	2.40
Dry density (Mg/m³)	1.98	2.12
Voids Ratio	0.339	0.253
Degree of Saturation (%)	120	143

Remarks:

Method of Preparation: BS 1377:Part 5:1990, clause 3.3 Preparation of specimen
BS 1377:Part 5:1990, clause 3.4 Preparation and assembly of apparatus

Method of Test: BS 1377:Part 5:1990, clause 3.5 Determination of the one-dimensional consolidation properties

UKAS TESTING 1464

Result reported relates only to the sample tested.

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Laboratory Test Report	2280408 / 1

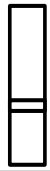
Site: Swan House **Job Number:** 2280408

Client: Envirolab Ltd **Page:** 5

DETERMINATION OF THE ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

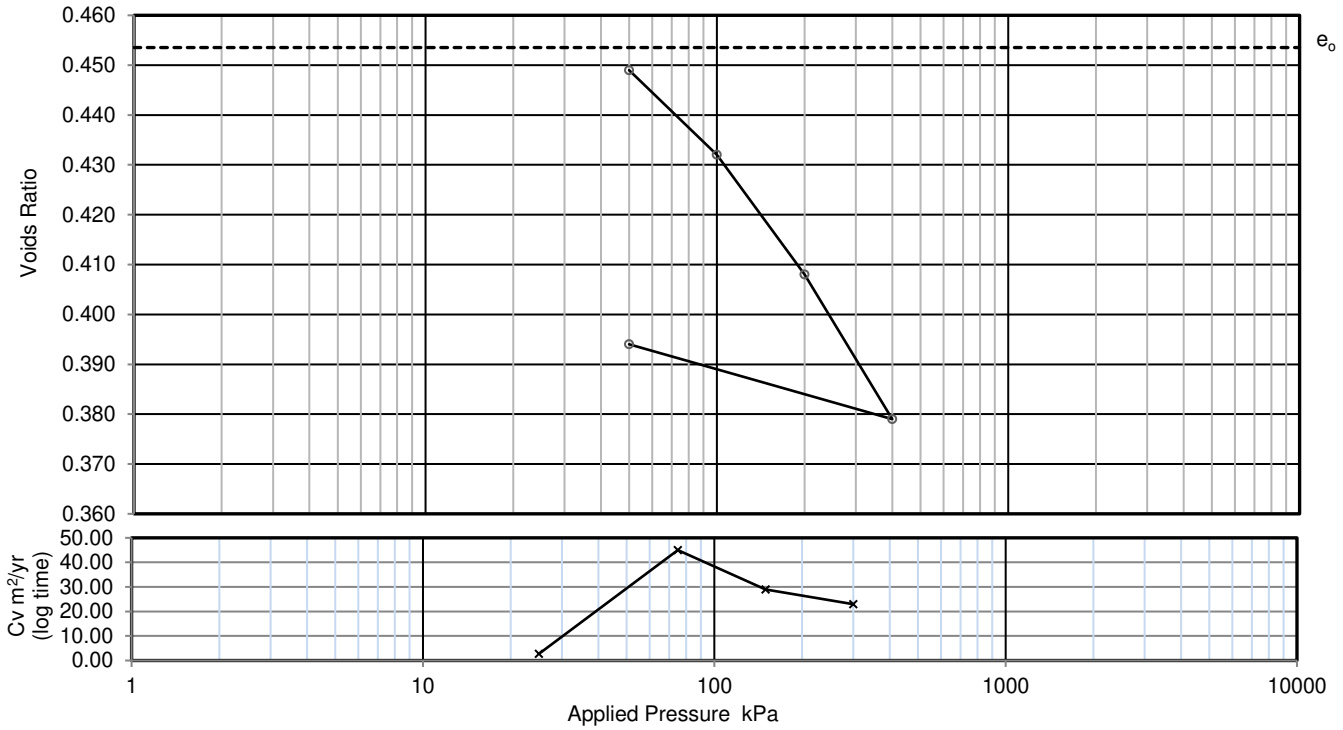
Borehole / Trial Pit	Depth (m)	Sample	Description
BH103	5.00	U	Brown silty CLAY

Initial Specimen



Length of Sample (mm)	438.54
Depth from top of specimen (mm)	269.95
Condition of Sample:	Undisturbed
Orientation:	Vertical

Diameter (mm)	74.74
Particle density (Mg/m³)	2.65 assumed
Swelling Pressure (kPa)	
Lab Temp. (°C)	20



Applied Pressure kPa	Mv m2/MN	Cv (t50, log) m2/yr	Cv (t90, root) m2/yr	Csec	Voids ratio
0.0	-	-	-	-	0.454
50	0.064	2.7	26	0.00067	0.449
100	0.24	45	30	0.0015	0.432
200	0.16	29	26	0.0019	0.408
400	0.11	23	45	0.0025	0.379
50	0.032				0.394

	Initial	Final
Height (mm)	20.29	19.46
Moisture Content (%)	19	19
Bulk density (Mg/m³)	2.17	2.26
Dry density (Mg/m³)	1.82	1.90
Voids Ratio	0.454	0.394
Degree of Saturation (%)	113	128

Remarks:

Method of Preparation: BS 1377:Part 5:1990, clause 3.3 Preparation of specimen
BS 1377:Part 5:1990, clause 3.4 Preparation and assembly of apparatus

Method of Test: BS 1377:Part 5:1990, clause 3.5 Determination of the one-dimensional consolidation properties

UKAS TESTING 1464

Result reported relates only to the sample tested.

Site: Swan House **Job Number:** 2280408

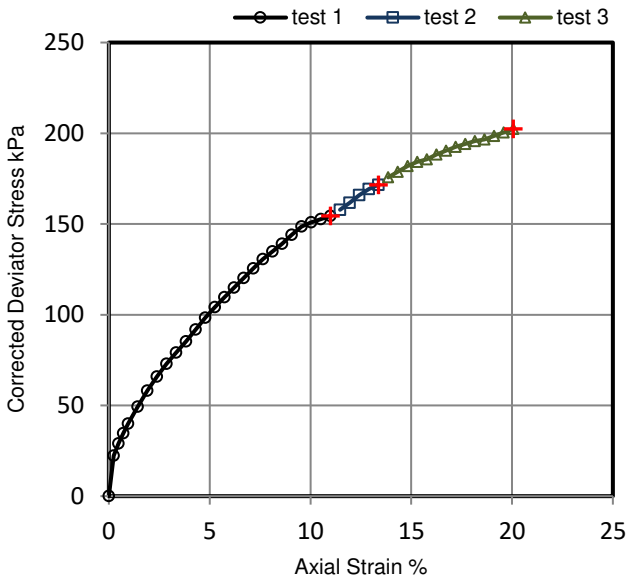
Client: Envirolab Ltd **Page:** 6

Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - Multistage test

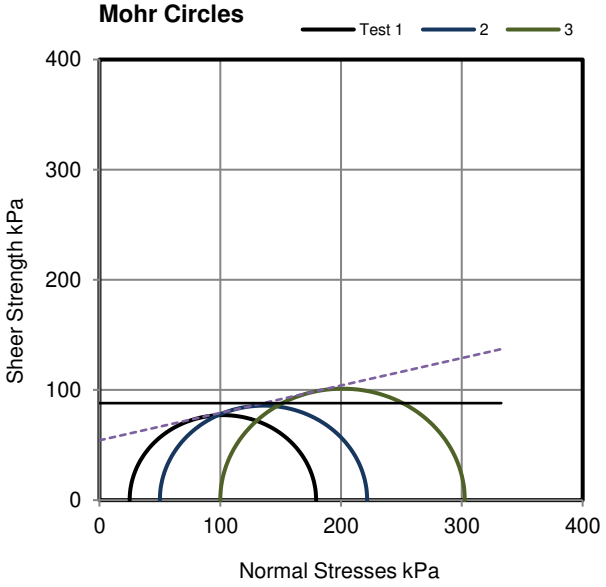
Borehole / Trial Pit	Depth (m)	Sample	Description
BH101A	5.00	U	Brown slightly silty, gravelly CLAY

Initial Sample	Original Length (mm)	424.39		
	Depth from Top (mm)	22.71		
	Condition	Undisturbed		
	Orientation	Vertical		
Length (mm)		209.30		
Diameter (mm)		101.91		
Moisture Content (%)		22.4		
Bulk Density (Mg/m3)		2.15		
Dry Density (Mg/m3)		1.75		
Membrane Thickness (mm)		0.18		
Membrane Type		Latex		
Rate of Strain (%/min)		1.91		
Test Results	Stage Number	1	2	3
	Cell Pressure (kPa)	25	50	100
	Axial Strain (%)	11	13	20
	Membrane Corr. (kPa)	0.4	0.5	0.7
	Deviator Stress (σ1 - σ3)f (kPa)	154	172	202
	Undrained Shear Strength, CU = ½(σ1 - σ3)f (kPa)	77	86	101
	Mode of Failure	Plastic		

Deviator Stress v Axial Strain



Mohr Circles



ϕu = 0

Average cu 88 kPa

Linear Regression

ϕu 14.0 °

cu 54 kPa

Mohr circles and their interpretation is not covered by BS1377. These are provided for information only.

Method of Preparation: BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing

Method of Test: BS 1377:PT2:1990:7.2 Determination of density by linear measurement. BS 1377:PT7:1990:9.4 Determination of undrained shear strength in triaxial compression with multistage loading and without measurement of pore pressure (Definitive method)

UKAS TESTING 1464

Result reported relates only to the sample tested.

IAN FARMER ASSOCIATES

Laboratory Test Report	2280408 / 1

Site: Swan House **Job Number:** 2280408

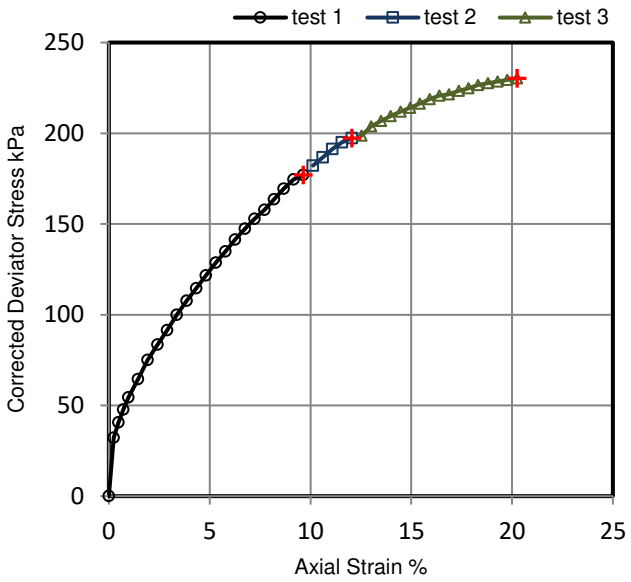
Client: Envirolab Ltd **Page:** 7

Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - Multistage test

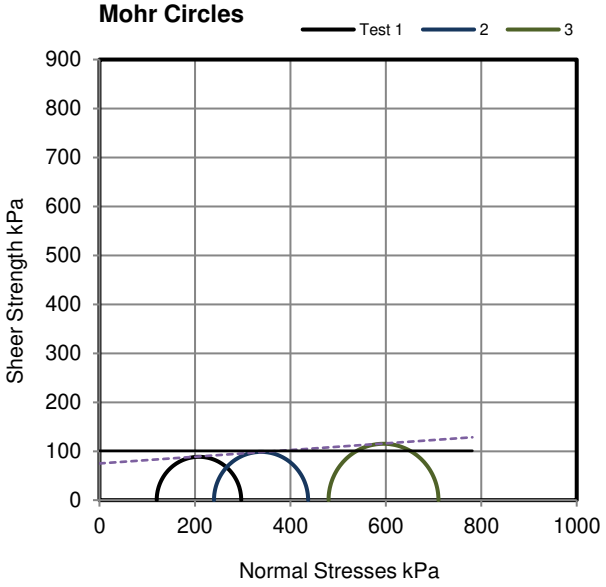
Borehole / Trial Pit	Depth (m)	Sample	Description
BH101A	12.00	U	Brown silty CLAY

Initial Sample	Original Length (mm)	357.15		
	Depth from Top (mm)	130.01		
	Condition	Undisturbed		
	Orientation	Vertical		
Length (mm)		207.43		
Diameter (mm)		102.31		
Moisture Content (%)		14.2		
Bulk Density (Mg/m3)		2.19		
Dry Density (Mg/m3)		1.92		
Membrane Thickness (mm)		0.28		
Membrane Type		Latex		
Rate of Strain (%/min)		1.93		
Test Results	Stage Number	1	2	3
	Cell Pressure (kPa)	120	240	480
	Axial Strain (%)	10	12	20
	Membrane Corr. (kPa)	0.6	0.7	1.1
	Deviator Stress (σ1 - σ3)f (kPa)	177	197	230
	Undrained Shear Strength, CU = ½(σ1 - σ3)f (kPa)	89	99	115
	Mode of Failure	Plastic		

Deviator Stress v Axial Strain



Mohr Circles



ϕu = 0

Average cu 101 kPa

Linear Regression

ϕu 3.9 °

cu 75 kPa

Mohr circles and their interpretation is not covered by BS1377. These are provided for information only.

Method of Preparation: BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or
BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing

Method of Test: BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:9.4 Determination of undrained shear strength in triaxial compression with multistage loading and without measurement of pore pressure (Definitive method)

Result reported relates only to the sample tested.

UKAS TESTING 1464

IAN FARMER ASSOCIATES

Laboratory Test Report	2280408 / 1

Site: Swan House **Job Number:** 2280408

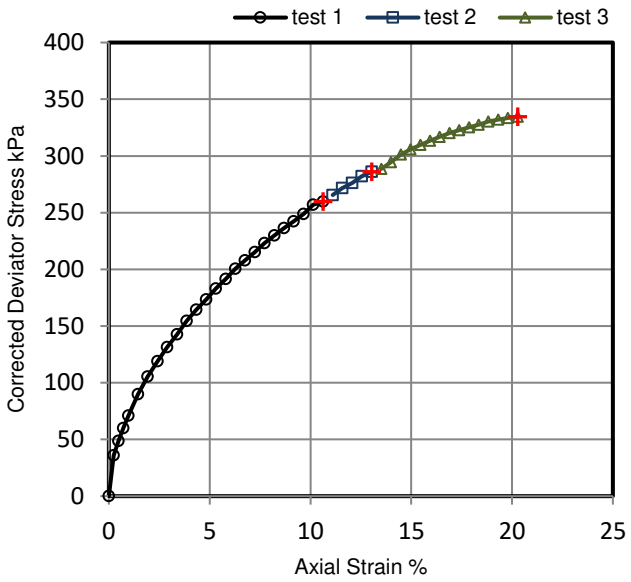
Client: Envirolab Ltd **Page:** 8

Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - Multistage test

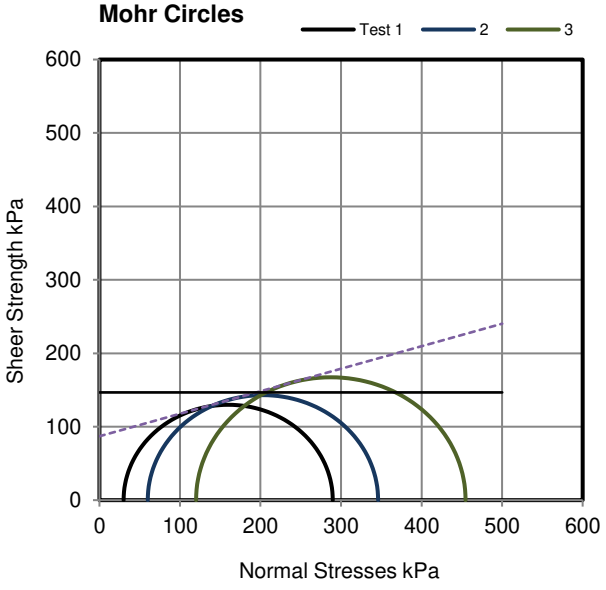
Borehole / Trial Pit	Depth (m)	Sample	Description
BH102	3.00	U	Brown silty CLAY

Initial Sample	Original Length (mm)	312.91		
	Depth from Top (mm)	35.49		
	Condition	Undisturbed		
	Orientation	Vertical		
Length (mm)		207.13		
Diameter (mm)		102.44		
Moisture Content (%)		17		
Bulk Density (Mg/m3)		2.12		
Dry Density (Mg/m3)		1.81		
Membrane Thickness (mm)		0.3		
Membrane Type		Latex		
Rate of Strain (%/min)		1.93		
Test Results	Stage Number	1	2	3
	Cell Pressure (kPa)	30	60	120
	Axial Strain (%)	11	13	20
	Membrane Corr. (kPa)	0.7	0.8	1.1
	Deviator Stress (σ1 - σ3)f (kPa)	260	286	335
	Undrained Shear Strength, CU = ½(σ1 - σ3)f (kPa)	130	143	167
	Mode of Failure	Plastic		

Deviator Stress v Axial Strain



Mohr Circles



ϕu = 0

Average cu 147 kPa

Linear Regression

ϕu 17.0 °

cu 87 kPa

Mohr circles and their interpretation is not covered by BS1377. These are provided for information only.

Method of Preparation: BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or
BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing

Method of Test: BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:9.4 Determination of undrained shear strength in triaxial compression with multistage loading and without measurement of pore pressure (Definitive method)

UKAS TESTING 1464

Result reported relates only to the sample tested.

IAN FARMER ASSOCIATES

Laboratory Test Report	2280408 / 1

Site: Swan House **Job Number:** 2280408

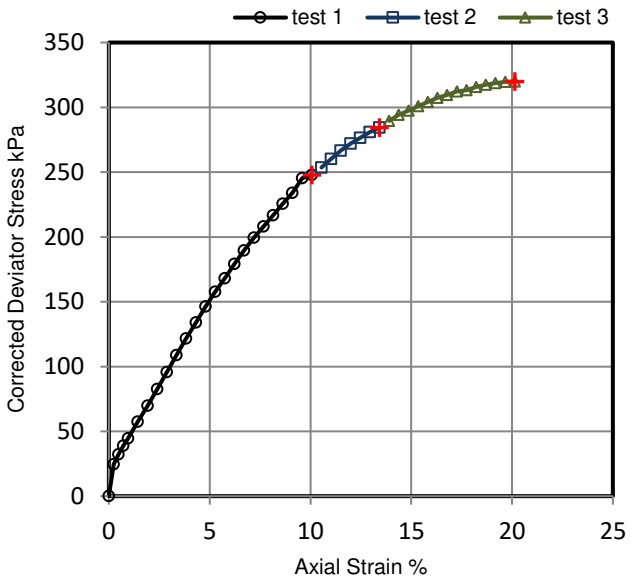
Client: Envirolab Ltd **Page:** 9

Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - Multistage test

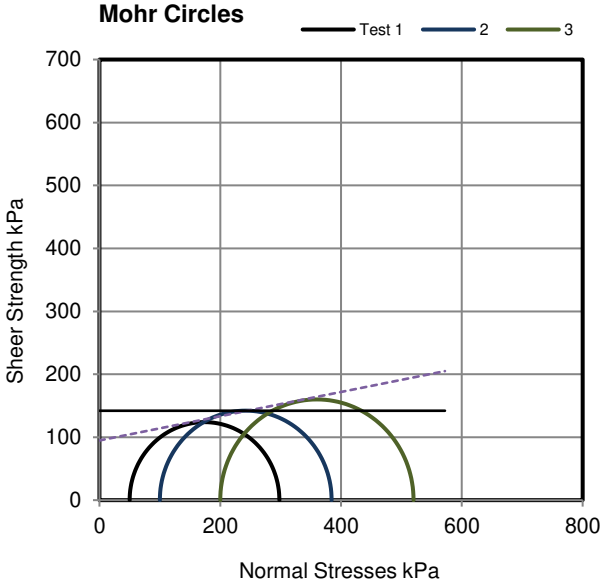
Borehole / Trial Pit	Depth (m)	Sample	Description
BH103	5.00	U	Brown silty CLAY

Initial Sample	Original Length (mm)	438.54		
	Depth from Top (mm)	41.38		
	Condition	Undisturbed		
	Orientation	Vertical		
Length (mm)		208.60		
Diameter (mm)		101.39		
Moisture Content (%)		19.6		
Bulk Density (Mg/m3)		2.15		
Dry Density (Mg/m3)		1.80		
Membrane Thickness (mm)		0.26		
Membrane Type		Latex		
Rate of Strain (%/min)		1.92		
Test Results	Stage Number	1	2	3
	Cell Pressure (kPa)	50	100	200
	Axial Strain (%)	10	13	20
	Membrane Corr. (kPa)	0.6	0.7	1.0
	Deviator Stress (σ1 - σ3)f (kPa)	248	284	320
	Undrained Shear Strength, CU = ½(σ1 - σ3)f (kPa)	124	142	160
	Mode of Failure	Plastic		

Deviator Stress v Axial Strain



Mohr Circles



ϕu = 0

Average cu 142 kPa

Linear Regression

ϕu 10.9 °

cu 95 kPa

Mohr circles and their interpretation is not covered by BS1377. These are provided for information only.

Method of Preparation: BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or
BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing

Method of Test: BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:9.4 Determination of undrained shear strength in triaxial compression with multistage loading and without measurement of pore pressure (Definitive method)

UKAS TESTING 1464

Result reported relates only to the sample tested.

IAN FARMER ASSOCIATES

Laboratory Test Report 2280408 / 1

Site: Swan House **Job Number:** 2280408

Client: Envirolab Ltd **Page:** 1

ROCK INDEX TESTS - SUMMARY OF RESULTS

Hole No.	Depth m	Sample	Rock description / Rock type	Natural Water Content1 %	Caliper2 Dry density Mg/m3	Caliper2 Porosity %	Buoyancy3 Dry density Mg/m3	Buoyancy3 Porosity %	Natural Bulk density Mg/m3	Remarks
BH101A	26.14	C	Red SANDSTONE	10.1						
BH101A	26.93	C	Red SANDSTONE	10.8						
BH101A	29.84	C	Red SANDSTONE	12.1						
BH101A	36.93	C	Red SANDSTONE	11.2						
BH101A	38.73	C	Red SANDSTONE	10.7						
BH102	29.00	C	Red SANDSTONE	11.6						
BH102	33.06	C	Red SANDSTONE	11.3						
BH102	39.68	C	Red SANDSTONE	10.2						
BH103	25.78	C	Red SANDSTONE	12.4						
BH103	30.12	C	Red SANDSTONE	10.8						
BH103	34.28	C	Red SANDSTONE	14.4						
BH103	39.08	C	Red SANDSTONE	13.4						

Notes 1. ISRM p87 test 1, water content at 105 ± 3 oC, specimen as received at the laboratory

2. ISRM p87 test 2, Porosity/density determination using saturation and caliper

3. ISRM p88 test 3, Porosity/density determination using saturation and buoyancy

2/3. pore volume determined by water saturation

Method of Preparation: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007.
Part 1.1 Suggested method for determination of the water conrent of a rock sample

Method of Test: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007.
Part 1.1 Suggested method for determination of the water conrent of a rock sample

Results reported relate only to the samples tested.

IAN FARMER ASSOCIATES

Laboratory Test Report 2280408 / 1

Site: Swan House **Job Number:** 2280408

Client: Envirolab Ltd **Page:** 11

UNIAXIAL COMPRESSION TEST ON ROCK - SUMMARY OF RESULTS

Hole No.	Depth m	Sample	Rock Type	Specimen Dimensions2			Bulk Density2	Water Content 1	Uniaxial Compression3				Remarks
				Dia. mm	Length mm	H/D	Mg/m3	%	Condition	Stress Rate MPa/s	Mode of failure	UCS MPa	
BH101A	24.10	C	Red SANDSTONE	85.7	181.0	*2.1	2.09	11.1	as received	0.5026	AC	7.0	
BH101A	30.66	C	Red SANDSTONE	85.9	192.2	*2.2	2.12	13.2	as received	0.5004	S	12.5	
BH101A	32.86	C	Red SANDSTONE	86.2	231.5	2.7	2.18	13.7	as received	0.4971	AC	13.6	
BH101A	35.85	C	Red SANDSTONE	85.1	95.1	*1.1	2.13	18.7	as received	0.5095	AC	6.1	
BH102	27.78	C	Red SANDSTONE	85.9	136.7	*1.6	2.14	11.9	as received	0.5003	MS	9.6	
BH102	31.52	C	Red SANDSTONE	84.8	111.7	*1.3	2.11	12.7	as received	0.5131	MS	7.6	
BH102	34.34	C	Red SANDSTONE	85.1	138.9	*1.6	2.18	14.0	as received	0.5098	S	8.2	
BH102	35.83	C	Red SANDSTONE	85.3	150.9	*1.8	2.14	10.9	as received	0.5069	MS	11.2	
BH103	28.20	C	Red SANDSTONE	85.4	95.7	*1.1	2.07	13.5	as received	0.5057	MS	3.7	
BH103	32.29	C	Red SANDSTONE	86.8	153.2	*1.8	2.05	11.0	as received	0.4896	AC	5.2	
BH103	37.28	C	Red SANDSTONE	87.5	216.2	2.5	2.04	12.3	as received	0.4825	MS	11.8	

Notes
1 ISRM p87 test 1, water content at 105 ± 3 oC, specimen as tested for UCS
2 ISRM p86 clause (vii), Caliper method used for determination of bulk volume and derivation of bulk density
3 ISRM p153 part 1, determination of Uniaxial Compressive Strength (UCS) of Rock Materials
above notes apply unless annotated otherwise in the remarks

*Denotes length diameter ratio outside ISRM specification

Mode of failure :
S - Single shear MS - multiple shear
AC - Axial cleavage F - Fragmented

Method of Preparation: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007

Method of Test: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007

Results reported relate only to the samples tested.

IAN FARMER ASSOCIATES

Laboratory Test Report 2280408 / 1

Site: Swan House **Job Number:** 2280408

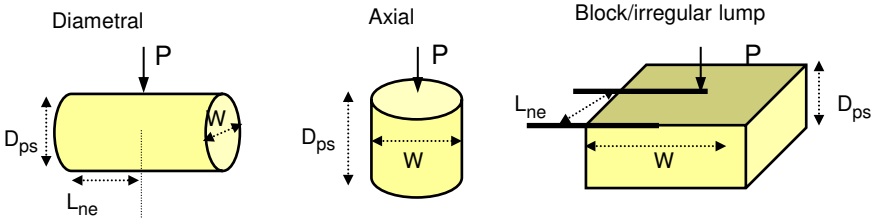
Client: Envirolab Ltd **Page:** 12

Point Load Strength Index Tests
Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM: Type (D, A, I, B)	Test Type see ISRM: Direction (PL, PD or U)	Failure Valid (Y/N)	Dimensions: Lne mm	Dimensions: W mm	Dimensions: Dps mm	Dimensions: Dps' mm	Force P kN	Equivalent diameter, De mm	Point Load Strength Index: Is . MPa	Point Load Strength Index: Is (50) MPa	Remarks (including water content if measured)
BH101A	26.14	C	Red SANDSTONE As received	D	PL	YES	85.8	85.2	85.2	82.2	0.7	85.2	0.10	0.12	
BH101A	26.14	C	Red SANDSTONE As received	A	PD	YES		85.5	81.6	64.6	1.7	94.3	0.19	0.25	
BH101A	26.93	C	Red SANDSTONE As received	D	PL	YES	87.1	85.6	85.6	84.6	0.5	85.6	0.06	0.08	
BH101A	26.93	C	Red SANDSTONE As received	A	PD	YES		86.1	95.3	83.3	0.8	102.2	0.08	0.11	
BH101A	29.84	C	Red SANDSTONE As received	D	U	YES	53.7	86.3	86.3	84.3	0.8	86.3	0.11	0.15	
BH101A	29.84	C	Red SANDSTONE As received	A	U	YES		86.3	55.8	48.8	1.5	78.3	0.25	0.31	
BH101A	36.93	C	Red SANDSTONE As received	D	PL	YES	106.4	86.5	86.5	84.5	1.0	86.5	0.13	0.17	
BH101A	36.93	C	Red SANDSTONE As received	A	PD	NO		86.4	104.1	94.1	2.1	107.0	0.18	0.26	
BH101A	38.73	C	Red SANDSTONE As received	D	U	YES	145.0	86.8	86.8	84.8	0.4	86.8	0.06	0.07	
BH101A	38.73	C	Red SANDSTONE As received	A	U	NO		84.0	129.3	123.3	1.4	117.6	0.10	0.15	
BH102	29	C	Red SANDSTONE As received	D	U	YES	87.8	85.6	85.6	81.6	0.4	85.6	0.06	0.07	
BH102	29	C	Red SANDSTONE As received	A	U	YES		85.9	86.1	80.1	1.0	97.0	0.10	0.14	
BH102	33.06	C	Red SANDSTONE As received	D	PL	YES	100.7	86.5	86.5	85.5	0.0	86.5	0.01	0.01	
BH102	33.06	C	Red SANDSTONE As received	A	PD	NO		86.2	99.0	90.0	1.7	104.2	0.16	0.22	
BH102	39.68	C	Red SANDSTONE As received	D	U	YES	84.2	86.8	86.8	73.8	1.7	86.8	0.23	0.29	
BH102	39.68	C	Red SANDSTONE As received	A	U	YES		88.0	86.8	64.8	2.4	98.6	0.24	0.33	
BH103	25.78	C	Red SANDSTONE As received	D	U	YES	56.6	85.0	85.0	77.0	0.2	85.0	0.03	0.04	
BH103	25.78	C	Red SANDSTONE As received	A	U	YES		85.6	63.4	51.4	0.7	83.1	0.10	0.12	
BH103	30.12	C	Red SANDSTONE As received	D	U	YES	104.7	85.4	85.4	74.4	0.5	85.4	0.07	0.09	
BH103	30.12	C	Red SANDSTONE As received	A	U	YES		86.0	98.0	84.0	0.8	103.6	0.07	0.10	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
PL - Parallel to planes of weakness
PD - Perpendicular to planes of weakness
U - Unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P
Size factor, F = (De/50)0.45 for all tests.

Detailed legend for test and dimensions, based on ISRM



Method of Preparation: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Results reported relate only to the samples tested.

IAN FARMER ASSOCIATES

Laboratory Test Report 2280408 / 1

Site: Swan House **Job Number:** 2280408

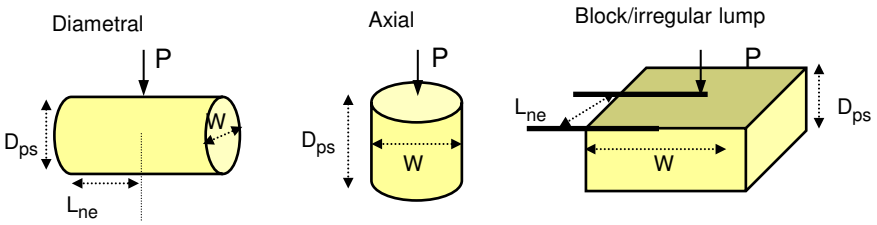
Client: Envirolab Ltd **Page:** 13

Point Load Strength Index Tests
Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P	Equivalent diameter, De	Point Load Strength Index		Remarks (including water content if measured)
				Type (D, A, I, B)	Direction (PL, PD or U)		Lne mm	W mm	Dps mm	Dps' mm	kN	mm	Is . MPa	Is (50) MPa	
BH103	34.28	C	Red SANDSTONE As received	D	PL	YES	86.0	84.3	84.3	70.3	0.8	84.3	0.12	0.15	
BH103	34.28	C	Red SANDSTONE As received	A	PD	YES		84.5	74.1	58.1	1.4	89.3	0.17	0.22	
BH103	39.08	C	Red SANDSTONE As received	D	U	YES	67.0	85.6	85.6	72.6	0.6	85.6	0.09	0.11	
BH103	39.08	C	Red SANDSTONE As received	A	U	YES		86.6	58.8	44.8	0.8	80.5	0.12	0.15	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
PL - Parallel to planes of weakness
PD - Perpendicular to planes of weakness
U - Unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P
Size factor, F = (De/50)0.45 for all tests.

Detailed legend for test and dimensions, based on ISRM



Method of Preparation: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Results reported relate only to the samples tested.

Final Test Report - 2280408 / 1

Site:	Swan House
Job Number:	2280408
Originating Client:	Envirolab Ltd

All opinions and interpretations contained within this report are outside of our Scope of Accreditation.

This test report shall not be reproduced, except in full and only with the written permission of Ian Farmer Associates Ltd.

Samples will be retained for 28 days from date of issue of the final test report before being disposed of, unless we receive written instruction to the contrary.

Report Issue Date: 25/02/2021

Appendix E – Ground Gas Monitoring Results

- 2018 Investigation
  - Visits 1 – 6, September 2018 – January 2019
  - Gas Monitor Calibration certificate, serial no. 321234
- 2021 Investigation.
  - Visits 1 – 4, February to March 2021
  - Gas Monitor Calibration certificate, serial no 326664

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Curtins
Merchant Exchange, 17-19 Whitworth Street West, Manchester, M1 5WG
Tel: 0161 236 2394
Fax: 0161 228 7902

GAS MONITORING LOG SHEET

Project:	Swan House, Manchester	**Date:**	25/09/2018
Job Number:	B067266.201	**Visit:**	1
Client:	Foundation Real Estate	**Weather:**	Sunny
Barometric State:	Falling	**Ground Conditions:**	Boreholes located inside

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	1027	0.0	0.0	0.0	0.0	1.0	1.0	18.0	1	1	Dry	4.15	
WS02	1027	0.0	0.0	0.0	0.0	4.3	4.3	13.1	0	1	Dry	4.95	
WS03	1028	0.0	0.0	0.0	0.0	0.0	0.0	20.7	1	1	2.73	2.75	
WS04	1028	0.0	0.0	0.0	0.0	0.3	0.3	20.3	0	0	Dry	2.23	
WS06	1029	0.0	0.0	0.0	0.0	1.4	1.4	17.0	0	0	2.73	4.75	
WS07	1029	0.0	0.0	0.0	0.0	0.4	0.4	18.3	1	1	1.23	4.85	

Notes

Logged by

SH

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
Merchant Exchange, 17-19 Whitworth Street West, Manchester, M1 5WG
Tel: 0161 236 2394
Fax: 0161 228 7902

GAS MONITORING LOG SHEET

Project:	Swan House, Manchester	**Date:**	10/10/2018
Job Number:	B067266.201	**Visit:**	2
Client:	Foundation Real Estate	**Weather:**	Sunny
Barometric State:	Falling	**Ground Conditions:**	Boreholes located inside

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	1003	0.0	0.0	0.0	0.0	1.9	1.9	17.00	1	5	Dry	4.13	
WS02	1004	0.0	0.0	0.0	0.0	4.6	4.6	14.10	1	3	4.61	4.82	
WS03	1004	0.0	0.0	0.0	0.0	0.0	0.0	20.80	2	0	2.7	2.89	
WS04	1004	0.0	0.0	0.0	0.0	0.3	0.3	20.30	0	5	Dry	2.23	
WS06	1005	-0.2	0.0	0.0	0.0	1.0	1.0	19.80	0	3	2.46	3.70	1
WS07	1006	0.0	0.0	0.0	0.0	0.3	0.3	20.7	0	3	1.19	4.74	

Notes

1 - Steady state flow rate achieved after 1 second.

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

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GAS MONITORING LOG SHEET

Project:	Swan House, Manchester	**Date:**	23/10/2018
Job Number:	B067266.201	**Visit:**	3
Client:	Foundation Real Estate	**Weather:**	Overcast, breezy
Barometric State:	Falling	**Ground Conditions:**	Boreholes located inside

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	1021	0.0	0.0	0.0	0.0	1.8	1.8	17.6	0	0	Dry	4.10	
WS02	1021	0.0	0.0	0.0	0.0	4.4	4.4	14.7	2	0	4.55	4.85	
WS03	1021	0.0	0.0	0.0	0.0	0.3	0.2	20.5	0	0	2.70	2.95	
WS04	1021	0.0	0.0	0.0	0.0	0.3	0.3	20.4	0	6	Dry	2.24	
WS06													1
WS07													1

Notes

1 - borehole inaccessible

Logged by

SH

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

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GAS MONITORING LOG SHEET

Project:	Swan House, Manchester	**Date:**	13/11/2018
Job Number:	B067266.201	**Visit:**	4
Client:	Foundation Real Estate	**Weather:**	Clear
Barometric State:	Steady	**Ground Conditions:**	Boreholes located inside

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	998	0.3	0.0	0.0	0.0	2.1	2.1	17.9	0	0	Dry	4.13	
WS02	999	0.0	0.0	0.0	0.0	4.8	4.8	14.6	0	0	4.52	4.88	
WS03	998	0.0	0.0	0.0	0.0	0.0	0.0	20.6	0	0	2.75	3.14	
WS04	999	0.7	0.0	0.0	0.0	2.0	2.0	20.3	0	0	Dry	2.24	
WS06	999	0.0	0.0	0.0	0.0	0.9	0.9	19.9	0	0	2.60	4.72	
WS07	1000	0.0	0.0	0.0	0.0	0.1	0.1	20.5	0	0	1.24	2.76	

Notes

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

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Tel: 0161 236 2394
Fax: 0161 228 7902

GAS MONITORING LOG SHEET

Project:	Swan House, Manchester	**Date:**	23/01/2019
Job Number:	B067266.201	**Visit:**	5
Client:	Foundation Real Estate	**Weather:**	Foggy & cold
Barometric State:	Steady	**Ground Conditions:**	Boreholes located inside

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	997	-0.6	-0.6	0.0	0.0	1.9	1.9	18.8	2	1	Dry	4.10	
WS02	997	-0.6	-0.6	0.0	0.0	5.4	5.4	15.0	1	0	4.45	4.90	
WS03	998	-0.6	-0.6	0.0	0.0	0.2	0.2	20.8	2	1	2.75	3.15	
WS04	997	-0.6	-0.6	0.0	0.0	0.3	0.3	20.5	7	7	Dry	2.25	
WS06	997	-0.6	-0.6	0.0	0.0	0.9	0.9	20.1	2	0	3.00	4.70	
WS07	997	-0.6	-0.6	0.0	0.0	0.7	0.7	18.7	2	0	1.20	4.75	

Notes

Logged by

JB

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
Merchant Exchange, 17-19 Whitworth Street West, Manchester, M1 5WG
Tel: 0161 236 2394
Fax: 0161 228 7902

GAS MONITORING LOG SHEET

Project:	Swan House, Manchester	**Date:**	31/01/2019
Job Number:	B067266.201	**Visit:**	6
Client:	Foundation Real Estate	**Weather:**	Sunny
Barometric State:	Falling	**Ground Conditions:**	Boreholes located inside

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													1
WS02	983	0.0	0.0	0.0	0.0	5.0	5.0	15.7	0	0	5.31	5.70	
WS03	984	0.0	0.0	0.0	0.0	0.1	0.1	20.9	1	0	2.75	3.12	
WS04	985	0.1	0.0	0.0	0.0	0.3	0.3	20.7	1	0	Dry	3.00	
WS06													1
WS07													1

Notes

1 No access to the basement.

Logged by

RT

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

TEST DATE AND CONDITIONS		
Date	18/12/18	
Atmospheric Pressure	986	mB
Ambient Temperature	22	°C
Environics Serial No.	5089	

GAS DATA LTD
Unit 4, Fairfield Court
Seven Stars Estate
Wheler Rd
Coventry
CV3 4LJ
Tel 02476303311 Fax 02476307711

GFM430 Final Inspection & Calibration Check Certificate

Customer	Curtins Consulting
Certificate Number	120678
Order Number	321234

Serial Number	10357
Software Version	G430-00.0024/0013

Recalibration DUE Date
18/12/19

Instrument Checks					
Keyboard	✓		Display Contrast	✓	
Pump Flow In	400	*Accept > 200 cc/min*	Pump Flow @ -200mB	300	*Accept > 200 cc/min*
Clock Set / Running	✓		Labels Fitted	✓	

Gas Checks						
	CH_4		CO_2		O_2	
	Instrument Gas Readings %	True Gas Value %	Instrument Gas Readings %	True Gas Value %	Instrument Gas Readings %	True Gas Value %
Sensor	59.7	*60*	40.4	*40*	20.9	*20.9*
	Accept ±3.0		*Accept ±3.0*		*Accept ±0.5*	
	5	*5*	5	*5*	6	*6*
	Accept ±0.3		*Accept ±0.3*		*Accept ±0.3*	
Zero Reading 100% N2	0	*0*	0	*0*	0	*0*
	Accept ±0.0		*Accept ±0.0*		*Accept ±0.1*	

Optional Gas Checks						
Applied Gas & Range		Concentration Tested @ (ppm)	Instrument Readings *(ppm)*			
			Zero Reading		Instrument Gas Reading	
Toxic Gas	Range *(ppm)*					
H2S	5000	*1500*	0	*Accept ±0.0*	1500	*Accept ±5.0*
CO	2000	*1000*	0	*Accept ±0.0*	1000	*Accept ±5.0*

Cross Gas Effects									
Applied Gas *(ppm)*		Instrument Readings *(ppm)*							
Toxic Gas	Concentration	Toxic 1:	H2S	Toxic 2:	CO	Toxic 3:			
H2S	*1500*	1500		0					
CO	*1000*	80		1000					

Pressure Checks						
Atmospheric Pressure [AP] *(mB)*				Static Pressure [SP] *(mB)*		
Current Atmospheric Pressure *(mB)*	Instrument Atmospheric Pressure Reading *(mB)*			Applied Pressure *(mB)*	Instrument Pressure *(mB)*	
All Ports	*Open Ports*	986	*Accept ±2.0*	*0.0mB*	N/A	*Accept ±0.0*
AP Port (Internal)	*+800 mB*	800	*Accept ±5.0*	*+50mB*	N/A	*Accept ±2.0*
AP Port (Internal)	*+1200mb*	1200	*Accept ±5.0*	*-100mB*	N/A	*Accept ±2.0*

Flow Checks					
Borehole Flow			Differential Pressure		
Applied Reading *(l/h)*	Instrument Reading *(l/h)*		Applied Pressure *(Pa)*	Instrument Reading *(Pa)*	
-30	-30.1	*Accept ±3.0*	-321	-319	*Accept ±50*
-3	-3	*Accept ±1.0*	-15	-15	*Accept ±6.0*
0	0	*Accept ±0.0*	0	0	*Accept ±0.5*
3	3.1	*Accept ±0.5*	15	16	*Accept ±3.0*
30	29.8	*Accept ±3.0*	320	312	*Accept ±50*
60	59.8	*Accept ±6.0*	964	955	*Accept ±130*
90	90.1	*Accept ±9.0*	1908	1925	*Accept ±250*

Temperature Checks		
Calibration Temperature Applied Temperature °C	Instrument Temperature Reading °C	
-10	-10	*Accept ±2.0*
0	0	*Accept ±1.0*
30	30	*Accept ±1.0*
60	60	*Accept ±1.0*
100	100	*Accept ±1.0*

Technician:	Date Tested:
Jack Rutland	*19/12/18*

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

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

TEST DATE AND CONDITIONS	
Date	18.12.18
Atmospheric Pressure	986 mB
Ambient Temp	22 °C
Environics Serial No.	50891

GAS DATA LTD
Unit 4, Fairfield Court
Seven Stars Estate
Wheler Rd
Coventry
CV3 4LJ
Tel 02476303311 Fax 02476307711

GFM430 -1 OUTWARD INSPECTION & QUALITY CHECK SHEET

INSTRUMENT DETAILS			
SO Number	Instrument Type	Instrument Serial Number + SW Version	Job Number(s)
321234	GFM430	10357 G430-00.0024/0013	120578

Calibration Technician ..... **Date** 18.12.18

Inspection Technician ..... **Date** 19.12.18

INSTRUMENT CHECKS			Pass (P), Fail (F) or not applicable (NA)	INSTRUMENT PACKING LIST		Tick if included
Function Tests	Dust Caps Fitted		P	Instrument		✓
	Keyboard Test (All Keys)		P	Leather Case		X
	Backlight		P	Instrument Strap		✓
	Clock Set / Running		P	AC Battery Charger (UK)		X
	Comms Test		P	AC Battery Charger (EURO)		X
	Pump Flow Test (In & Out)		P	AC Battery Charger (US)		X
	Overall Leak Test (30mB)		n/a	AC Battery Charger (AUS)		X
	Battery Charge Test		P	Hard Carry Case		X
	Service Date set to?		18-12-19	Gas Sample Tube – *(new issue)*		✓
Channel Test	Data Logging Enabled?		P	Flow Sample Tube – *(new issue)*		✓
	Verify CH4/LEL		P	Spares Pot		X
	Verify CO2		P	Allen Key		X
	Verify O2		P	Temperature Probe		X
	Verify LEL		P	Vane Anemometer		X
	Verify 1st Option Gas	H2S	P	USB Cable		X
	Verify 2nd Option Gas	CO	P	USB Memory stick		X
	Verify 3rd Option Gas		N/A	SiteMan Software	Ver 4.15	X
	Verify 4th Option Gas		N/A	Internal Filter Pack	Qty	X
	Verify Atmospheric pressure		P	External Filter Pack	Qty	X
	Verify static pressure		N/A	Field Guide		X
	Verify differential pressure		P	Operation Manual (hard copy)		X
	Verify flow		P	Extra Items:		
	Verify temperature probe input		P	H2S Sample Tube		
	Verify vane anemometer input		P			
DataBase Checks	Jobcard(s) completed and signed		P			
	Jobcard(s) booked off database		P			
	Calibration certificate completed		P			
	Complete & print QI record		n/a	Comments:		
Label Checks	No. of Calibration label fitted		GDC 08508			
	Warranty label fitted					
H2S Range	H2S Range from Sales Order		5000 ppm			
	H2S Range from Cal Cert		5000 ppm			
	Over-range value correct?		P			

Curtins
Merchant Exchange, 17-19 Whitworth Street West, Manchester, M1 5WG
Tel: 0161 236 2394
Fax: 0161 228 7902

GAS MONITORING LOG SHEET

Project:	Swan House Additional GI	**Date:**	05/02/2021
Job Number:	B077409	**Visit:**	1
Client:	RGCM Ltd	**Weather:**	Sunny
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						
BH101A	1001	-0.7	-0.7	0.0	0.0	0.0	0.0	20.9	3	1	14.25	14.48	**1**
BH102	1000	0.0	0.0	0.0	0.0	0.1	0.0	20.8	3	4	24.46	26.79	
BH103	1000										2.80	5.00	**2**

Notes

1 - Steady state air flow rate remained at -0.7 l/hr after 1 minute.
2 - No pathway through gas bung for monitoring to be undertaken. Hole made in bung and replaced prior to visit 2.

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
Merchant Exchange, 17-19 Whitworth Street West, Manchester, M1 5WG
Tel: 0161 236 2394
Fax: 0161 228 7902

GAS MONITORING LOG SHEET

Project:	Swan House Additional GI	**Date:**	11/02/2021
Job Number:	B077409	**Visit:**	2
Client:	RGCM Ltd	**Weather:**	Sunny
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						
BH101A	1020	-1.0	-0.8	0.0	0.0	0.0	0.0	20.9	1	2	14.3	14.40	**1**
BH102	1020	0.0	0.0	0.0	0.0	0.0	0.0	20.8	0	2	24.63	25.67	
BH103	1020	0.0	0.0	2.2	2.2	0.4	0.4	10.9	1	2	3.59	4.94	**2**

Notes

1 - Steady state air flow rate fluctuated between -1.0 l/hr and -0.8 l/hr.
2 - Lower Explosive Limit = 50.7%

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
Merchant Exchange, 17-19 Whitworth Street West, Manchester, M1 5WG
Tel: 0161 236 2394
Fax: 0161 228 7902

GAS MONITORING LOG SHEET

Project:	Swan House Additional GI	**Date:**	18/02/2021
Job Number:	B077409	**Visit:**	3
Client:	RGCM Ltd	**Weather:**	Cloudy
Barometric State:	Rising	**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						
BH101A	992	-1.0	-1.0	0.0	0.0	0.0	0.0	20.9	1	2	14.33	14.33	
BH102	991	0.0	0.0	0.0	0.0	0.6	0.6	20.4	2	2	24.29	25.23	**1**
BH103	991	0.4	0.0	0.9	0.9	0.4	0.4	13.5	2	0	3.34	4.91	**2, 3**

Notes

1 - Water sample obtained from 24.29 - 25.23m bgl.
2 - Water sample obtained from 3.34 - 4.91m bgl. Slight hydrocarbon odour noted in water sample. Slight oily sheen noted in water sample.
3 - Lower Explosive Limit = 50.7%

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
Merchant Exchange, 17-19 Whitworth Street West, Manchester, M1 5WG
Tel: 0161 236 2394
Fax: 0161 228 7902

GAS MONITORING LOG SHEET

Project:	Swan House Additional GI	**Date:**	05/03/2021
Job Number:	B077409	**Visit:**	4
Client:	RGCM Ltd	**Weather:**	Overcast
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						
BH101A													1
BH102	1029	0.0	0.0	0.0	0.0	0.0	0.0	21.8	0	0	24.57	25.65	
BH103	1029	-0.1	-0.1	0.0	0.0	1.2	1.2	0.3	4	0	3.53	4.95	

Notes

1 Inaccessible, covered by a decontamination unit.

Logged by

NF

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

TEST DATE AND CONDITIONS		
Date	10/09/2020	
Atmospheric Pressure	1005	mB
Ambient Temperature	22.3	°C
Environics Serial No.	5089	

GAS DATA LTD
Unit 4, Fairfield Court
Seven Stars Estate
Wheler Rd
Coventry
CV3 4LJ
Tel 02476303311 Fax 02476307711

GFM436 Final Inspection & Calibration Check Certificate

Customer	Shaw City
Certificate Number	121993
Order Number	326664

Serial Number	12099
Software Version	G436-00.0027/0009

Recalibration DUE Date
10/09/21

Instrument Checks					
Keyboard	✓		Display Contrast	✓	
Pump Flow In	400	*Accept > 200 cc/min*	Pump Flow @ -200mB	300	*Accept > 200 cc/min*
Clock Set / Running	✓		Labels Fitted	✓	

Gas Checks						
	CH_4		CO_2		O_2	
	Instrument Gas Readings %	True Gas Value %	Instrument Gas Readings %	True Gas Value %	Instrument Gas Readings %	True Gas Value %
Sensor	59.8 *Accept ±3.0*	*60*	39.7 *Accept ±3.0*	*40*	20.9 *Accept ±0.5*	*20.9*
	5 *Accept ±0.3*	*5*	5 *Accept ±0.3*	*5*	6 *Accept ±0.3*	*6*
Zero Reading 100% N2	0 *Accept ±0.0*	*0*	0 *Accept ±0.0*	*0*	0 *Accept ±0.1*	*0*

Optional Gas Checks						
Applied Gas & Range		Concentration Tested @ (ppm)	Instrument Readings *(ppm)*			
			Zero Reading		Instrument Gas Reading	
Gas Type	Range *(ppm)*					
H2S	5000	*1500*	0	*Accept ±0.0*	1500	*Accept ±5.0*
CO	2000	*1000*	0	*Accept ±0.0*	1000	*Accept ±5.0*
Hexane	*2.0%*	2.0%	0	*Accept ±0.0*	1.99	*Accept ±10.0*

TEST DATE AND CONDITIONS	
Date	10.9.20
Atmospheric Pressure	1005 mB
Ambient Temp	22.3 °C
Environics Serial No.	5089

GAS DATA LTD
Unit 4, Fairfield Court
Seven Stars Estate
Wheler Rd
Coventry
CV3 4LJ
Tel 02476303311 Fax 02476307711

GFM436-1 OUTWARD INSPECTION & QUALITY CHECK SHEET

INSTRUMENT DETAILS			
SO Number	Instrument Type	Instrument Serial Number + SW Version	Job Number(s)
326644	GFM436	R099 G436-2-7/09	12993

Calibration Technician ..... **Date** 10.9.20

Inspection Technician ..... **Date** 11-9-20

INSTRUMENT CHECKS		Pass (P), Fail (F) or not applicable (NA)	INSTRUMENT PACKING LIST		Tick if included
Function Tests	Dust Caps Fitted	P	Instrument		✓
	Keyboard Test (All Keys)	P	Leather Case		X
	Backlight	P	Instrument Strap		✓
	Clock Set / Running	P	AC Battery Charger (UK)		X
	Comms Test	P	AC Battery Charger (EURO)		X
	Pump Flow Test (In & Out)	P	AC Battery Charger (US)		X
	Overall Leak Test (30mB)	n/a	AC Battery Charger (AUS)		X
	Battery Charge Test	P	Gas Sample Pipe - *(new issue)*		X
	Service Date set to?	10.9.21	Flow Sample Pipe - *(new issue)*		X
Channel Tests	Data Logging Enabled?	P	Hard Carry Case		SEE COMMENTS
	Verify CH4/LEL/Hexane/PID	P	Allen Key		X
	Verify CO2	P	Spares Pot		X
	Verify O2	P	Temperature Probe		X
	Verify H2S	P	Vane Anemometer		X
	Verify CO	P	USB Cable		X
	Verify LEL	P	USB Memory stick		X
	Verify 1st Option Gas	N/A	SM V5 Software	Ver 5.05	X
	Verify Atmospheric pressure	P	Internal Filter Pack	Qty	X
	Verify differential pressure	P	External Filter Pack	Qty	X
	Verify flow	P	Field Guide		X
	Verify temperature probe input	P	**Extra Items:**		
	Verify vane anemometer input	P			
DataBase Checks	Jobcard(s) completed and signed	P			
	Jobcard(s) booked off database	P			
	Calibration certificate completed	P			
	Complete & print QI record	n/a			
Label Checks	No. of Calibration label fitted	GDC 08996	**Comments:**		
	MCERTS label displayed	P	IN PELI CASE WITH		
	Warranty label fitted	P	GFM 12101 & 13255		
H2S Range	H2S Range from Sales Order	5000 ppm			
	H2S Range from Cal Cert	5000 ppm			
	Over-range value correct?	P			

Appendix F – GAC Screening Thresholds

- Curtins GAC Tier 1 Thresholds.

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Adopted Soil Generic Assessment Criteria
Sandy loam with 1% SOM

curtins

Contaminants	Residential with home grown produce	Residential without 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 *(elemental)*	**1**	**1**	**26**	**26**	*16*	**26**[8] *[30]*
Mercury (inorganic)	**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*
Tetrachlorethene (PCE)	*0.18*	*0.18*	*0.65*	*19*	*1400*	*810*
1,1,1 Trichlorethane	*8.8*	*9*	*48*	*660*	*140000*	*57000*

Notes

1. All values above are in mg/kg
2. **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
3. Soil organic matter (SOM) is assumed to be 1% - DEFAULT VALUE
4. Soil type is assumed to be sandy loam - DEFAULT SOIL TYPE
5. 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
6. 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
7. For classrooms consider increasing the dust loading fator in the 'Soil and Building Data' of the CLEA 1.04 model from 50 to 100µg m^{-3}
8. Based on vapour saturation limt as suggested by EA / [ ] model value
9. Lowest of o-, m- and p-xylene
10. Based on comparison of inhalation exposure with inhalation TDI
11. Based on comparison of oral, dermal, and inhalation exposure with the oral TDI
12. Based on a comparison of oral and dermal soil exposure with oral Index Dose only
13. Averaged over and based on lifetime exposure
14. 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)
15. NA: Not applicable

Appendix G – Detailed UXO Risk Assessment Report

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1ST LINE DEFENCE



Detailed Unexploded Ordnance (UXO) Risk Assessment

Project Name	Swan Street, Manchester
Client	Curtins
Site Address	Swan Street, Manchester, M4 5JG
Report Reference	DA12456-00
Date	12th February 2021
Originator	LG

1st Line Defence Ltd
Unit 3, Maple Park, Essex Road, Hoddesdon, Herts. EN11 0EX
Tel: +44 (0)1992 245 020 info@1stlinedefence.co.uk

Executive Summary

Site Location and Description

The site is located with the Northern Quarter of Manchester City Centre. Recent aerial photography dated 2019 shows the site is bound to the north-west by *Rochdale Road*, to the north-east by *Cable Street,* to the south-east by *Mason Street*, to the south and south-west by commercial properties situated on *Swan Street*.

A recent aerial photograph dated May 2019 shows the site to comprise an L-shaped, two-storey warehouse structure bound by the adjacent roadways of *Rochdale Road*, *Cable Street* and *Mason Street*.

The site is approximately centred on the OS grid reference: **SJ 84503 98863.**

Proposed Works

The exact extent and nature of the proposed works on site was available at the time of writing this report although initial intrusive works are understood to include three boreholes to 40.00m bgl.

Geology and Bomb Penetration Depth

The British Geological Survey (BGS) map shows Chester Formation - Sandstone. Sedimentary Bedrock formed approximately 247 to 250 million years ago in the Triassic Period.

Site specific geotechnical information was not available to 1st Line Defence at the time of the production of this report. An assessment of maximum bomb penetration depth can be made once such data becomes available, or by a UXO specialist during on-site support.

It should be noted that the maximum depth that a bomb could reach may vary across a site and will be largely dependent on the specific underlying geological strata and its density.

UXO Risk Assessment

1st Line Defence has assessed that there is a **Low Risk** from items of German aerial delivered and anti-aircraft UXO and a **Negligible Risk** of Allied UXO across the site. This assessment is based on the following factors:

Risk of German aerial delivered UXO:

- During WWII, the site was located within the County Borough of Manchester which was subject to an overall low density of bombing, with an average of 29.0 bombs per1000 acres according to official Home Office Bombing Statistics. Manchester was however still subject to a number of significant Luftwaffe raids, most notably the 'Christmas Blitz' of December 1940.
- Consulted historical records do not record any bomb incidents on site or in the immediate vicinity of the site boundary. The closest bombing incident recorded on the Manchester bomb damage map was a 'fire bomb' strike plotted approximately 70m north-east of the site in the vicinity of *Addington Street*.
- This is corroborated by the Manchester Emergency Committee's Log Book of Bombing Incidents 22-24 December 1940 within Graham Pythian's *Blitz Britain: Manchester and Salford,* which records no specific references to bombing incidents within or in the immediate vicinity of the site location, the nearest recorded incident being 100m to the south-east.
- During this period, the site was occupied by a large 'L-shaped' warehouse building that appears to have retained the same composition to today. It was bordered by a row of terraced residential properties to the south and by roadways in all other directions.
- The Manchester bomb damage map records no bomb damage to this structure on site. The outline of one terraced structure adjacent to the southern extent of the site boundary is highlighted in red indicating that the structure sustained some bomb damage. However, as this is not represented in the damage key and the structure appears structurally intact in the post-WWII era, the recorded damage is anticipated to have been minor in nature.

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UXO Risk Assessment

- Several structures further to the north, east, south-east and west of the site are shown to have been demolished, but all were situated on the opposite side of roadways. The closest was situated approximately 10m south-east of the site on the opposite side of *Mason Street*, although no corresponding bombing incident is evident.
- Post-WWII era aerial photography largely corroborates the evidence presented within the Manchester bomb damage map, indicating that the structures within and in immediate proximity to the site appear to remain intact following WWII. The photography also reveals obvious areas of clearance across the wider area, the closest of which is shown to be on the opposite side of *Mason Street* and *Cable Street*, approximately 10m south-east and 10m north-east of the site respectively. However, none of these areas appear to have had any significant impact on the condition or usage of the site footprint. Given this, their distance and the fact that the site was separated by sections of roadway, these surrounding areas of clearance are not anticipated to significantly elevate the risk of UXO contamination on site.
- Owing to the fact that the structures occupying and immediately adjacent to the site, appear to have survived the war intact, it is anticipated that the ground cover within and in close proximity of the site would have been conducive to evidence of UXO. Furthermore, the adjacent roadways comprising hardstanding ground would have also been favourable to spotting indications of UXO, such as craters or entry holes.
- Due to the fact that the site comprised a warehouse structure adjacent to several main roads and in close proximity to the *Smithfield Market* within the northern quarter of Manchester city centre, the site and surrounding area are anticipated to have been subject to a good level of monitor and frequent access throughout WWII.

Risk of Allied UXO:

- There is no evidence that the site formerly had any military occupation or usage that could have led to contamination with items of Allied ordnance, such as LSA and SAA. The conditions in which HAA or LAA projectiles may have fallen unnoticed within the site boundary are however to those regarding aerial delivered ordnance.

Post-war development:

- Recent aerial photography dated May 2019 indicates that post-war redevelopment of the site has been limited. The structures currently occupying the site resemble those present in the immediate post-WWII era and in OS mapping from 1966 - 1969.
- The risk of UXO remaining is considered to be mitigated at the location of and down to the depth of any post-war redevelopment on site. Within the footprints of post-WWII redevelopments, the risk from shallow-buried UXO (especially 1kg German incendiaries and British AA projectiles) should have been encountered/removed during initial excavations. However, the risk from deep-buried German UXBs will only have been mitigated within the volumes of any post-war pile foundations or deep excavations for basement levels. The risk will remain within virgin geology below and amongst these post-war works, down to the maximum bomb penetration depth.

Recommended Risk Mitigation Measures

The following risk mitigation measures are recommended to support the proposed works at the Swan Street, Manchester:

All Works

- UXO Risk Management Plan
- Site Specific UXO Awareness Briefings to all personnel conducting intrusive works.

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Glossary

Abbreviation	Definition
AA	Anti-Aircraft
AFS	Auxiliary Fire Service
AP	Anti-Personnel
ARP	Air Raid Precautions
DA	Delay-action
EOC	Explosive Ordnance Clearance
EOD	Explosive Ordnance Disposal
FP	Fire Pot
GM	G Mine (Parachute mine)
HAA	Heavy Anti-Aircraft
HE	High Explosive
IB	Incendiary Bomb
JSEODOC	Joint Services Explosive Ordnance Disposal Operation Centre
LAA	Light Anti-Aircraft
LCC	London County Council
LRRB	Long Range Rocket Bomb (V-2)
LSA	Land Service Ammunition
NFF	National Filling Factory
OB	Oil Bomb
PAC	Pilotless Aircraft (V-1)
PB	Phosphorous Bomb
PM	Parachute Mine
POW	Prisoner Of War
RAF	Royal Air Force
RCAF	Royal Canadian Air Force
RFC	Royal Flying Corps
RNAS	Royal Naval Air Service
ROF	Royal Ordnance Factory
SA	Small Arms
SAA	Small Arms Ammunition
SD2	Anti-personnel “Butterfly Bomb”
SIP	Self-Igniting Phosphorous
U/C	Unclassified bomb
UP	Unrotated Projectile (rocket)
USAAF	United States Army Air Force
UX	Unexploded
UXAA	Unexploded Anti-Aircraft
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
V-1	Flying Bomb (Doodlebug)
V-2	Long Range Rocket
WAAF	Women’s Auxiliary Air Force
X	Exploded

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Detailed Unexploded Ordnance (UXO) Risk Assessment

Site: Swan Street, Manchester
Client: Curtins

1. Introduction

1.1. Background

1st Line Defence has been commissioned by Curtins to conduct a Detailed Unexploded Ordnance (UXO) Risk Assessment for the works proposed at the Swan Street site in Manchester.

Buried UXO can present a significant risk to construction works and development projects. The discovery of a suspect device during works can cause considerable disruption to operations as well as cause unwanted delays and expense.

UXO in the UK can originate from three principal sources:

1. Munitions resulting from wartime activities including German bombing in WWI and WWII, long range shelling, and defensive activities.
2. Munitions deposited as a result of military training and exercises.
3. Munitions lost, burnt, buried or otherwise discarded either deliberately, accidentally, or ineffectively.

This report will assess the potential factors that may contribute to the risk of UXO contamination. If an elevated risk is identified at the site, this report will recommend appropriate mitigation measures, in order to reduce the risk to as low as is reasonably practicable. Detailed analysis and evidence will be provided to ensure an understanding of the basis for the assessed risk level and any recommendations.

This report complies with the guidelines outlined in *CIRIA C681*, 'Unexploded Ordnance (UXO) A Guide for the Construction Industry.'

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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 Swan Street, Manchester. The report will also recommend appropriate site and work-specific risk mitigation measures to reduce the risk from explosive ordnance during the envisaged works to a level that is as low as reasonably practicable.

2.2. Risk Assessment Process

1st Line Defence has undertaken a five-step process for assessing the risk of UXO contamination:

1. The likelihood that the site was contaminated with UXO.
2. The likelihood that UXO remains on the site.
3. The likelihood that UXO may be encountered during the proposed works.
4. The likelihood that UXO may be initiated.
5. The consequences of initiating or encountering UXO.

In order to address the above, 1st Line Defence has taken into consideration the following factors:

- Evidence of WWI and WWII German aerial delivered bombing as well as the legacy of Allied occupation.
- The nature and conditions of the site during WWII.
- The extent of post-war development and UXO clearance operations on site.
- The scope and nature of the proposed works and the maximum assessed bomb penetration depth.
- The nature of ordnance that may have contaminated the proposed site area.

2.3. Sources of Information

Every reasonable effort has been made to ensure that relevant evidence has been consulted and presented in order to produce a thorough and comprehensible report for the client. To achieve this the following, which includes military records and archive material held in the public domain, have been accessed:

- The National Archives and Manchester Archives and Local Studies.
- Historical mapping datasets.
- Historic England National Monuments Record.
- Relevant information supplied by Curtins.
- Available material from 33 Engineer Regiment (EOD) Archive (now 28 Regt).
- 1st Line Defence's extensive historical archives, library and UXO geo-datasets.
- Open sources such as published books and internet resources.

Research involved a visit to The National Archives and Manchester Archives and Local Studies.

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3. Background to Bombing Records

3.1. General Considerations of Historical Research

This desktop assessment is based largely upon analysis of historical evidence. Every reasonable effort has been made to locate and present significant and pertinent information. 1st Line Defence cannot be held accountable for any changes to the assessed risk level or risk mitigation measures, based on documentation or other data that may come to light at a later date, or which was not available to 1st Line Defence during the production of this report.

It is often problematic and sometimes impossible to verify the completeness and accuracy of WWII-era records. As a consequence, conclusions as to the exact location and nature of a UXO risk can rarely be quantified and are, to a degree, subjective. To counter this, a range of sources have been consulted, presented and analysed. The same methodology is applied to each report during the risk assessment process. 1st Line Defence cannot be held responsible for any inaccuracies or the incompleteness in available historical information.

3.2. German Bombing Records

During WWII, bombing records were generally gathered locally by the police, Air Raid Precaution (ARP) wardens and military personnel. These records typically contained information such as the date, the location, the amount of damage caused and the types of bombs that had fallen during an air raid. This information was made either through direct observation or post-raid surveys. The Ministry of Home Security Bomb Census Organisation would then receive this information, which was plotted onto maps, charts, and tracing sheets by regional technical officers. The collective record set (regional bomb census mapping and locally gathered incidents records) would then be processed and summarised into reports by the Ministry of Home Security Research and Experiments Branch. The latter were tasked with providing the government 'a complete picture of air raid patterns, types of weapons used and damage caused- in particular to strategic services and installations such as railways, shipyards, factories and public utilities.'[1]

The quality, detail and nature of record keeping could vary considerably between provincial towns, boroughs and cities. No two areas identically collated or recorded data. While some local authorities maintained records with a methodical approach, sources in certain areas can be considerably more vague, dispersed, and narrower in scope. In addition, the immediate priority was mostly focused on assisting casualties and minimising damage at the time. As a result, some records can be incomplete and contradictory. Furthermore, many records were even damaged or destroyed in subsequent air raids. Records of raids that took place on sparsely or uninhabited areas were often based upon third party or hearsay information and are therefore not always reliable. Whereas records of attacks on military or strategic targets were often maintained separately and have not always survived.

3.3. Allied Records

During WWII, considerable areas of land were requisitioned by the War Office for the purpose of defence, training, munitions production and the construction of airfields. Records relating to military features vary and some may remain censored. Within urban environments datasets will be consulted detailing the location of munition production as well as wartime air and land defences. In rural locations it may be possible to obtain plans of military establishments, such as airfields, as well as training logs, record books, plans and personal memoirs. As with bombing records, every reasonable effort will be made to access records of, and ascertain any evidence of, military land use. However, there are occasions where such evidence is not available, as records may not be accessible, have been lost/destroyed, or simply were not kept in the first place.

[1] http://www.nationalarchives.gov.uk/help-with-your-research/research-guides/bomb-census-survey-records-1940-1945/.

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4. UK Regulatory Environment and Guidelines

4.1. General

There is no formal obligation requiring a UXO risk assessment to be undertaken for construction projects in the UK, nor is there any specific legislation stipulating the management or mitigation of UXO risk. However, it is implicit in the legislation outlined below that those responsible for intrusive works (archaeology, site investigation, drilling, piling, excavation etc.) should undertake a comprehensive and robust assessment of the potential risks to employees and that mitigation measures are implemented to address any identified hazards.

4.2. CDM Regulations 2015

The Construction (Design and Management) Regulations 2015 (CDM 2015) define the responsibilities of parties involved in the construction of temporary or permanent structures.

The CDM 2015 establishes a duty of care extending from clients, principle co-ordinators, designers, and contractors to those working on, or affected by, a project. Those responsible for construction projects may therefore be accountable for the personal or proprietary loss of third parties, if correct health and safety procedure has not been applied.

Although the CDM does not specifically reference UXO, the risk presented by such items is both within the scope and purpose of the legislation. It is therefore implied that there is an obligation for parties to:

- Provide an appropriate assessment of potential UXO risks at the site (or ensure such an assessment is completed by others).
- Put in place appropriate risk mitigation measures if necessary.
- Supply all parties with information relevant to the risks presented by the project.
- Ensure the preparation of a suitably robust emergency response plan.

4.3. The 1974 Health and Safety at Work etc. Act

All employers have a responsibility under the Health and Safety at Work etc. Act 1974 and the Management of Health and Safety at Work Regulations 1999, to ensure the health and safety of their employees and third parties, so far as is reasonably practicable and conduct suitable and sufficient risk assessments.

4.4. CIRIA C681

In 2009, the Construction Industry Research and Information Association (CIRIA) produced a guide to the risk posed by UXO to the UK construction industry (CIRIA C681). CIRIA is a neutral, independent and not-for-profit body, linking organisations with common interests and facilitating a range of collaborative activities that help improve the industry.

The publication provides the UK construction industry with a defined process for the management of risks associated with UXO from WWI and WWII aerial bombardment. It is also broadly applicable to the risks from other forms of UXO that might be encountered. It focuses on construction professionals' needs, particularly if there is a suspected item of UXO on site, and covers issues such as what to expect from a UXO specialist. The guidance also helps clients to fulfil their legal duty under CDM 2015 to provide designers and contractors with project specific health and safety information needed to identify hazards and risks associated with the design and construction work. This report conforms to this CIRIA guidance and to the various recommendations for good practice referenced therein. It is

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recommended that this document is acquired and studied where possible to allow a better understanding of the background to both the risk assessment process and the UXO issue in the UK in general.

4.5. Additional Legislation

In the event of a casualty resulting from the failure of an employer/client to address the risks relating to UXO, the organisation may be criminally liable under the Corporate Manslaughter and Corporate Homicide Act 2007.

5. The Role of Commercial UXO Contractors and The Authorities

5.1. Commercial UXO Specialists

The role of a UXO Specialist (often referred to as UXO Consultant or UXO Contractor) such as 1st Line Defence, is defined in CIRIA C681 as the provision of expert knowledge and guidance to the client on the most appropriate and cost-effective approach to UXO risk management at a site.

The principal role of UXO Specialists is to provide the client with an appropriate assessment of the risk posed by UXO for a specific project, and identify and carry out suitable methodology for the mitigation of any identified risks to reduce them to an acceptable level.

The requirement for a UXO Specialist should ideally be identified in the initial stages of a project, and it is recommended that this occur prior to the start of any detailed design. This will enable the client to budget for expenditure that may be required to address the risks from UXO, and may enable the project team to identify appropriate techniques to eliminate or reduce potential risks through considered design, without the need for UXO specific mitigation measures. The UXO Specialist should have suitable qualifications, levels of competency and insurances.

Please note 1st Line Defence has the capability to provide a complete range of required UXO risk mitigation services, in order to reduce a risk to as low as reasonably practicable. This can involve the provision of both ground investigation, and where appropriate, UXO clearance services.

5.2. The Authorities

The police have a responsibility to co-ordinate the emergency services in the event of an ordnance-related incident at a construction site. Upon inspection they may impose a safety cordon, order an evacuation, and call the military authorities Joint Services Explosive Ordnance Disposal Operation Centre (JSEODOC) to arrange for investigation and/or disposal. Within the Metropolitan Police Operational Area, SO15 EOD will be tasked to any discovery of suspected UXO. The request for Explosive Officer (Expo) support is well understood and practiced by all Metropolitan Boroughs. The requirement for any additional assets will then be coordinated by the Expo if required.

In the absence of a UXO specialist, police officers will usually employ such precautionary safety measures, thereby causing works to cease, and possibly requiring the evacuation of neighbouring businesses and properties.

The priority given to the police request will depend on the EOD teams judgement of the nature of the UXO risk, the location, people and assets at risk, as well as the availability of resources. The speed of response varies; authorities may respond immediately or in some cases it may take several days for the item of ordnance to be dealt with. Depending on the on-site risk assessment the item of ordnance may be removed from the site and/or destroyed by a controlled explosion.

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Following the removal of an item of UXO, the military authorities will only undertake further investigations or clearances in high-risk situations. If there are regular UXO finds on a site the JSEODOC may not treat each occurrence as an emergency and will recommend the construction company puts in place alternative procedures, such as the appointment of a commercial contractor to manage the situation.

6. The Site

6.1. Site Location

The site is located with the Northern Quarter of Manchester City Centre. Recent aerial photography dated 2019 shows the site is bound to the north-west by *Rochdale Road*, to the north-east by *Cable Street,* to the south-east by *Mason Street*, to the south and south-west by commercial properties situated on *Swan Street*.

The site is approximately centred on the OS grid reference: **SJ 84503 98863**.

Site location maps are presented in **Annex A**.

6.2. Site Description

A recent aerial photograph dated May 2019 shows the site to comprise an L-shaped, two-storey warehouse structure bound by the adjacent roadways of *Rochdale Road*, *Cable Street* and *Mason Street*.

A recent aerial photograph and site plan are presented in **Annex B** and **Annex C** respectively.

7. Scope of the Proposed Works

7.1. General

The exact extent and nature of the proposed works on site was available at the time of writing this report although initial intrusive works are understood to include three boreholes to 40.00m bgl.

8. Ground Conditions

8.1. General Geology

The British Geological Survey (BGS) map shows Chester Formation - Sandstone. Sedimentary Bedrock of the Triassic Period. The superficial deposits are formed by Til, Devensian – Diamicton of the Quaternary Period.

8.2. Site Specific Geology

Site-specific geotechnical data was not available during the production of this report. While the British Geological Survey (BGS) source provides a historical borehole database, none of these logs were located either on or in the immediate vicinity of the site.

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9. Site History

9.1. Introduction

The purpose of this section is to identify the composition of the site pre and post-WWII. It is important to establish the historical use of the site, as this may indicate the site's relation to potential sources of UXO as well as help with determining factors such as the land use, groundcover, likely frequency of access and signs of bomb damage.

9.2. Ordnance Survey Historical Maps

Relevant historical maps were obtained for this report and are presented in **Annex D.** See below for a summary of the site history shown on acquired mapping.

Pre-WWII		
Date	**Scale**	**Description**
1908	1:2,500	This OS map edition shows the site comprises a number of different sized structures within the northern, eastern and southern sections of the site. A *Public House* can be seen occupying the north-west sector, adjacent to *Rochdale Road*. A row of terraced commercial and residential structures can be seen bordering the south-western extent of the site boundary. A *Tramway* can be seen running along *Rochdale Road* and *Swan Street*. *Smithfield Market,* a *Wholesale Fish Market* and a *Clothes Market* are presented further south and south-east of the site. The wider vicinity as a whole was entirely developed through a large number of blocks built around a network of roadways.
1922 - 1932	1:2,500	This OS map edition corroborates the structural outlay of the site presented within 1908 OS mapping. The closest development that can be discerned in the vicinity, occurs approximately 15m north and north-east of the site, on the opposite side of *Cable Street*, in which several small structures have been cleared and redeveloped into two large commercial-style structures. Similar examples of structural clearance and consolidation were observable throughout the wider vicinity.

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Post-WWII		
Date	**Scale**	**Description**
1951 - 1952	1:2,500	This OS map edition shows the site and surrounding vicinity to have undergone significant re-development since the pre-war era. Either an area of hard standing ground, or an unspecified structure occupies the approximate footprint of the site. Further to the north and west of the site, several *Ruins* and areas of clearance can be discerned. To the east of the site, several notable changes have occurred, in which clusters of smaller structures have either been cleared completely or re-developed into larger warehouse-style structures. Notably, a *Ruin* and an area of clearance can be seen on the opposite side of *Mason Street* approximately 10m south-east of the site boundary. The area south of the site appears to remain relatively unchanged in the post-war era, *Smithfield Market* and several other adjacent market structures can be seen beyond *Swan Street.*
1966 - 1969	1:1,250	This OS map edition shows the site to comprise a single *Warehouse* structure in the approximate footprint of the site boundary. To the immediate south of the site several terraced structures have been cleared and redeveloped into a single *Bank* structure. Further to the north, east and west of the site, several areas formerly occupied by cleared ground now comprise *Warehouse* or *Works* structures. No notable major changes have occurred further to the south of the site.

9.3. Pre-WWII Photography of the Site

Pre-WWII aerial photography has been obtained from the Aerofilms collection available from *Britain From Above*. This imagery provides a view of the site in 1937 (see **Annex E**). See below for a description:

Title of Photograph	**Comments**
Shudehill and environs, Manchester, 1937	This pre-war oblique aerial photograph from 1937 is of poor quality but appears to show the area in the approximate footprint of the site is in the process of being developed into a single warehouse-style structure. Scaffolding can be seen around the site in the foreground along *Rochdale Road*, whereas saw-style roofing can be seen to cover the area of the site beyond this, adjacent to *Cable Street* and *Mason Street*. The wider vicinity is shown to be heavily urbanised, with what appear to be several large, multi-storey residential-style structures to the north, east and west of the site. The distinctive saw-roof of *Smithfield Market* and surrounding environs can be seen to the south of the site beyond *Swan Street*.

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9.4. City of Manchester Plan 1945

This historical plan of the central Manchester area in 1945 was obtained from the *University of Manchester*. The plan presents the structural outlay of the site and surrounding area in the immediate post-war era, as well as displaying the era in which the buildings were constructed (see **Annex F**). See below for a description:

Title of Historical Plan	Comments
City of Manchester Plan 1945	This historical plan of the central Manchester area shows the site to comprise a single structure that was constructed after 1932. Structures adjacent to the south-western extent of the site boundary that were constructed before 1850, are also shown to still be present. Several areas within close proximity and across the wider area to the north, east and west of the site are notably void of any structures. The closest of which can be seen approximately 10m south-east of the site on the opposite side of *Mason Street* and approximately 10m north-east on the opposite side of *Cable Street*.

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10. Introduction to German Aerial Delivered Ordnance

10.1. General

During WWI and WWII, the UK was subjected to bombing which often resulted in extensive damage to city centres, docks, rail infrastructure and industrial areas. The poor accuracy of WWII targeting technology and the nature of bombing techniques often resulted in neighbouring areas to targets sustaining collateral damage.

In addition to raids which concentrated on specific targets, indiscriminate bombing of large areas also took place. This occurred most prominently in the London 'Blitz', though affected many other towns and cities. As discussed in the following sections, a proportion of the bombs dropped on the UK did not detonate as designed. Although extensive efforts were made to locate and deal with these UXBs at the time, many still remain buried and can present a potential risk to construction projects.

The main focus of research for this section of the report will concern German aerial delivered ordnance dropped during WWII, although WWI bombing will also be considered.

10.2. Generic Types of WWII German Aerial Delivered Ordnance

To provide an informed assessment of the hazards posed by any items of unexploded ordnance that may remain in situ on site, the table below provides information on the types of German aerial delivered ordnance most commonly used by the Luftwaffe during WWII. Images and brief summaries of the characteristics of these items of ordnance are listed in **Annex G**.

Generic Types of WWII German Aerial Delivered Ordnance		
Type	**Frequency**	**Likelihood of detection**
High Explosive (HE) bombs	In terms of weight of ordnance dropped, HE bombs were the most frequently deployed by the Luftwaffe during WWII.	Although efforts were made to identify the presence of unexploded ordnance following an air raid, often the damage and destruction caused by detonated bombs made observation of UXB entry holes impossible. The entry hole of an unexploded bomb can be as little as 20cm in diameter and was easily overlooked in certain ground conditions (see **Annex H**). Furthermore, ARP documents describe the danger of assuming that damage, actually caused by a large UXB, was due to an exploded smaller bomb. UXBs therefore present the greatest risk to present–day intrusive works.
1kg Incendiary bombs (IB)	In terms of the number of weapons dropped, small IBs were the most numerous. Millions of these were dropped throughout WWII.	IBs had very limited penetration capability and in urban areas would often have been located in post-raid surveys. If they failed to initiate and fell in water, on soft vegetated ground, or bombed rubble, they could easily go unnoticed.
Large Incendiary bombs (IB)	These were not as common as the 1kg IBs, although they were more frequently deployed than PMs and AP bomblets.	If large IBs did penetrate the ground, complete combustion did not always occur and in such cases they could remain a risk to intrusive works.
Aerial or Parachute mines (PM)	These were deployed less frequently than HE and IBs due to size, cost and the difficulty of deployment.	If functioning correctly, PMs would generally have had a slow rate of descent and were very unlikely to have penetrated the ground. Where the parachute failed, mines would have simply shattered on impact if the main charge failed to explode. There have been extreme cases when these items have been found unexploded. However, in these scenarios, the ground was either extremely soft or the munition fell into water.
Anti-personnel (AP) bomblets	These were not commonly used and are generally considered to pose a low risk to most works in the UK.	SD2 bomblets were packed into containers holding between 6 and 108 submunitions. They had little ground penetration ability and should have been located by the post-raid survey unless they fell into water, dense vegetation or bomb rubble.

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10.3. Failure Rate of German Aerial Delivered Ordnance

It has been estimated that 10% of WWII German aerial delivered HE bombs failed to explode as designed. Reasons for why such weapons might have failed to function as designed include:

- Malfunction of the fuze or gain mechanism (manufacturing fault, sabotage by forced labour or faulty installation).
- Many were fitted with a clockwork mechanism that could become immobilised on impact.
- Failure of the bomber aircraft to arm the bombs due to human error or an equipment defect.
- Jettisoning the bomb before it was armed or from a very low altitude. This most likely occurred if the bomber aircraft was under attack or crashing.

From 1940 to 1945, bomb disposal teams reportedly dealt with a total of 50,000 explosive items of 50kg, over 7,000 anti-aircraft projectiles and 300,000 beach mines. Unexploded ordnance is still regularly encountered across the UK, see press articles in **Annex I**.

10.4. UXB Ground Penetration

An important consideration when assessing the risk from a UXB is the likely maximum depth of burial. There are several factors which determine the depth that an unexploded bomb will penetrate:

- Mass and shape of bomb.
- Height of release.
- Velocity and angle of bomb.
- Nature of the ground cover.
- Underlying geology.

Geology is perhaps the most important variable. If the ground is soft, there is a greater potential of deeper penetration. For example, peat and alluvium are easier to penetrate than gravel and sand, whereas layers of hard strata will significantly retard and may stop the trajectory of a UXB.

10.4.1. The J-Curve Effect Principle

J-curve is the term used to describe the characteristic curve commonly followed by an aerial delivered bomb dropped from height after it penetrates the ground. Typically, as the bomb is slowed by its passage through underlying soils, its trajectory curves towards the surface. Many UXBs are found with their nose cone pointing upwards as a result of this effect. More importantly, however, is the resulting horizontal offset from the point of entry. This is typically a distance of about one third of the bomb's penetration depth, but can be higher in certain conditions (see **Annex H**).

10.4.2. WWII UXB Ground Penetration Studies

During WWII the Ministry of Home Security undertook a major study on actual bomb penetration depths, carrying out statistical analysis on the measured depths of 1,328 bombs as reported by bomb disposal (BD) teams. Conclusions were drawn predicting the likely average and maximum depths of penetration of different sized bombs in different geological strata.

For example, the largest common German bomb (500kg) had a likely concluded penetration depth of 6m in sand or gravel but 11m in clay. The maximum observed depth for a 500kg bomb was 11.4m and for a 1,000kg bomb 12.8m. Theoretical calculations suggested that significantly greater penetration depths were probable.

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10.4.3. Site Specific Bomb Penetration Considerations

When considering an assessment of the bomb penetration at the site of proposed works the following parameters have been used:

- WWII geology – Chester Formation - Sandstone. Sedimentary Bedrock.
- 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 geotechnical information currently available. An assessment can be made once further information becomes available or by an UXO Specialist on-site.

10.5. V-Weapons

Hitler's 'V-weapon' campaign began from mid-1944. It used newly developed unmanned cruise missiles and rockets. The V-1, known as the *flying bomb* or *pilotless aircraft*, and the V-2, a long range rocket, were launched from bases in Germany and occupied Europe. A total of 9,251 V-1s and 1,115 V-2s were recorded in the United Kingdom.

Although these weapons caused considerable damage, their range was limited by their position of deployment across Europe and as a result the vast majority of V-weapon strikes were directed against targets in the south-east of England, predominantly in the London Boroughs and Home Counties. This limitation of capability meant targets in Manchester were generally too far to be considered for V-weapon strikes by the Luftwaffe.

The risk from V-weapons is therefore considered negligible and will not be further addressed in this report.

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11. The Likelihood of Contamination from German Aerial Delivered UXBs

11.1. World War I

During WWI Britain was targeted and bombed by Zeppelin Airships, as well as Gotha and Giant fixed-wing aircraft. A WWI map of air raids and naval bombardments across England is presented in **Annex J**. This source does not record any WWI bombing incidents to have affected Manchester.

WWI bombs were generally smaller and dropped from a lower altitude than those used in WWII. This resulted in limited UXB penetration depths. Aerial bombing was often such a novelty at the time that it attracted public interest and even spectators to watch the raids in progress. For these reasons there is a limited risk that UXBs passed undiscovered in the urban environment. When combined with the relative infrequency of attacks and an overall low bombing density, the risk from WWI UXBs is considered low and will not be further addressed in this report.

11.2. World War II Bombing of the County Borough of Manchester

The Luftwaffe's main objective for the attacks on Britain was to inhibit the country's economic and military capability. To achieve this they targeted airfields, depots, docks, warehouses, wharves, railway lines, factories, and power stations. As the war progressed the Luftwaffe bombing campaign expanded to include the indiscriminate bombing of civilian areas in an attempt to subvert public morale.

During WWII the site was located within the County Borough of Manchester, which sustained an overall low density of bombing, as represented by bomb density data figures presented in section 11.3.

Manchester was not targeted with the same intensity and frequency as other major British cities such as Liverpool, Coventry, and Birmingham, however it was still subject to several major raids in the years 1940-1941. These raids tended to be focused on the Salford and Stretford areas of Greater Manchester, where the majority of the dock and industrial facilities were located. As a result, the centre of Manchester, including the northern quarter, in which the site was located, is not depicted in the Luftwaffe target imagery shown in **Annex K**. Whilst the site and surrounding area was not specifically targeted, it is likely that the area was subject to 'tip and run' raids whereby bombers dropped any remaining ordnance over areas adjacent to targets before attempting a return flight to continental Europe.

Records of bombing incidents in the civilian areas of the County Borough of Manchester were typically collected by Air Raid Precautions wardens and collated by Civil Defence personnel. Some other organisations, such as port and railway authorities, maintained separate records. Records would be in the form of typed or hand written incident notes, maps and statistics. Bombing data was carefully analysed, not only due to the requirement to identify those parts of the country most needing assistance, but also in an attempt to find patterns in the Germans' bombing strategy in order to predict where future raids might take place.

Records of bombing incidents are presented in the following sections.

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11.3. WWII Home Office Bombing Statistics

The following table summarises the quantity of German aerial delivered bombs (excluding 1kg incendiaries and anti-personnel bombs) dropped on the County Borough of Manchester between 1940 and 1945.

Record of German Ordnance Dropped on the County Borough of Manchester		
Area Acreage		**27,255**
Weapons	High Explosive bombs (all types)	712
	Parachute mines	18
	Oil bombs	7
	Phosphorus bombs	0
	Fire pots	0
	Pilotless aircraft (V-1)	1
	Long range rocket bombs (V-2)	0
Total		**738**
Number of Items per 1,000 acres		**27.1**

Source: Home Office Statistics
This table does not include UXO found during or after WWII.

Detailed records of the quantity and locations of the 1kg incendiary and anti-personnel bombs were not routinely maintained by the authorities as they were frequently too numerous to record. Although the risk relating to IBs is lesser than that relating to larger HE bombs, they were similarly designed to inflict damage and injury. Anti-personnel bombs were used in much smaller quantities and are rarely found today but are potentially more dangerous. Although Home Office statistics did not record these types of ordnance, both should not be overlooked when assessing the general risk to personnel and equipment.

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11.4. Manchester Bomb Damage Map

A bomb census map compiled by Manchester City Council showing high explosive (HE) and incendiary bomb strikes as well as recorded damage and demolished structures within the borough was obtained from Manchester University Library. The section showing the area of the site is presented in **Annex L**.

Manchester Bomb Damage Map – Annex L	
Date Range	**Comments**
22nd – 24th December 1940	This map, which only shows bombing incidents and damage from the largest air raids on Manchester in late December 1940, does not display any bombing or damage within the site location. The closest bombing incident recorded was a 'fire bomb' strike plotted approximately 70m north-east of the site in the vicinity of *Addington Street*. The outline of one terraced structure adjacent to the southern extent of the site boundary, on Swan Street, is highlighted in red indicating that the structure sustained some bomb damage. However, as this is not represented in the damage key, this is anticipated to have been minor in nature. Several structures further to the north, east, south-east and west of the site are shown to have been demolished, the closest of which was situated approximately 10m south-east of the site on the opposite side of *Mason Street*, although no corresponding bombing incident is evident.

11.5. Manchester Emergency Committee Log Book of Bombing Incidents

The published source *Blitz Britain: Manchester and Salford* by Graham Phythian was obtained and consulted in regards to the site and surrounding area. This publication contains a transcription of ARP incident records for Manchester, taken from the Manchester Emergency Committee's Log of Bombing Incidents. This record set also only covers the raid known as the 'Manchester Blitz' on the 22nd and 23rd December 1940. Only two incidents are recorded at a location close to the site, which are transcribed in the table below. Example imagery of these entries are presented in **Annex M**.

Manchester Emergency Committee Log Book of Bombing Incidents – Annex M		
Date	**Bomb Type**	**Comments**
8:20pm 22nd December 1940	Incendiary	Smithfield Market Shower of incendiary bombs in the vicinity of Smithfield Market at 8:20p.m. 22nd. Damage was caused to the roof and various stalls and offices in the Wholesale and Retailed Fish and Produce Markets. Several premises in **Swan St** were extensively damaged by fire. Fires were extinguished by the fire brigade, and the incidents were later closed.
8:20pm 22nd December 1940	Incendiary	**Swan St**, Between Oak St & Tib St Incendiary Bomb approx. 9:00p.m. 22nd. Serious damage caused to 19 – 19a – 23 & 21 **Swan St**, by fire. Incident now closed. 12:10pm 23rd. **Approximately 100m south-east of the site.**

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11.6. Manchester Bomb Damage Cards

Bomb damage cards compiled by Manchester City Council during WWII were consulted at the Manchester Central Library. These reports recorded information such as the date, location, type and damage caused by major bomb incidents in Manchester. Whilst these records were consulted, no reference could be found to damage sustained on site or to any structures in the immediate proximity of the site. The two nearest incidents entries are transcribed in the table below and presented in **Annex N**.

Manchester Bomb Damage Cards – Annex N			
Date	**Bomb Type**	**Location**	**Extent of Damage**
Unknown Date	(detonated) S.C. (Sprengbombe Cylindrisch / High-Explosive bomb)	12, 14, 16 Cable Street, Ancoats. **Approximately 60m south-east of the site.**	N/A
31st December 1940	D (detonated) S.C. (Sprengbombe Cylindrisch / High-Explosive bomb)	15, 17, 19, 21 Riga Street, Hulme. **Approximately 120m north-west of the site.**	15 - Average about 1'-0" (1 foot 0 inches) BA , debris to remove 17, 19, 21 - Floors 'Holed' and 'Off or Displaced'

11.7. Air Raid Damage Files

Air Raid Damage files for Manchester were obtained from The National Archives. These reports recorded information such as the date, time, type and damage caused by major bomb incidents in Manchester. These records were generally restricted to covering incidents from 1942 onwards and are therefore not considered comprehensive. No relevant information regarding the site area could be located.

11.8. WWII-Era Aerial Photography

WWII-era aerial photography for the site area was obtained from the National Monuments Record Office (Historic England). This photography provides a record of the potential composition of the site during the war, as well as its condition immediately following the war (**see Annex O**).

WWII-Era Aerial Photography	
Date	**Description**
7th May 1946 Historic England	This aerial photograph presents the structural outlay of the site and surrounding area in the immediate post-WWII era. The site is shown to comprise a single structure in the approximate footprint of the site location. No obvious damage indicators such as collapsed/discoloured roofing were observable across the boundary. All terraced structures along the south-western extent of the site boundary are present and similarly lacked any obvious signs of damage. Several areas of clearance are clearly visible in the wider vicinity to the north, east, south-east and west of the site. The closest of which is located on the opposite side of *Cable Street* and *Mason Street*, approximately 10m north-east and south-east of the site respectively. See **Annex O2** for a damage overlay of the site area.

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11.9. Abandoned Bombs

A post air-raid survey of buildings, facilities, and installations would have included a search for evidence of bomb entry holes. If evidence of an entry hole was encountered, Bomb Disposal Officer Teams would normally have been requested to attempt to locate, render safe, and dispose of the bomb. Occasionally, evidence of UXBs was discovered but due to a relatively benign position, access problems, or a shortage of resources the UXB could not be exposed and rendered safe. Such an incident may have been recorded and noted as an 'abandoned bomb'.

Given the inaccuracy of WWII records, and the fact that these bombs were 'abandoned', their locations cannot be considered definitive or the lists exhaustive. The MoD states that 'action to make the devices safe would be taken only if it was thought they were unstable'. It should be noted that other than the 'officially' abandoned bombs, there will inevitably be UXBs that were never recorded.

1st Line Defence holds no records of officially registered abandoned bombs at or near the site of the proposed works.

11.10. Bomb Disposal Tasks

The information service from the Explosive Ordnance Disposal (EOD) Archive Information Office at 33 Engineer Regiment (EOD) (now 29 Regt) is currently facing considerable delay. It has therefore not been possible to include any updated official information regarding bomb disposal/clearance tasks with regards to this site. A database of known disposal/clearance tasks has been referred to which does not make reference to such instances occurring within the site of proposed works. If any relevant information is received at a later date Curtins will be advised.

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11.11. Evaluation of German Aerial Delivered UXO Records

Factors	Conclusion
Density of Bombing *It is important to consider the bombing density when assessing the possibility that UXBs remain in an area. High bombing density could allow for error in record keeping due to extreme damage caused to the area.*	During WWII, the site was located within the County Borough of Manchester which was subject to an overall low density of bombing, with an average of 29.0 bombs per 1000 acres according to official Home Office Bombing Statistics. Whilst the site was situated a relative distance from Strategic Luftwaffe bombing targets such as Stretford Industrial area and Salford Docks, the site was in close proximity to Manchester's two main railway stations, which were obvious secondary bombing targets due to their strategic and logistical importance. Consulted historical records do not record any bomb incidents on site. The closest bombing incident recorded on the Manchester bomb damage map was a 'fire bomb' strike plotted approximately 70m north east of the site in the vicinity of *Addington Street*. This is corroborated by the Manchester Emergency Committee's Log Book of Bombing Incidents 22-24 December 1940 within Graham Pythian's *Blitz Britain: Manchester and Salford,* which records no specific references to bombing incidents within or in the immediate vicinity of the site location, the nearest recorded incident being 100m to the south.
Damage *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.*	The Manchester bomb damage map records one terraced structure adjacent to the southern extent of the site boundary as having sustained bomb damage, although this is anticipated to have been minor in nature. Several structures further to the north, east, south-east and west of the site are shown to have been demolished, the closest of which was situated approximately 10m south-east of the site on the opposite side of *Mason Street*. Post-WWII era aerial photography largely corroborates the evidence presented within the Manchester bomb damage map, indicating that the structures on and adjacent to the site appear to remain intact following WWII, including the aforementioned building to the immediate south. Several obvious areas of clearance can be seen across the wider area, the closest of which is shown to be on the opposite side of *Mason Street* and *Cable Street*, approximately 10m south-east and 10m north-east of the site respectively. See **Annex O2** for a damage overlay
Ground Cover *The nature of the ground cover present during WWII would have a substantial influence on any visual indication that may indicate UXO being present.*	Owing to the fact that the structures occupying and immediately adjacent to the site, appear to have survived the war intact, it is anticipated that the ground cover within and in close proximity of the site would have been conducive to evidence of UXO. Furthermore, the adjacent roadways comprising hardstanding ground would have also been favourable to spotting indications of UXO, such as craters or entry holes.
Access Frequency *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.*	Due to the fact that the site comprised a warehouse structure adjacent to several main roads and in close proximity to the *Smithfield Market* within the northern quarter of Manchester city centre, the site and surrounding area are anticipated to have been subject to a good level of monitor and frequent access. Such conditions typically allowed for regular post-raid checks for items of UXO.

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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	1st Line Defence holds no records of abandoned bombs at or within the site vicinity.
Bombing Decoy sites	1st Line Defence could find no evidence of bombing decoy sites within the site vicinity.
Bomb Disposal Tasks	1st Line Defence could find no evidence of bomb disposal tasks within the site boundary and immediate area.

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12. Introduction to Allied Explosive Ordnance

12.1. General

Many areas across the UK may be at risk from Allied UXO because of both wartime and peacetime military use. Typical military activities and uses that may have led to a legacy of military UXO at a site include former minefields, home guard positions, anti-aircraft emplacements, training and firing ranges, military camps, as well as weapons manufacture and storage areas.

Although land formerly used by the military was usually subject to clearance before returned to civilian use, items of UXO are sometimes discovered and can present a potential risk to construction projects.

It should be highlighted that there is no evidence that the site formerly had any military occupation or usage that could have led to contamination with such items of Allied ordnance. Despite this, urban areas, such as the location of the site, can be at risk from buried unexploded anti-aircraft projectiles fired during WWII – as addressed below.

12.2. Defending the UK From Aerial Attack

During WWII the War Office employed a number of defence tactics against the Luftwaffe from bombing major towns, cities, manufacturing areas, ports and airfields. These can be divided into passive and active defences (examples are provided in the table below).

Active Defences	Passive Defences
• Anti-aircraft gun emplacements to engage enemy aircraft. • Fighter aircraft to act as interceptors. • Rockets and missiles were used later during WWII.	• Blackouts and camouflaging to hinder the identification of Luftwaffe targets. • Decoy sites were located away from targets and used dummy buildings and lighting to replicate urban, military, or industrial areas. • Barrage balloons forced enemy aircraft to greater altitudes. • Searchlights were often used to track and divert adversary bomber crews during night raids.

Active defences such as anti-aircraft artillery present a greater risk of UXO contamination than passive defences. Unexploded ordnance resulting from dogfights and fighter interceptors is rarely encountered and difficult to accurately qualify.

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12.2.1. Anti-Aircraft Artillery (AAA)

During WWII three main types of gun sites existed: heavy anti-aircraft (HAA), light anti-aircraft (LAA) and 'Z' batteries (ZAA). If the projectiles and rockets fired from these guns failed to explode or strike an aircraft they would descend back to land. The table below provides further information on the operation and ordnance associated with these type of weapons.

Anti-Aircraft Artillery				
Item	**Description**			
HAA	These large calibre guns such as the 3.7" QF (Quick Firing) were used to engage high flying enemy bombers. They often fired large HE projectiles, which were usually initiated by integral fuzes, triggered by impact, area, time delay or a combination of aforementioned mechanisms.			
LAA	These mobile guns were intended to engage fast, low flying aircraft. They were typically rotated between locations on the perimeters of towns and strategically important industrial works. As they could be moved to new positions with relative ease when required, records of their locations are limited. The most numerous of these were the 40mm Bofors gun which could fire up to 120 x 40mm HE projectiles per minute to over 1,800m.			
Variations in HAA and LSA Ammunition	**Gun type**	**Calibre**	**Shell Weight**	**Shell Dimensions**
	3.0 Inch	76mm	7.3kg	76mm x 356mm
	3.7 Inch	94mm	12.7kg	94mm x 438mm
	4.5 Inch	114mm	24.7kg	114mm x 578mm
	40mm	40mm	0.9kg	40mm x 311mm
Z-AA	The three inch unrotated rocket/projectile known as the UP-3 had initially been developed for the Royal Navy. The UP-3 was also used in ground-based single and 128-round launchers known as ''Z'' batteries. The rocket, containing a high explosive warhead was often propelled by cordite.			

The closest recorded HAA to the site was located approximately 1.46km north-east of the site, however the range of a projectile can be up to 15km. The site would also have been in range of mobile light anti-aircraft guns.

The conditions in which anti-aircraft projectiles may have fallen unnoticed within a site area are analogous to those regarding aerial delivered ordnance. Unexploded anti-aircraft projectiles could essentially have fallen indiscriminately anywhere within range of the guns. The chance of such items being observed, reported and removed during the war depends on factors such as land use, ground cover, damage and frequency of access – the same factors that govern whether evidence of a UXB is likely to have been noted. More information about these factors with regards to this particular site can be found in the German Aerial Delivered Ordnance section of this report.

Illustrations of Anti-Aircraft artillery, projectiles and rockets are presented at **Annex P**.

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13. The Likelihood of Contamination from Allied Ordnance

13.1. Introduction

There are several factors that may serve to either affirm, increase, or decrease the level of risk within a site with a history of military usage. Such factors are typically dependent upon the proximity of the proposed area of works to training activities, munition productions and storage, as well as its function across the years.

This section will examine the history of the proposed site and assess to what degree, if any, the site could have become contaminated as a result of the military use of the surrounding area.

13.2. Evaluation of Contamination Risk from Allied UXO

1st Line Defence has considered the following potential sources of Allied ordnance contamination:

Sources of Allied UXO Contamination	Conclusion
Military Camps *Military camps present an elevated risk from ordnance simply due to the large military presence and likelihood of associated live ordnance training.*	1st Line Defence could find no evidence of a military camp within the site.
Anti-Aircraft Defences *Anti-Aircraft defences were employed across the country. Proximity to anti-aircraft defences increases the chance of encountering AA projectiles.*	1st Line Defence could find no evidence of Anti-Aircraft defences such as a HAA or LAA gun emplacement occupying or bordering the site. The closest HAA was located approximately 1.46km north-east of the site, however the range of a projectile can be up to 15km. The conditions in which HAA or LAA projectiles may have fallen unnoticed within a site footprint are analogous to those regarding German aerial delivered ordnance.
Home Guard Activity *The Home Guard regularly undertook training and ordnance practice in open areas, as well as burying ordnance as part of anti-invasion defences.*	1st Line Defence has no evidence of any Home Guard activities on the site.
Defensive Positions *Defensive positions suggest the presence of military activity, which is often indicative of ordnance storage, usage or disposal.*	There is no evidence of any defensive features formerly located on or bordering the site footprint.
Training or firing ranges *Areas of ordnance training saw historical ordnance usage in large numbers, often with inadequate disposal of expended and live items. The presence of these ranges significantly impact on the risk of encountering items of ordnance in their vicinity.*	There is no evidence of such features affecting the site.

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Defensive Minefields *Minefields were placed in strategic areas to defend the country in the event of a German invasion. Minefields were not always cleared with an appropriate level of vigilance.*	There is no evidence of defensive minefields affecting the site.
Ordnance Manufacture *Ordnance manufacture indicates an increased chance that items of ordnance were stored, or disposed of, within a location.*	No information of ordnance being stored, produced, or disposed of within the proposed site could be found.
Military Related Airfields *Military airfields present an elevated risk from ordnance simply due to the large military presence and likelihood of associated live ordnance training or bombing practice.*	The site was not situated within the perimeters or vicinity of a military airfield.

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14. The Likelihood of UXO Contamination Summary

The following table assesses the likelihood that the site was contaminated by items of German aerial delivered and Allied ordnance. Factors such as the risk of UXO initiation, remaining, and encountering will be discussed later in the report.

UXO Contamination Summary	
Quality of the Historical Record	The research has evaluated pre and post-WWII Ordnance Survey maps, pre-WWII oblique aerial photography, city of Manchester plan 1945, Luftwaffe target imagery, Home Office bombing statistics, *Blitz Britain: Manchester and Salford* by Graham Pythian, Manchester bomb damage map, Manchester bomb damage cards, and WWII-era aerial photography. The record set is generally of satisfactory quality. The structural composition of the site and surrounding area prior to and after WWII was able to be corroborated across various sources. However, despite the fact that consulted records depict a clear indication of the war-time conditions on site, they do not appear to be comprehensive as there is significantly more damage and areas of clearance in the wider vicinity than what recorded bombing incidents can account for.
German Aerial Delivered Ordnance	• During WWII, the site was located within the County Borough of Manchester which was subject to an overall low density of bombing, with an average of 29.0 bombs per1000 acres according to official Home Office Bombing Statistics. Manchester was however still subject to a number of significant Luftwaffe raids, most notably the 'Christmas Blitz' of December 1940. • Consulted historical records do not record any bomb incidents on site or in the immediate vicinity of the site boundary. The closest bombing incident recorded on the Manchester bomb damage map was a 'fire bomb' strike plotted approximately 70m north-east of the site in the vicinity of *Addington Street*. • This is corroborated by the Manchester Emergency Committee's Log Book of Bombing Incidents 22-24 December 1940 within Graham Pythian's *Blitz Britain: Manchester and Salford,* which records no specific references to bombing incidents within or in the immediate vicinity of the site location, the nearest recorded incident being 100m to the south-east. • During this period, the site was occupied by a large 'L-shaped' warehouse building that appears to have retained the same composition to today. It was bordered by a row of terraced residential properties to the south and by roadways in all other directions. • The Manchester bomb damage map records no bomb damage to this structure on site. The outline of one terraced structure adjacent to the southern extent of the site boundary is highlighted in red indicating that the structure sustained some bomb damage. However, as this is not represented in the damage key and the structure appears structurally intact in the post-WWII era, the recorded damage is anticipated to have been minor in nature. • Several structures further to the north, east, south-east and west of the site are shown to have been demolished, but all were situated on the opposite side of roadways. The closest was situated approximately 10m south-east of the site on the opposite side of *Mason Street*, although no corresponding bombing incident is evident. • Post-WWII era aerial photography largely corroborates the evidence presented within the Manchester bomb damage map, indicating that the structures within and in immediate proximity to the site appear to remain intact following WWII. The photography also reveals obvious areas of clearance across the wider area, the closest of which is shown to be on the opposite side of *Mason Street* and *Cable Street*, approximately 10m south-east and 10m north-east of the site respectively. However, none of these areas appear to have had any significant

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	impact on the condition or usage of the site footprint. Given this, their distance and the fact that the site was separated by sections of roadway, these surrounding areas of clearance are not anticipated to significantly elevate the risk of UXO contamination on site. • Owing to the fact that the structures occupying and immediately adjacent to the site, appear to have survived the war intact, it is anticipated that the ground cover within and in close proximity of the site would have been conducive to evidence of UXO. Furthermore, the adjacent roadways comprising hardstanding ground would have also been favourable to spotting indications of UXO, such as craters or entry holes. • Due to the fact that the site comprised a warehouse structure adjacent to several main roads and in close proximity to the *Smithfield Market* within the northern quarter of Manchester city centre, the site and surrounding area are anticipated to have been subject to a good level of monitor and frequent access throughout WWII.
Allied Ordnance	• There is no evidence that the site formerly had any military occupation or usage that could have led to contamination with items of Allied ordnance, such as LSA and SAA. The conditions in which HAA or LAA projectiles may have fallen unnoticed within the site boundary are however to those regarding aerial delivered ordnance.

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15. The Likelihood that UXO Remains

15.1. Introduction

It is important to consider the extent to which any explosive ordnance clearance (EOC) activities or extensive ground works have occurred on site. This may indicate previous ordnance contamination or reduce the risk that ordnance remains undiscovered.

15.2. UXO Clearance

1st Line Defence has found no evidence in the public domain or within internal records that any official ordnance clearance operations have taken place on site. Note however that we have not received confirmation of this fact from the 33 EOD Regiment Archive (now part of 29 Regt). It should also be noted that in addition to 29 Regt archival information, 1st Line Defence also do not currently have access to data that may be relevant including 5131(BD)SQN Archive, SD Training Technical Advisory Section (TAS) and MACA Records (bomb disposal callouts).

If such information is available at a later date, it is recommended that it be reviewed as it will assist with understanding both levels and types of contamination likely to be present, and may indicate risk reduction in certain areas.

15.3. Post-War Redevelopment

Recent aerial photography dated May 2019 indicates that post-war redevelopment of the site has been limited. The structures currently occupying the site resemble those present in the immediate post-WWII era and in OS mapping from 1966 - 1969.

OS mapping from 1951 – 1952 shows the surrounding vicinity to have undergone significant re-development since the pre-war era. The same structure being built in 1937 oblique aerial photography and a 1945 plan of Manchester city centre occupies the approximate footprint of the site. Further to the north and west of the site, several *Ruins* and areas of clearance can be discerned. To the east of the site, several notable changes have occurred, in which clusters of smaller structures have either been cleared completely or re-developed into larger warehouse-style structures. Notably, a *Ruin* and an area of clearance can be seen on the opposite side of *Mason Street* approximately 10m south-east of the site boundary. The area further south of the site appears to remain relatively unchanged in the post-war era, *Smithfield Market* and several other adjacent market structures can be seen beyond *Swan Street.*

OS mapping from 1966 - 1969 shows no change to the structural outlay of the site, which comprises a single *Warehouse* structure in the approximate footprint of the site boundary. To the immediate south of the site several terraced structures have been cleared and redeveloped into a single *Bank* structure. Further to the north, east and west of the site, several areas formerly occupied by cleared ground now comprise *Warehouse* or *Works* structures. No notable major changes have occurred further to the south of the site in this era.

The risk of UXO remaining is considered to be mitigated at the location of and down to the depth of any post-war redevelopment on site. Within the footprints of post-WWII redevelopments, the risk from shallow-buried UXO (especially 1kg German incendiaries and British AA projectiles) should have been encountered/removed during initial excavations. However, the risk from deep-buried German UXBs will only have been mitigated within the volumes of any post-war pile foundations or deep excavations for basement levels. The risk will remain within virgin geology below and amongst these post-war works, down to the maximum bomb penetration depth.

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16. The Likelihood of UXO Encounter

16.1. Introduction

For UXO to pose a risk at a site, there should be a means by which any potential UXO might be encountered on that site.

The likelihood of encountering UXO on the site of proposed would depend on various factors, such as the type of UXO that might be present and the intrusive works planned on site. In most cases, UXO is more likely to be present below surface (buried) than on surface.

In general, the greater the extent and depth of intrusive works, the greater the risk of encountering. The most likely scenarios under which items of UXO could be encountered during construction works is during piling, drilling operations or bulk excavations for basement levels. The overall risk will depend on the extent of the works, such as the numbers of boreholes/piles (if required) and the volume of the excavations.

Generally speaking, the risk of encountering any type of UXO will be minimal for any works planned within the footprint and down to the depth of post-war foundations and excavations.

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17. The Likelihood of UXO Initiation

17.1. Introduction

UXO does not spontaneously explode. Older UXO devices will require an external event/energy to create the conditions for detonation to occur. The likelihood that a device will function can depend on a number of factors including the type of weaponry, its age and the amount of energy it is struck with.

17.2. Initiating Aerial Delivered Ordnance

Unexploded bombs do not spontaneously explode. All high explosive filling requires significant energy to create the conditions for detonation to occur.

In recent decades, there have been a number of incidents in Europe where Allied UXBs have detonated, and incidents where fatalities have resulted.. There have been several hypotheses as to the reason why the issue is more prevalent in mainland Europe – reasons could include the significantly greater number of bombs dropped by the Allied forces on occupied Europe, the preferred use by the Allies of mechanical rather than electrical fuzes, and perhaps just good fortune. The risk from UXO in the UK is also being treated very seriously in many sectors of the construction industry, and proactive risk mitigation efforts will also have affected the lack of detonations in the UK.

There are certain construction activities which make initiation more likely, and several potential initiation mechanisms must be considered:

UXB Initiation	
Direct Impact	Unless the fuze or fuze pocket is struck, there needs to be a significant impact e.g. from piling or large and violent mechanical excavation, onto the main body of the weapon to initiate a buried iron bomb. Such violent action can cause the bomb to detonate.
Re- starting the Clock	A small proportion of German WWII bombs employed clockwork fuzes. It is probable that significant corrosion would have taken place within the fuze mechanism over the last 70+ years that would prevent clockwork mechanisms from functioning. Nevertheless, it was reported that the clockwork fuze in a UXB dealt with by 33 EOD Regiment in Surrey in 2002 did re-start.
Friction Impact	The most likely scenario resulting in the detonation of a UXB is friction impact initiating the shock-sensitive fuze explosive. The combined effects of seasonal changes in temperature and general degradation over time can cause explosive compounds to crystallise and extrude out from the main body of the bomb. It may only require a limited amount of energy to initiate the extruded explosive which could detonate the main charge.

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18. Consequences of Initiation/Encounter

18.1. Introduction

The repercussions of the inadvertent detonation of UXO during intrusive ground works, or if an item or ordnance is interfered with or disturbed, are potentially profound, both in terms of human and financial cost. A serious risk to life and limb, damage to plant and total site shutdown during follow-up investigations are potential outcomes. However, if appropriate risk mitigation measures are put in place, the chances of initiating an item of UXO during ground works is comparatively low.

The consequences of encountering UXO can be particularly notable in the case of high-profile sites (such as airports and train stations) where it is necessary to evacuate the public from the surrounding area. A site may be closed for anything from a few hours to a week with potentially significant cost in lost time. It should be noted that even the discovery of suspected or possible item of UXO during intrusive works (if handled solely through the authorities), may also involve significant loss of production

18.2. Consequences of Detonation

When considering the potential consequences of a detonation, it is necessary to identify the significant receptors that may be affected. The receptors that may potentially be at risk from a UXO detonation on a construction site will vary depending on the site specific conditions but can be summarised as follows:

- People – site workers, local residents and general public.
- Plant and equipment – construction plant on site.
- Services – subsurface gas, electricity, telecommunications.
- Structures – not only visible damage to above ground buildings, but potentially damage to foundations and the weakening of support structures.
- Environment – introduction of potentially contaminating materials.

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19. 1st Line Defence Risk Assessment

19.1. Risk Assessment Stages

Taking into account the quality of the historical evidence, the assessment of the overall risk from unexploded ordnance is based on the following five considerations:

1. That the site was contaminated with unexploded ordnance.
2. That unexploded ordnance remains on site.
3. That such items will be encountered during the proposed works.
4. That ordnance may be initiated by the works operations.
5. The consequences of encountering or initiating ordnance.

19.2. Assessed Risk Level

1st Line Defence has assessed that there is an overall **Low Risk** from German and anti-aircraft unexploded ordnance at the site of proposed works. There is also an assessed **Negligible Risk** from all other types of Allied ordnance.

Ordnance Type	Risk Level			
	Negligible	Low	Medium	High
German Unexploded HE Bombs		✓		
German 1kg Incendiary Bombs		✓		
Allied Anti-Aircraft Artillery Projectiles		✓		
Allied Land Service and Small Arms Ammunition	✓			

Please note – although the risk from unexploded ordnance on this site has been assessed as 'Low', this does not mean there is 'no' risk of encountering UXO. This report has been undertaken with due diligence, and all reasonable care has been taken to access and analyse relevant historical information. By necessity, when dealing historical evidence, and when making assessments of UXO risk, various assumptions have to be made which we have discussed and justified throughout this report. Our reports take a common-sense and practical approach to the assessment of risk, and we strive to be reasonable and pragmatic in our conclusions.

It should however be stressed that if any suspect items are encountered during the proposed works, 1st Line Defence should be contacted for advice/assistance, and to re-assess the risk where necessary. The mitigation measures outlined in the next section are recommended as a minimum precaution to alert ground personnel to the history of the site, what to look out for, and what measures to take in the event that a suspect item is encountered. It should also be noted that the conclusions of this report are based on the scope of works outlined in the 'Proposed Works' section of this report. Should the scope of works change or additional works be proposed, 1st Line Defence should be contacted to re-evaluate the risk.

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20. Proposed Risk Mitigation Methodology

20.1. General

The following risk mitigation measures are recommended to support the proposed works at Swan Street, Manchester:

Type of Work	Recommended Mitigation Measure
All Works	• **UXO Risk Management Plan** It is recommended that a site-specific plan for the management of UXO risk be written for this site. This plan should be kept on site and be referred to in the event that a suspect item of UXO is encountered at any stage of the project. It should detail the steps to be taken in the event of such a discovery, considering elements such as communication, raising the alarm, nominated responsible persons etc. Contact 1st Line Defence for help/more information. • **Site Specific UXO Awareness Briefings to all personnel conducting intrusive works.** As a minimum precaution, all personnel working on the site should be briefed on the basic identification of UXO and what to do in the event of encountering a suspect item. This should in the first instance be undertaken by a UXO Specialist. Posters and information on the risk of UXO can be held in the site office for reference.

In making this assessment and recommending these risk mitigation measures, if known, the works outlined in the 'Scope of the Proposed Works' section were considered. Should the planned works be modified or additional intrusive engineering works be considered, 1st Line Defence should be consulted to see if a re-assessment of the risk or mitigation recommendations is necessary.

1st Line Defence Limited **12/02/2021**

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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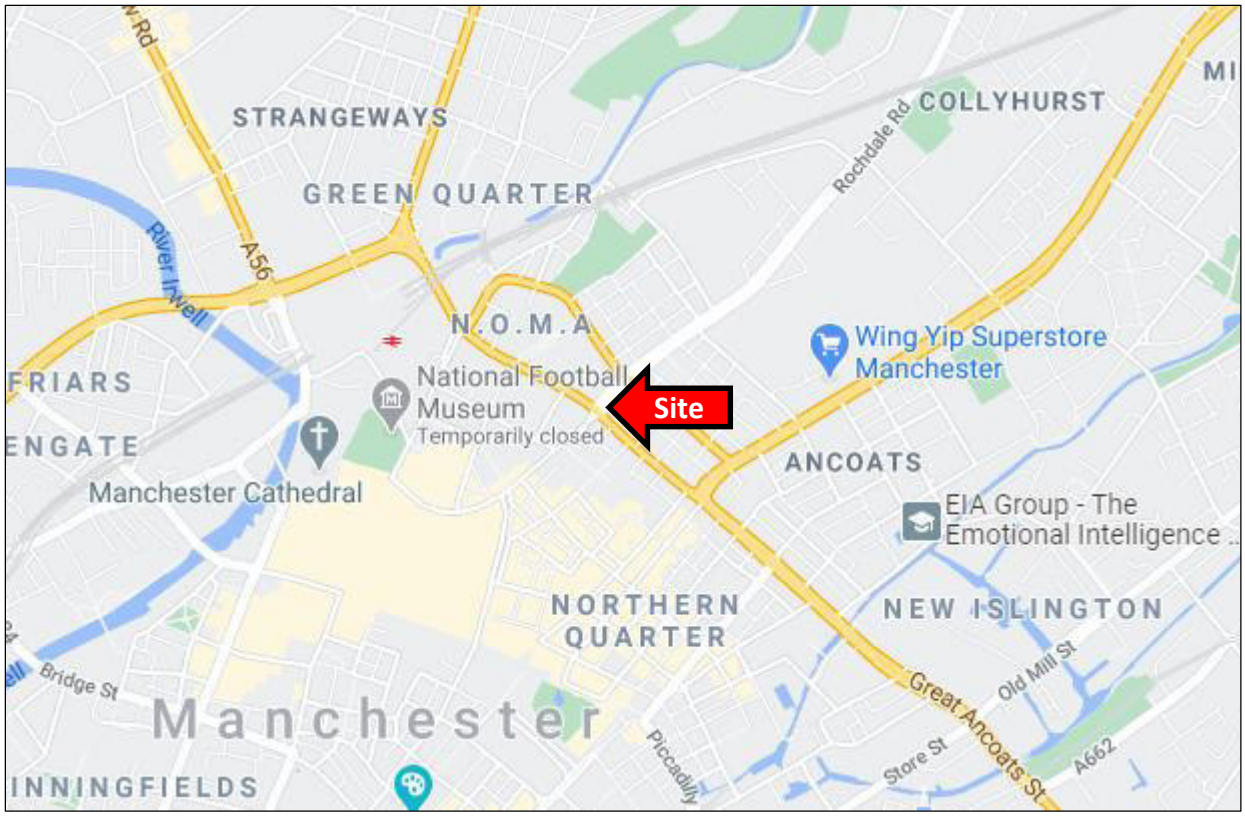
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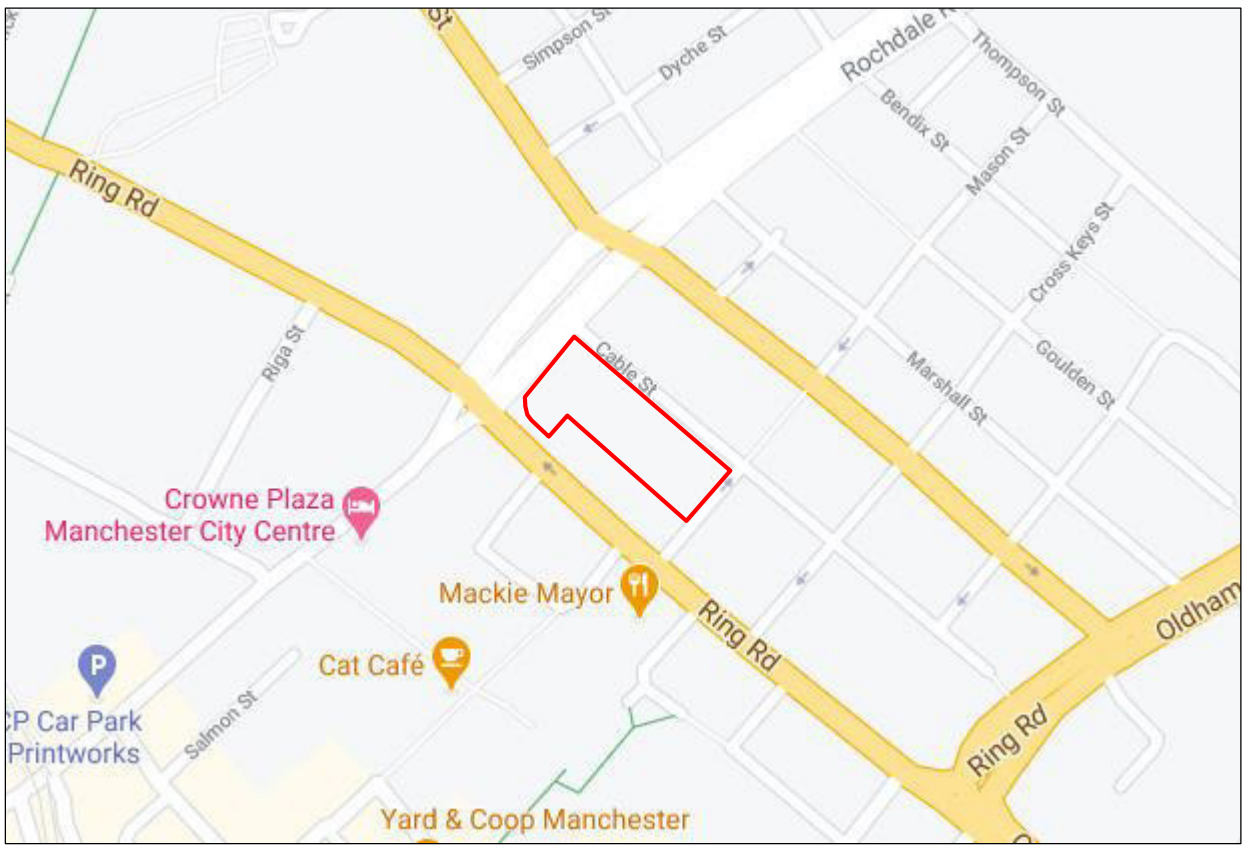
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Site Location Maps

Annex: **A**





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Email: info@1stlinedefence.co.uk
Tel: +44 (0)1992 245 020

Client: **Curtins**

Project: **Swan Street, Manchester**

Ref: **DA12456-00**

Source: Google Maps

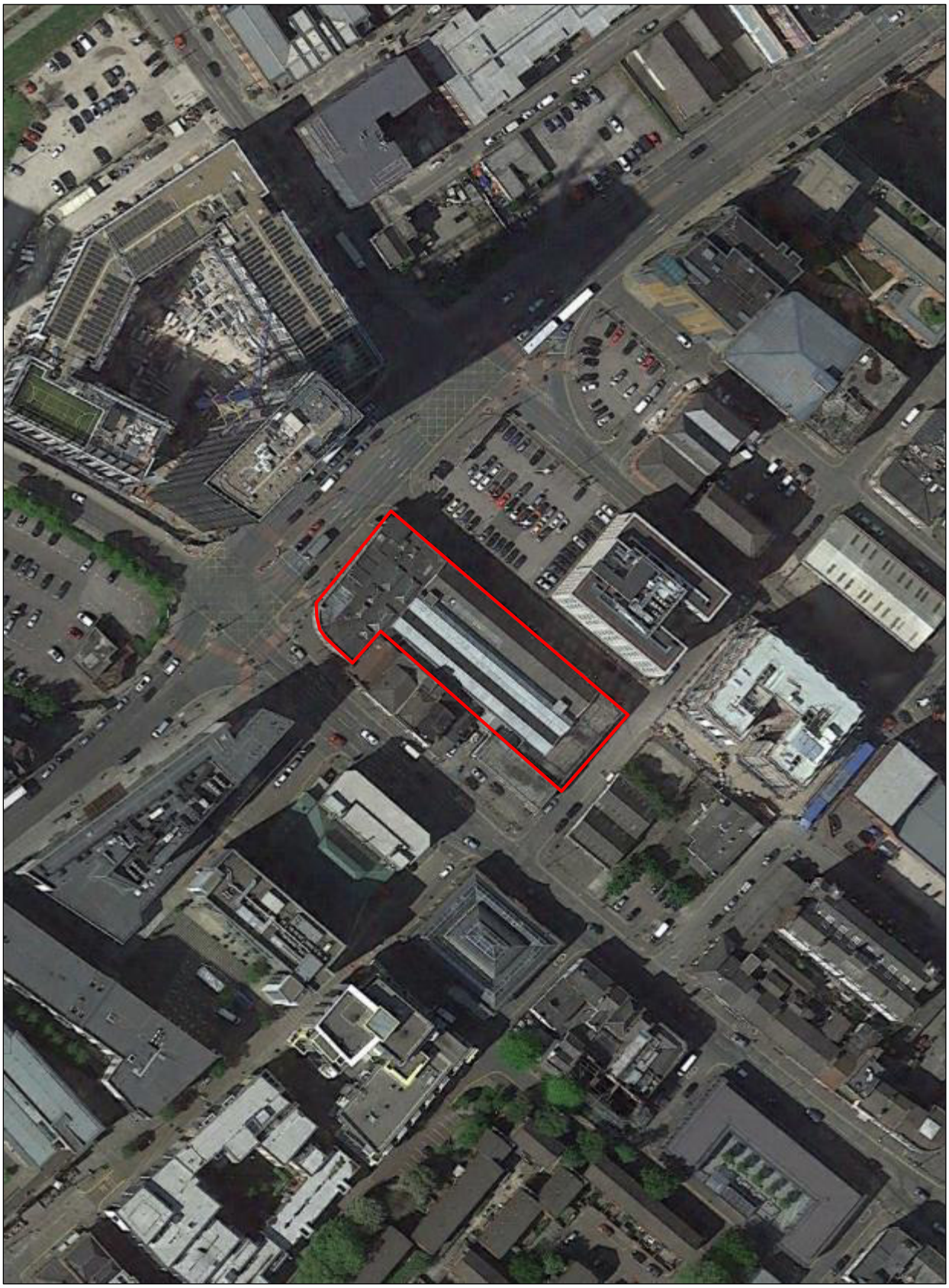
Approximate site boundary

N

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Recent Aerial Photography

Annex: **B**



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Approximate site boundary

Project: **Swan Street, Manchester**

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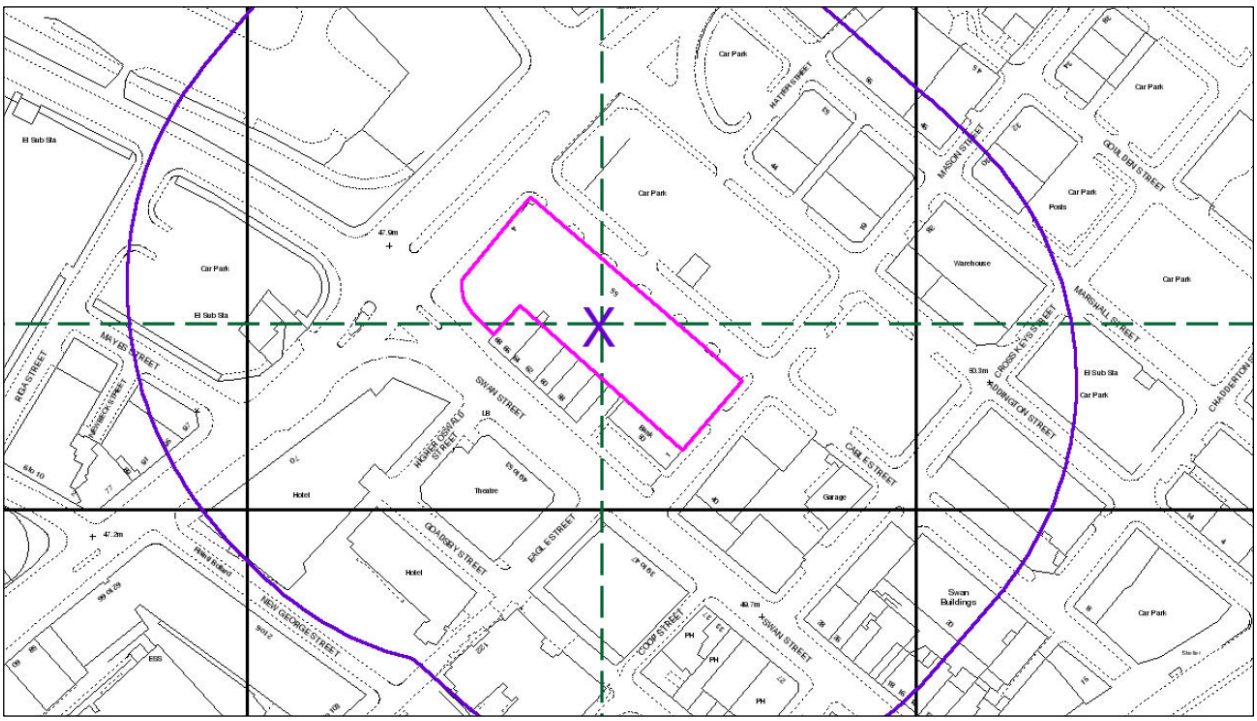
Ref: **DA12456-00**

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Client Provided Site Plan

Annex: C



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Project: **Swan Street, Manchester**

Ref: **DA12456-00**

Source: Curtins

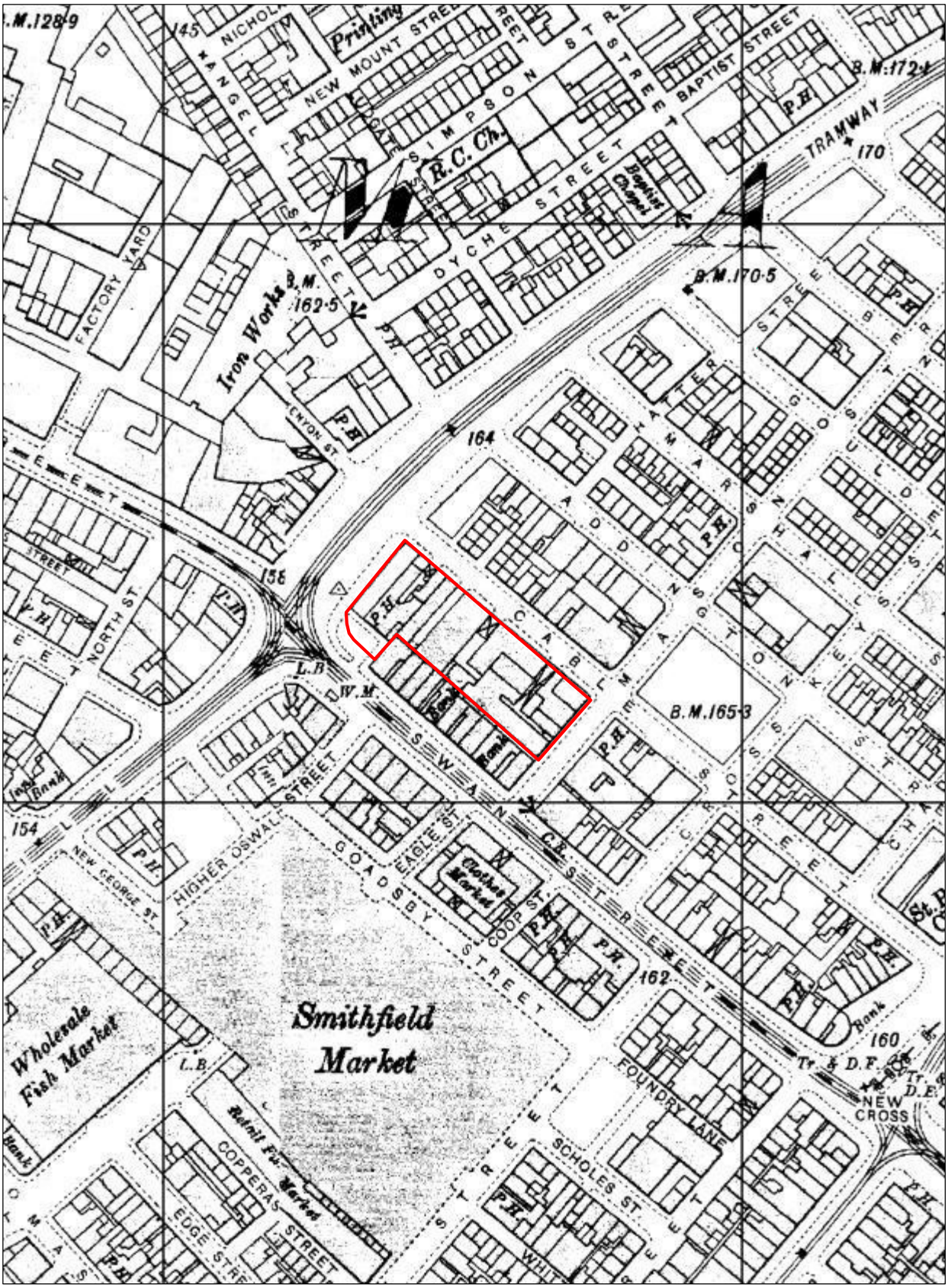
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Pre-WWII Historical Map 1908

Annex: **D1**



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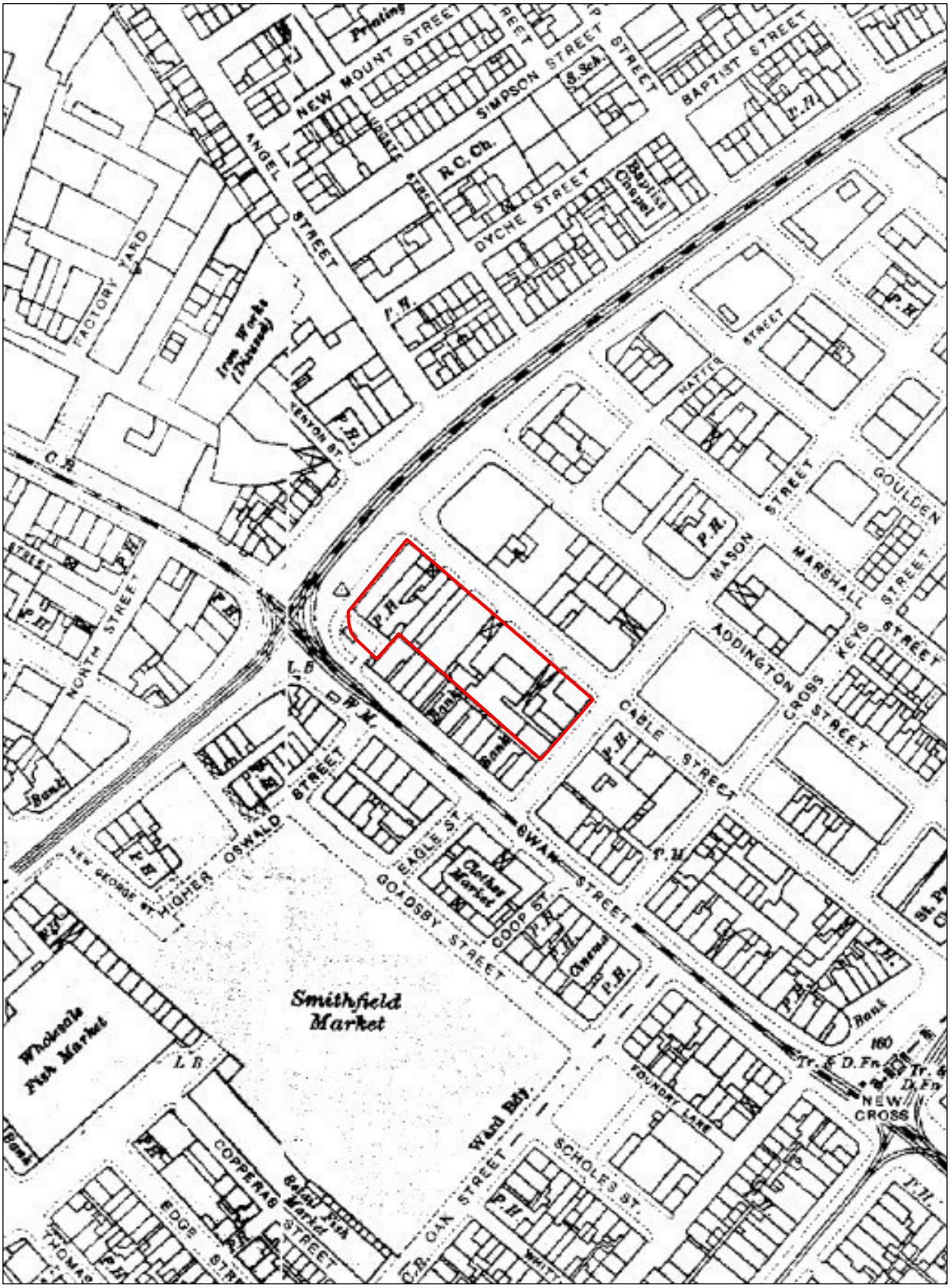
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Pre-WWII Historical Map 1922 - 1933

Annex: D2



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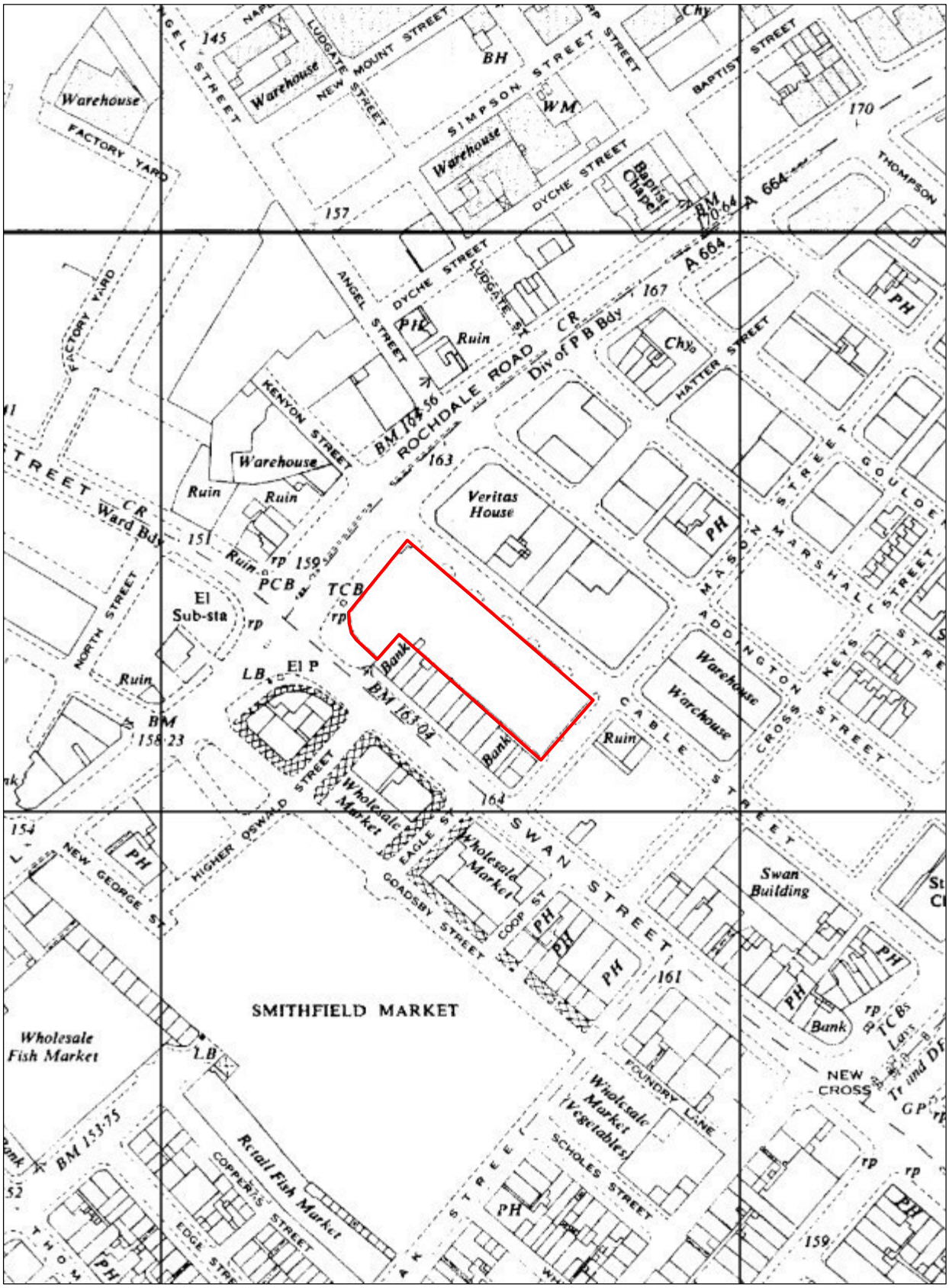
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Post-WWII Historical Map 1951 - 1952

Annex: D3



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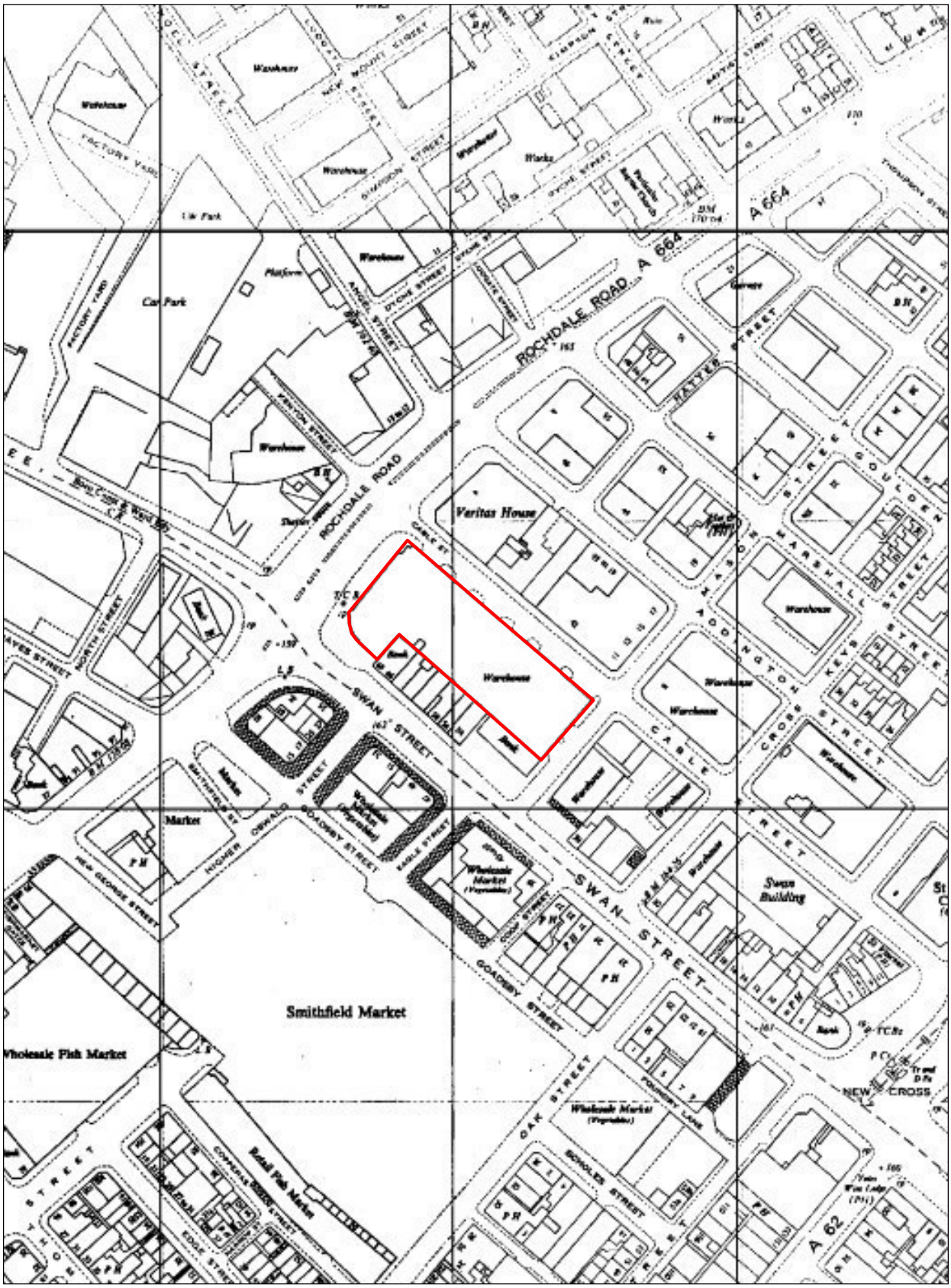
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Post-WWII Development Historical Map 1966 - 1969

Annex: D4



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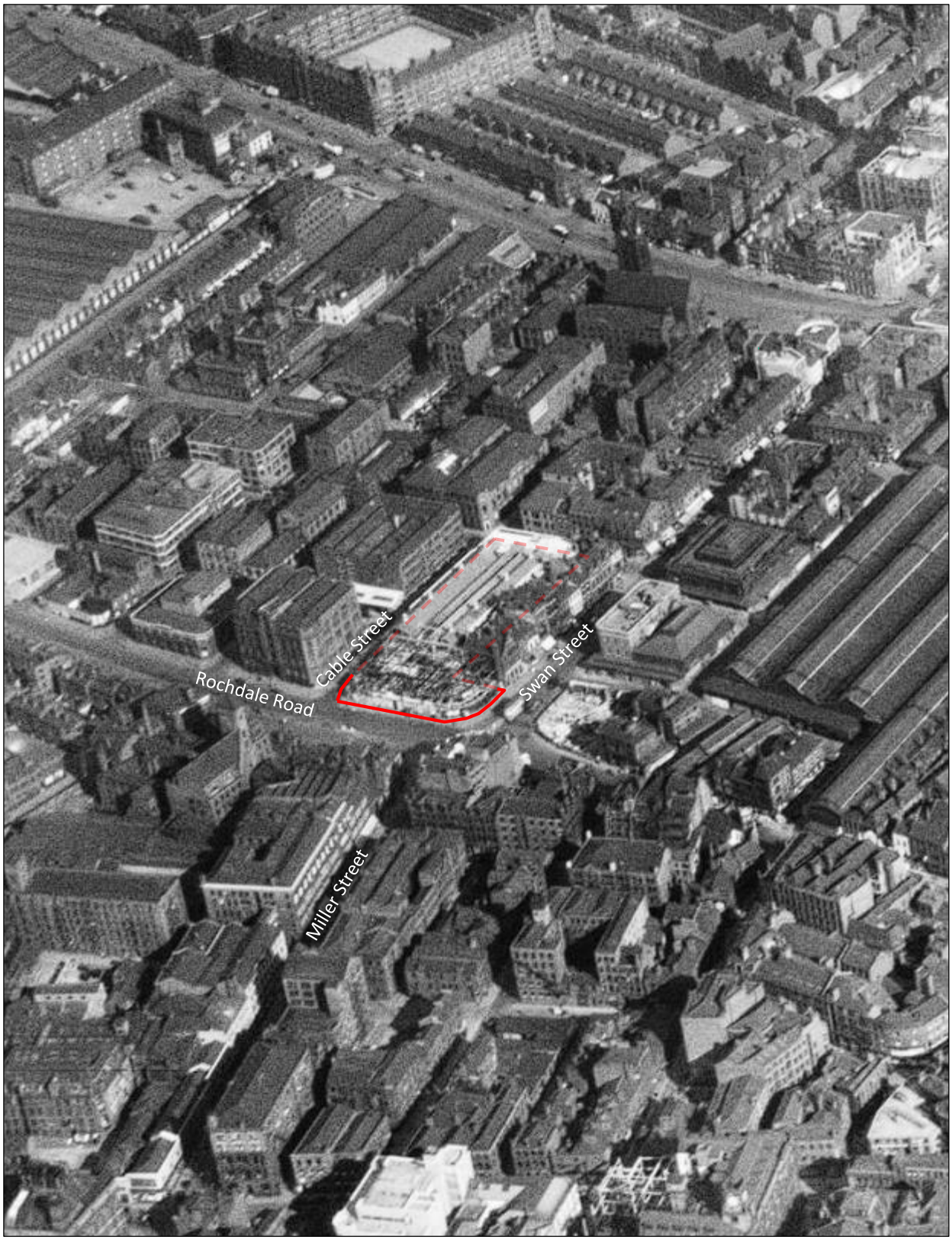
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Pre-War Oblique Aerial Photography - 1937

Annex: **E**



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Source: Britain from Above

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City of Manchester Plan 1945

Annex: **F**



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Approximate site boundary

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Project: **Swan Street, Manchester**

Ref: **DA12456-00**

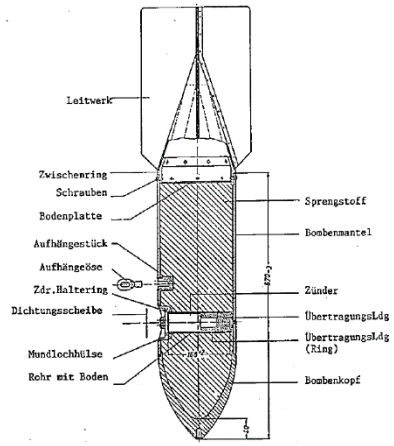
Source: University of Manchester

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Examples of German Air-Delivered Ordnance

SC 50kg High Explosive Bomb

Bomb Weight	40-54kg (88-119lb)
Explosive Weight	25kg (55lb)
Fuze Type	Impact fuze/electro-mechanical time delay fuze
Bomb Dimensions	1,090 x 280mm (42.9 x 11.0in)
Body Diameter	200mm (7.87in)
Use	Against lightly damageable materials, hangars, railway rolling stock, ammunition depots, light bridges and buildings up to three stories.
Remarks	The smallest and most common conventional German bomb. Nearly 70% of bombs dropped on the UK were 50kg.

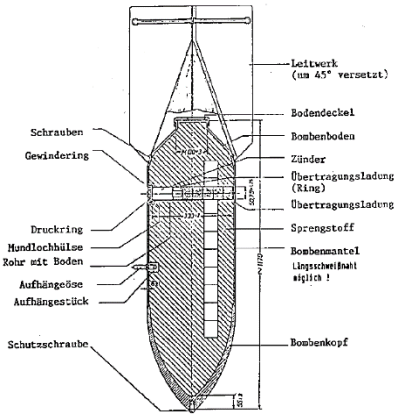






SC 250kg High Explosive Bomb

Bomb Weight	245-256kg (540-564lb)
Explosive Weight	125-130kg (276-287lb)
Fuze Type	Electrical impact/mechanical time delay fuze.
Bomb Dimensions	1640 x 512mm (64.57 x 20.16in)
Body Diameter	368mm (14.5in)
Use	Against railway installations, embankments, flyovers, underpasses, large buildings and below-ground installations.
Remarks	It could be carried by almost all German bomber aircraft, and was used to notable effect by the Junkers Ju-87 Stuka (Sturzkampfflugzeug or dive-bomber).



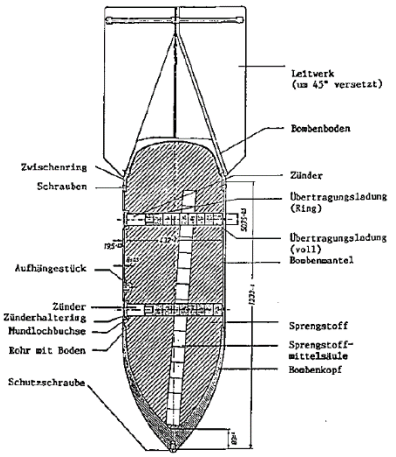


SC250 bomb being loaded onto German bomber

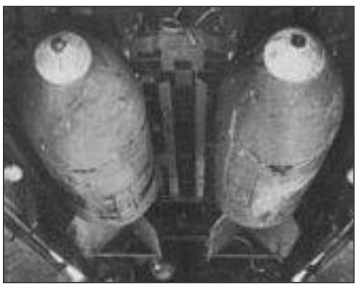


SC 500kg High Explosive Bomb

Bomb Weight	480-520kg (1,058-1,146lb)
Explosive Weight	250-260kg (551-573lb)
Fuze Type	Electrical impact/mechanical time delay fuze.
Bomb Dimensions	1957 x 640mm (77 x 25.2in)
Body Diameter	470mm (18.5in)
Use	Against fixed airfield installations, hangars, assembly halls, flyovers, underpasses, high-rise buildings and below-ground installations.
Remarks	40/60 or 50/50 Amatol TNT, trialene. Bombs recovered with Trialen filling have cylindrical paper wrapped pellets 1-15/16 in. in length and diameter forming







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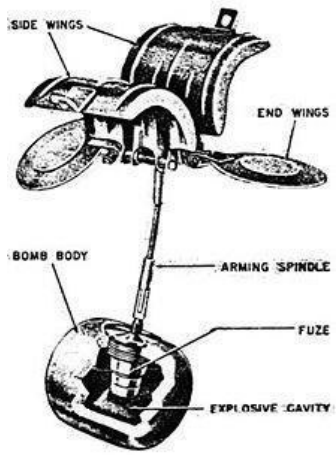
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Examples of German Air-Delivered Ordnance

SD2 Anti-Personnel 'Butterfly Bomb'

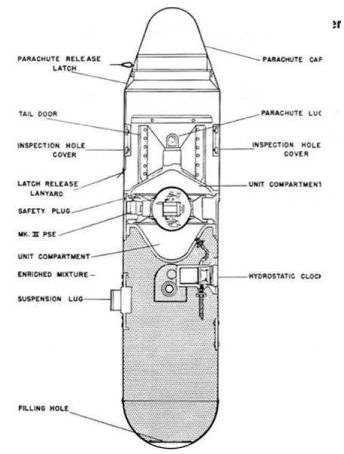
Bomb Weight	Approx. 2kg (4.41lb)
Explosive Weight	Approx. 7.5oz (225 grams) of Amatol surrounded by a layer of bituminous composition.
Fuze Type	41 fuze (time) , 67 fuze (clockwork time delay) or 70 fuze (anti-handling device)
Body Diameter	3in (7.62 cm) diameter, 3.1in (7.874) long
Use	Designed as an anti-personnel/ fragmentation weapon. They were delivered by air, being dropped in containers of 23-144 sub-munitions that opened at a predetermined height, thus scattering the bombs.
Remarks	Very rare. First used against Ipswich in 1940, but were also dropped on Kingston upon Hull, Grimsby and Cleethorpes in June 1943, amongst various other targets in UK. As the bombs fell the outer case flicked open by springs which caused four light metal drogues with a protruding 5 inch steel cable to deploy in the form of a parachute & wind vane which armed the device as it span.





Parachute Mine (Luftmine B / LMB)

Bomb Weight	Approx. 990kg (2176lb)
Explosive Weight	Approx. 705kg (1,554lb)
Fuze Type	Impact/ Time delay / hydrostatic pressure fuze
Dimensions	2.64m x 0.64m (3.04m with parachute housing)
Use	Against civilian, military and industrial targets. Used as blast bombs and designed to detonate above ground level to maximise damage to a wider area.
Remarks	Deployed a parachute when dropped in order to control its descent. Had the potential to cause extensive damage in a 100m radius.



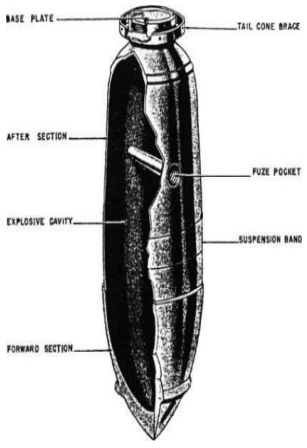






SC 1000kg

Bomb Weight	Approx. 993-1027kg (2,189-2,264lb)
Explosive Weight	Approx. 530-620kg (1168-1367lb)
Fuze Type	Electrical impact/mechanical time delay fuze.
Filling	Mixture of 40% amatol and 60% TNT, but when used as an anti-shipping bomb it was filled with Trialen 105, a mixture of 15% RDX, 70% TNT and 15% aluminium powder.
Bomb Dimensions	2800 x 654mm (110 x 25.8in)
Body Diameter	654mm (18.5in)
Use	SC type bombs are General Purpose Bombs used primarily for general demolition work. Constructed of parallel walls with comparatively heavy noses. They are usually of three piece welded construction





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Client: **Curtins**

Project: **Swan Street, Manchester**

Ref: **DA12456-00**

Source: Various sources

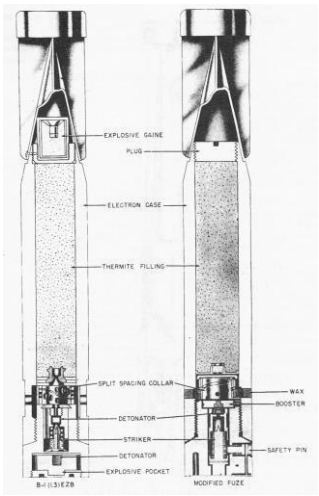
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German Incendiary Bombs

Annex: G3

1kg Incendiary Bomb

Bomb Weight	Approx. 1.0 - 1.3kg (2.2 and 2.9lb)
Explosive Weight	Approx. 680g (1.5lb) 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 on towns and industrial complexes
Remarks	Magnesium alloy case. Sometimes fitted with high explosive charge. The body is a cylindrical alloy casting threaded internally at the nose to receive the fuze holder and fuze.

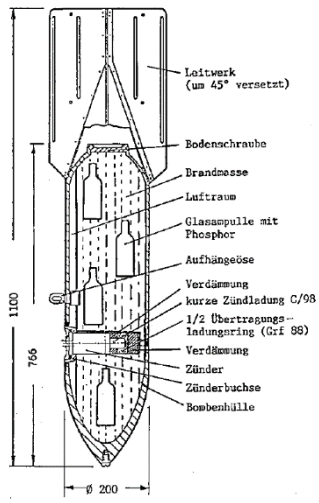


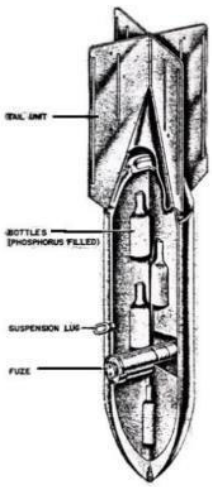




C50 A Incendiary Bomb

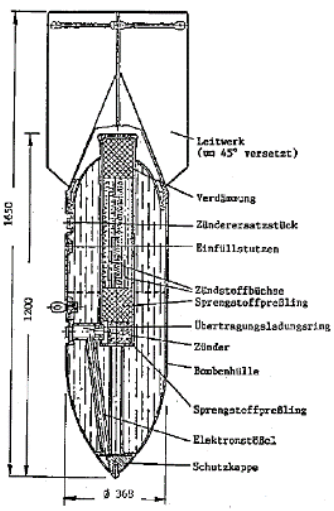
Bomb Weight	Approx. 41kg (90.4lb)
Explosive Weight	Approx. 0.03kg (0.066lb)
Incendiary Filling	12kg (25.5lb) liquid filling with phosphor igniters in glass phials. Benzine 85%; Phosphorus 4%; Pure Rubber 10%
Fuze Type	Electrical impact fuze
Bomb Dimensions	1,100 x 280mm (43.2 x 8in)
Use	Against any targets where an incendiary effect is required
Remarks	Early fill was a phosphorous/carbon disulphide incendiary mixture





Flam C-250 Oil Bomb

Bomb Weight	Approx. 125kg (276lb)
Explosive Weight	Approx. 1kg (2.2lb)
Fuze Type	Super-fast electrical impact fuze
Filling	Mixture of 30% petrol and 70% crude oil
Bomb Dimensions	1,650 x 512.2mm (65 x 20.2in)
Body Diameter	368mm (14.5in)
Use	Often used for surprise attacks on ground troops, against troop barracks and industrial installations. Thin casing – not designed for ground penetration





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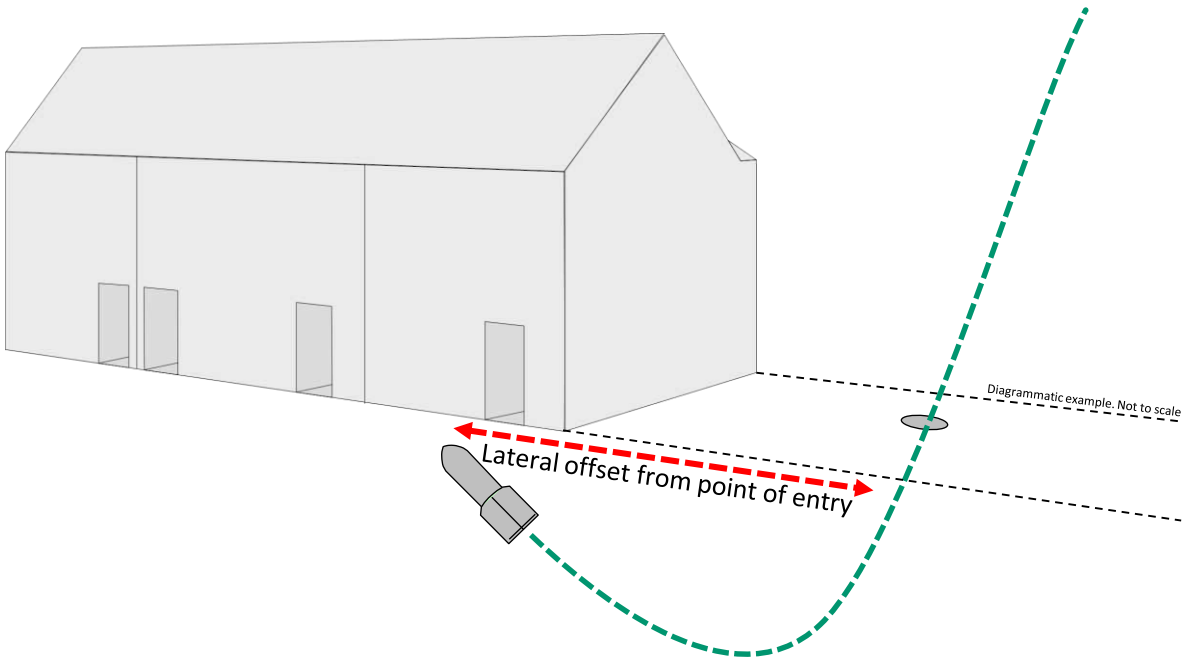
Project: **Swan Street, Manchester**

Ref: **DA12456-00**

Source: Various sources

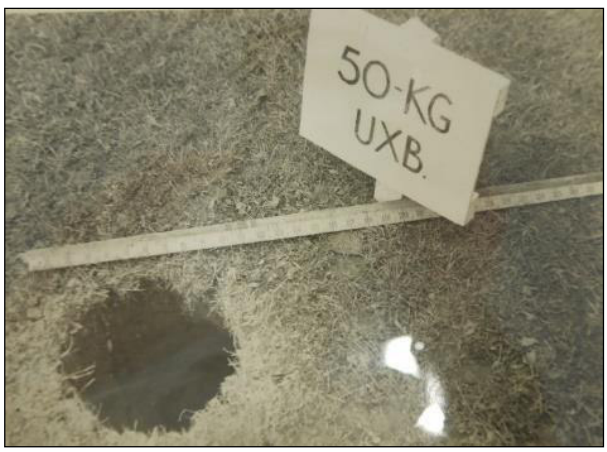
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The 'J-Curve' Effect Principle









Top: J-curve Effect - Due to angle of entry, unexploded bombs would often end their trajectory at a lateral offset from point of entry, often ending up beneath adjacent extant structures/sites. The photograph above shows 250kg bomb found in Bermondsey pointing upwards, demonstrating 'J-curve'

One of the most common scenarios for UXO going unnoticed was when a UXB fell into a 'bomb site' (such as the area shown **Top Left**), the entry hole of the bomb obscured by any debris and rubble present. Note that the entry hole of a 50kg UXB could be as little as 20cm in diameter (**Left**).

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BBC NEWS

Bermondsey bomb: World War Two device safely removed



An unexploded World War Two bomb found in south London has been driven away safely under police and Army escort.

The 500lb (250kg) device was found on a building site in Grange Walk, Bermondsey on Monday.

March 2015

BBC NEWS

Bethnal Green WW2 bomb: Experts remove unexploded device



An unexploded World War Two bomb that prompted the evacuation of 700 people in east London has been made safe and removed by the military.

Families spent the night in a school hall after the 500lb bomb was found in the basement of a building site on Temple Street, in Bethnal Green, on Monday afternoon.

A 200m (650ft) exclusion zone was set up around the device.

August 2016

BBC NEWS

Bath WW2 bomb scare: Device defused, police say



A 500lb World War Two bomb found on the site of a former school in Bath has been defused and made safe.

The discovery of the bomb on Thursday **led to the evacuation of hundreds of homes** and many road closures in the Lansdown area of the city.

A cordon around the site was lifted on Friday evening, more than 24 hours after residents were asked to leave their homes.

May 2016

BBC NEWS

London City Airport reopens after WW2 bomb moved



London City Airport has reopened after an unexploded 500kg World War Two bomb was safely moved from the area.

The device was discovered at the King George V Dock on Sunday during planned work at the east London airport.

All flights were cancelled on Monday after an exclusion zone was put in place, **with the closure affecting up to 16,000 passengers and nearby residents being evacuated from their homes.**

May 2015

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Examples of Unexpected Detonation of WWII Bombs

Annex: I2

BASF has confirmed that an explosive device, most likely a World War II-era bomb, caused the blast that left one person injured Tuesday at a plant construction site in Germany.

The explosion was reported at BASF's Ludwigshafen toluene diisocyanate (TDI) plant, which recently broke ground for a 300,000 metric tons per year TDI production plant and other construction to expand its facilities.



BASF Provides Some Details

Responding to a request from *PaintSquare News* for more information on Wednesday (Feb. 27), BASF's manager of media relations and corporate communications Europe, Ursula von Stetten, wrote in an email, "So here [are] the facts: The detonation took place at 10:00 a.m. One person was injured; the injury is not serious. He will be kept in the hospital for some days.

"Cause of the detonation was an explosive device, presumably a bomb deriving from the Second World War. The device detonated when grounding work was done. No details on [a] delay [are] available. At the moment, the exact circumstances of the incident are [being] evaluated."

1st March 2013

SPIEGEL ONLINE

Blast Kills One

World War II Bomb Explodes on German Motorway

A highway construction worker in Germany accidentally struck an unexploded World War II bomb, causing an explosion which killed him and wrecked several passing cars.



A World War II bomb has exploded during construction work on a German highway, killing one worker and injuring several motorists who were driving past, police said.

The worker had been cutting through the road surface near the south-western town of Aschaffenburg when his machine struck the bomb and triggered it. Police said they weren't sure yet what type of bomb it was. "The explosion seems to have been too small for it to have been an aircraft bomb," a police spokesman said.

23rd October 2006

WWII bomb injures 17 at Hattingen construction site



Seventeen people were injured on Friday when a construction crew unwittingly detonated a buried World War II-era bomb in Hattingen.

An excavator apparently drove over a 250-kilogramme (550 pound) American bomb, damaging surrounding buildings. Most of the injured suffered auditory trauma from the blast, and the excavator operator suffered injuries to his hands, police in the German state of North Rhine-Westphalia said.

"The hole was astoundingly small for such a large bomb full of so many explosives," Armin Gebhard, head of the Arnsberg department for military ordnance removal, told The Local. "But of course it damaged all the surrounding buildings too. We are really happy it wasn't worse."

19th September 2013

BBC NEWS

World War II bomb kills three in Germany



A special commission is investigating the causes of the explosion, while prosecutors are considering whether the team leader should face charges of manslaughter through culpable negligence, the BBC's Oana Lungescu reports from Berlin.

The blast happened an hour before the defusing operation was due to start.

Officials said the three men who died were experienced sappers, or combat engineers, who over 20 years had defused up to 700 bombs.

More than 7,000 people were immediately evacuated when the 500kg bomb was found. Several schools, a kindergarten and local companies remain closed.

2nd June 2010



June 2006

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Project: **Swan Street, Manchester**

Ref: **DA12456-00**

Source: Various news sources

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BBC NEWS

Unexploded WW2 bomb forces Salford road closures

6 November 2015 | Manchester

Share



The shell was discovered at the site of the former Royal Ordnance Factory in Green Lane, which has been demolished to make way for housing

An unexploded World War Two bomb has been found at a former munitions factory in Greater Manchester, leading to a partial evacuation of the area.

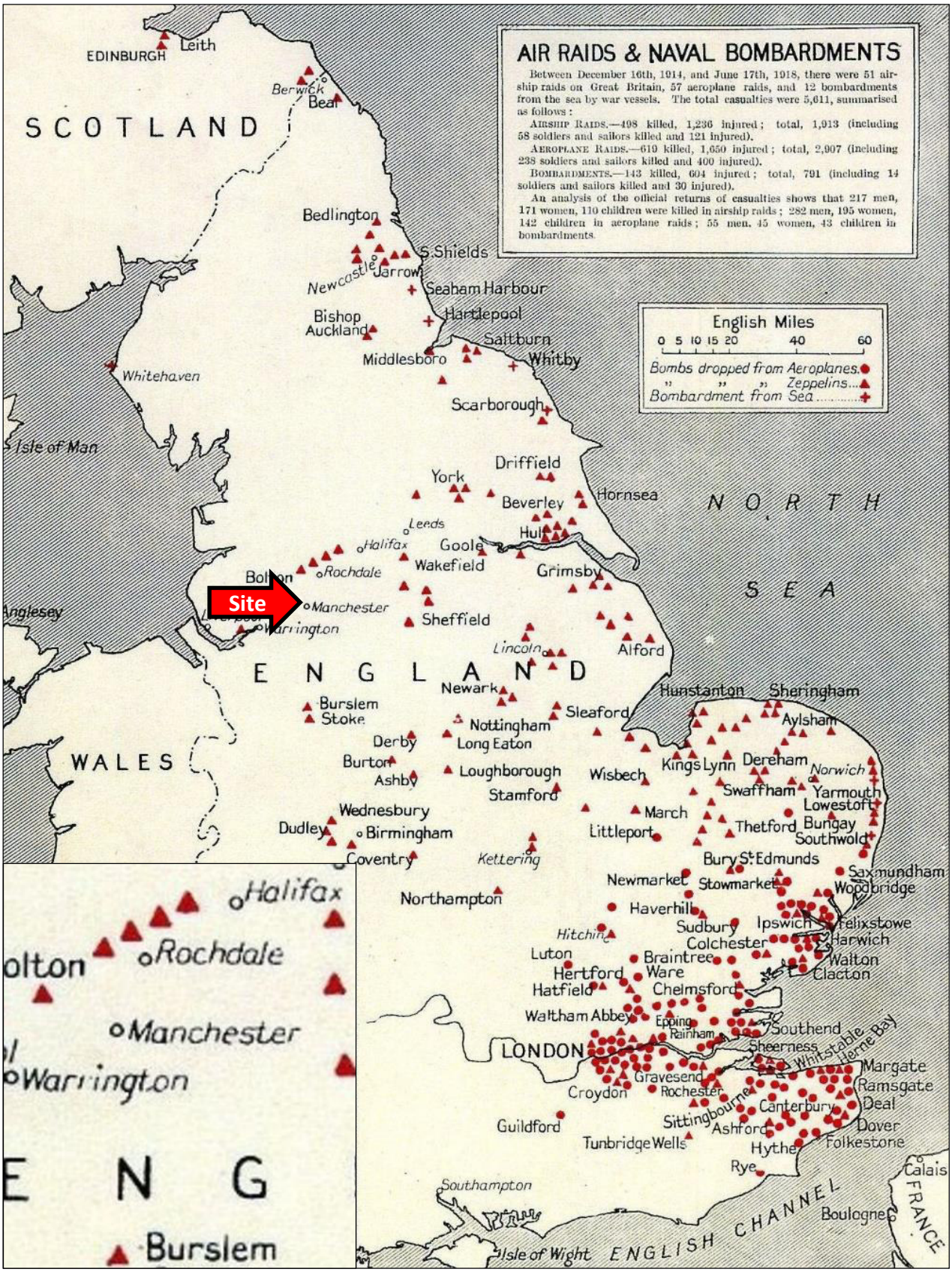
Army bomb disposal experts were called to the former Royal Ordnance Factory in Green Lane, Patricroft, Salford, at about 11:30 GMT.

Surrounding roads were closed while the mortar shell was examined.

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WWI Map of Air Raids and Naval Bombardments

Annex: J



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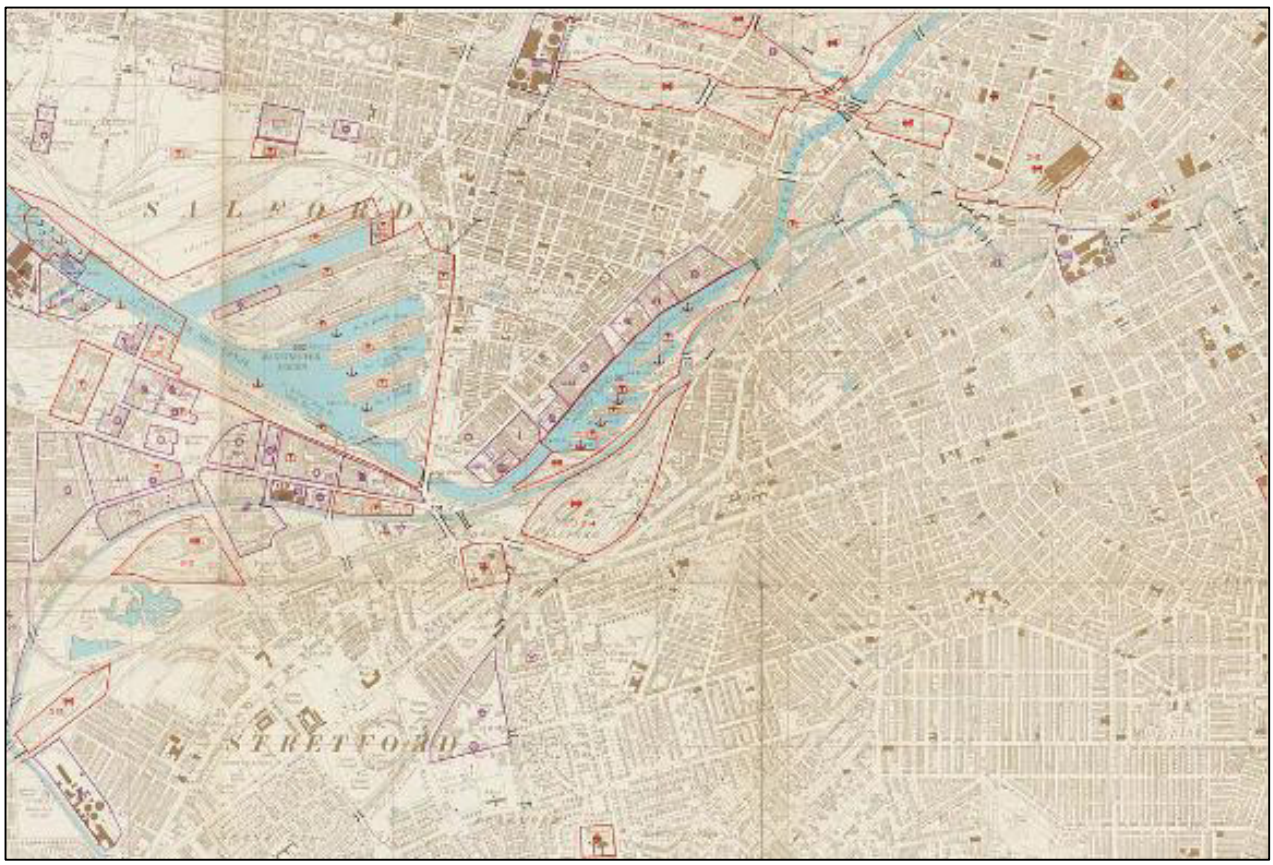
Project: **Swan Street, Manchester**

Ref: **DA12456-00**

Source: J. Morris, *German Air Raids on Britain*

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Luftwaffe Image, Unknown Date



The Salford Dockyards presented an obvious and lucrative target for the Luftwaffe and were resultantly bombed. On 23 March 1941. Among the merchant ships sunk in the attacks on the Salford Docks was SS Stella with its cargo of pig iron. The official handwritten record of incidents notes that three ships (unspecified) were sunk in this attack. Besides the three craft lost, five more cargo boats or liners suffered damage. the SS London II had its anti-mine equipment destroyed through incendiaries.

The docks were hit once more on the night of 7-8 May 1941 with No. 7 Dock and the wharf railways badly damaged. Although no ships were destroyed in this attack – four large merchant ships had narrow escapes from UXBs – the oil installations on both sides of the docks were set ablaze. Some tanks of whale oil were ruptured and some of the burning oil flooded on to the canal banks before being contained.

The site located approximately 3.5km north-east of the Salford Dockyards.

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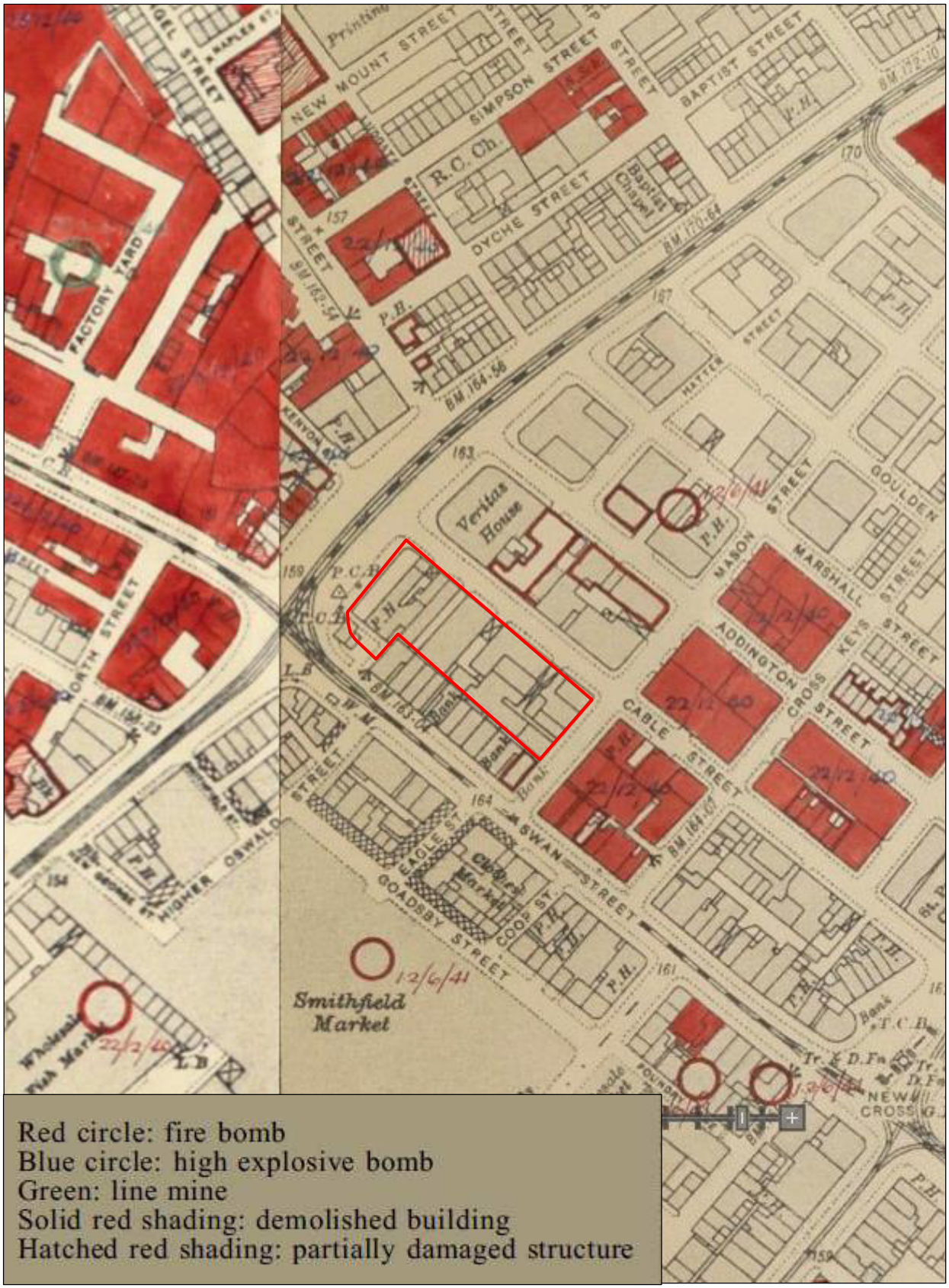
Ref: **DA12456-00**

Source: Nigel J. Clarke, "Adolf Hitler's Home Counties Holiday Snaps"

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Manchester Bomb Damage Map

Annex: L



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Project: **Swan Street, Manchester**

Ref: **DA12456-00**

Source: Manchester University Library

Approximate site boundary

N

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22nd & 23rd December 1940

65. SMITHFIELD MARKET
[MAJOR INCIDENT – SEE NOS 74, 92, 100, 106, 171]
Shower of incendiary bombs in the vicinity of the Market at 8.20 p.m. 22nd. Damage was caused to the roof and various stalls and offices in the Wholesale and Retail Fish and Produce Markets. Several premises in Swan St were extensively damaged by fire. Fires were extinguished by the fire brigade, and the incidents were later closed.

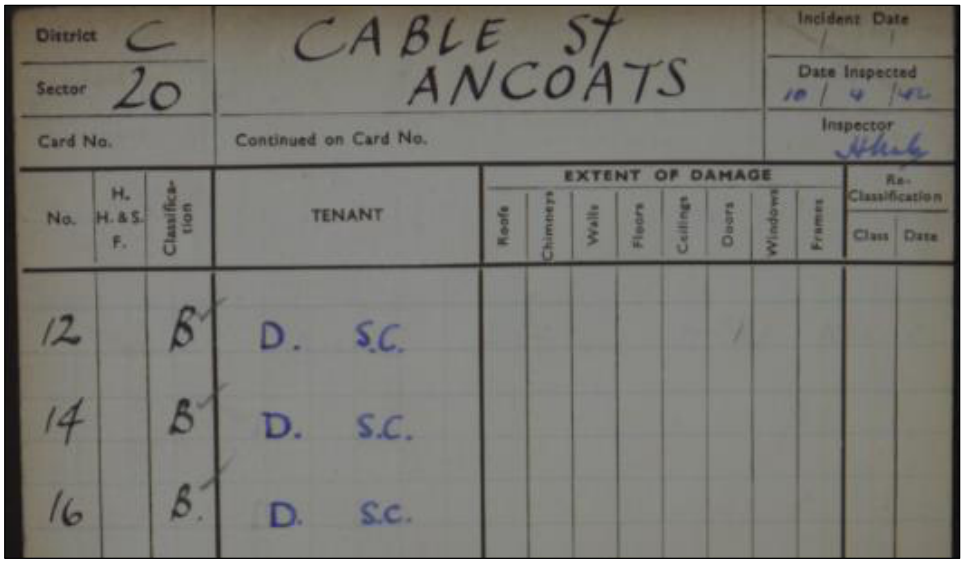
Unknown distance south and south-east of site

80. SWAN ST, BETWEEN OAK ST & TIB ST
Incendiary bomb approx. 9.00 p.m. 22nd.
Serious damage caused to 19 – 19a – 23 & 21 Swan St, by fire. Incident now closed. 12.10 p.m. 23rd.

100m south-east of site

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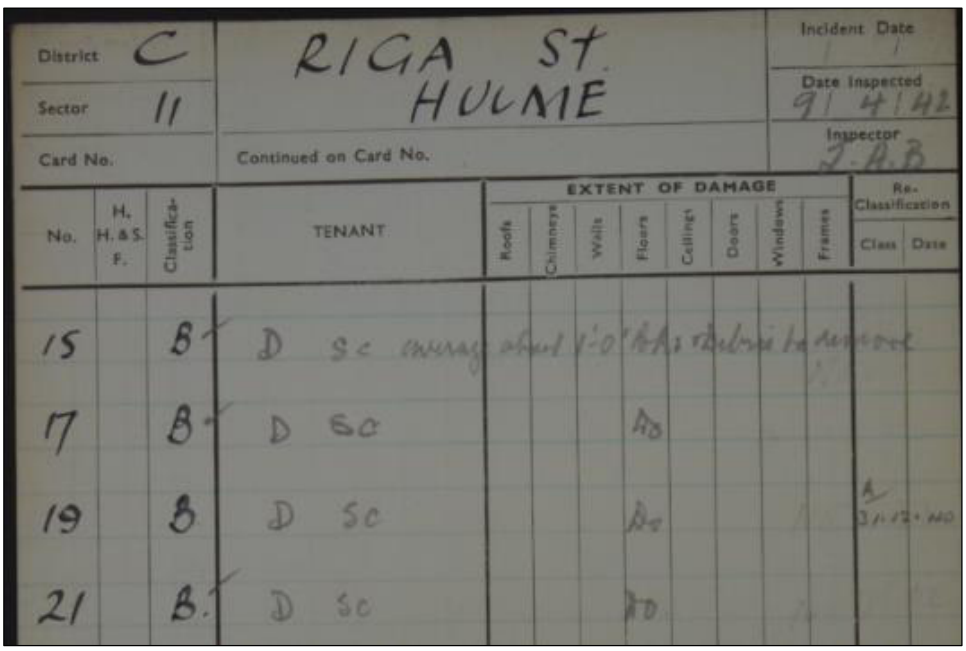
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District C
Sector 20
Card No.
CABLE ST ANCOATS
Continued on Card No.
Incident Date
Date Inspected 10/4/42
Inspector

No.	H. H.&S. F.	Classification	TENANT	EXTENT OF DAMAGE: Roofs	Chimneys	Walls	Floors	Ceilings	Doors	Windows	Frames	Re-Classification: Class	Date
12		B	D. S.C.										
14		B	D. S.C.										
16		B	D. S.C.										

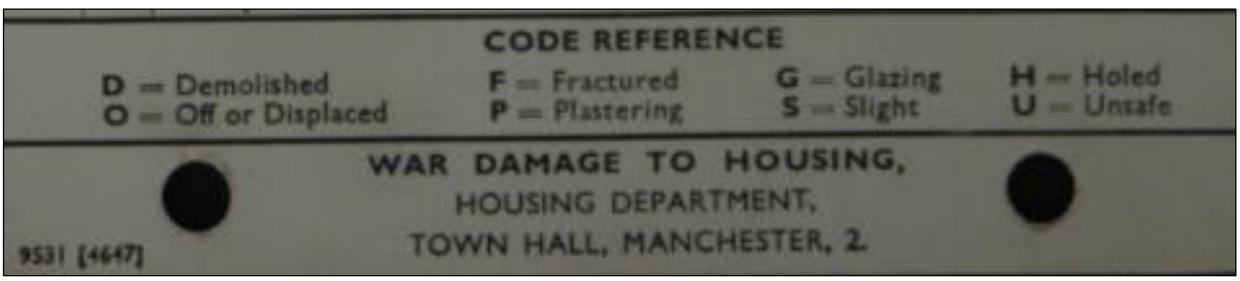
Approximately 10m east – 100m south-east of site



District C
Sector 11
Card No.
RIGA ST. HULME
Continued on Card No.
Incident Date
Date Inspected 9/4/42
Inspector J.A.B

No.	H. H.&S. F.	Classification	TENANT	EXTENT OF DAMAGE: Roofs	Chimneys	Walls	Floors	Ceilings	Doors	Windows	Frames	Re-Classification: Class	Date
15		B	D Sc										
17		B	D Sc				Ho						
19		B	D Sc				Do					A	31.12.NO
21		B	D Sc				Do						

Approximately 100m - 120m west of site



CODE REFERENCE

D = Demolished
O = Off or Displaced
F = Fractured
P = Plastering
G = Glazing
S = Slight
H = Holed
U = Unsafe

WAR DAMAGE TO HOUSING,
HOUSING DEPARTMENT,
TOWN HALL, MANCHESTER, 2.

9531 [4647]

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Post-WWII RAF Aerial Photography 7th May 1946

Annex: **O1**



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Project: **Swan Street, Manchester**

Ref: **DA12456-00**

Source: National Monuments Record Office (Historic England)

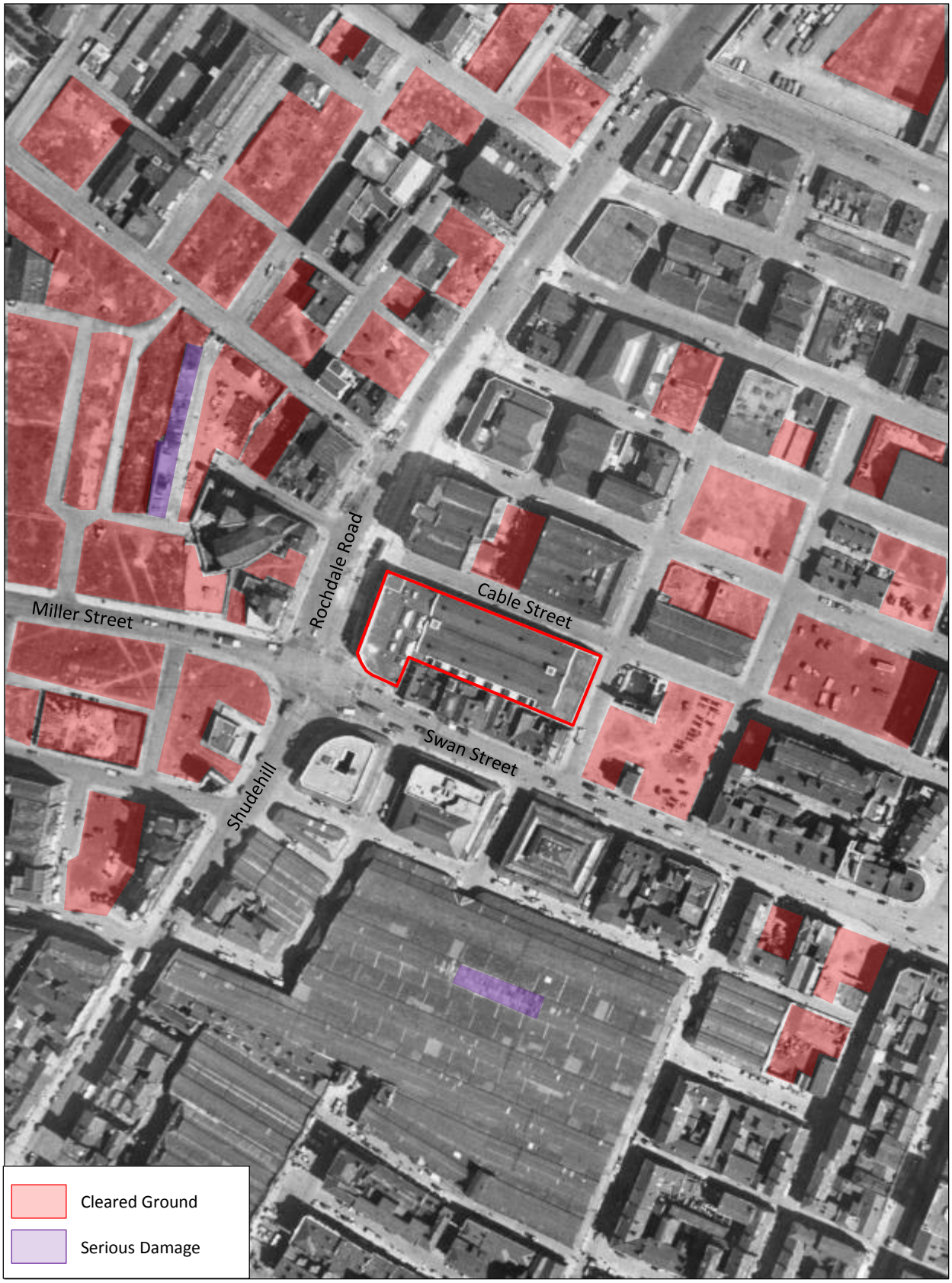
Approximate site boundary

N

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Post-WWII RAF Aerial Photography 7th May 1946 – Damage Overlay

Annex: **O2**



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Client: **Curtins**

Project: **Swan Street, Manchester**

Ref: **DA12456-00**

Source: National Monuments Record Office (Historic England)

Approximate site boundary

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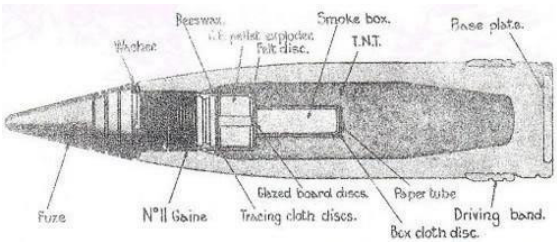
Examples of Anti-Aircraft Projectiles

3.7 Inch QF Anti-Aircraft Projectile

Projectile Weight	28lb (12.6 kg)
Explosive Weight	2.52lbs
Fuze Type	Mechanical Time Fuze
Dimensions	3.7in x 14.7in (94mm x 360mm)
Rate of Fire	10 to 20 rounds per minute
Use	The 3.7in AA Mks 1-3 were the standard Heavy Anti-Aircraft guns of the British Army.
Ceiling	30,000ft to 59,000ft





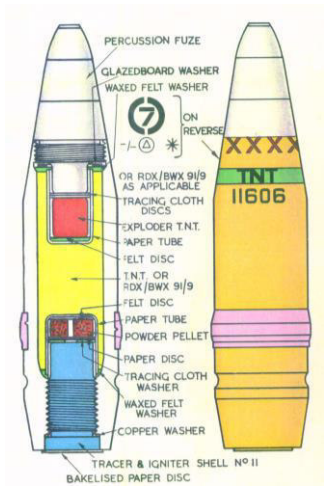


40mm Bofors Projectile

Projectile Weight	1.96lb (0.86kg)
Explosive Weight	300g (0.6lb)
Fuze Type	Impact Fuze
Rate of Fire	120 rounds per minute
Projectile Dimensions	40 x 180mm
Ceiling	23,000ft (7000m)
Remarks	Light quick fire high explosive anti-aircraft projectile. Each projectile fitted with small tracer element. If no target hit, shell would explode when tracer burnt out. Designed to engage aircraft flying below 2,000ft



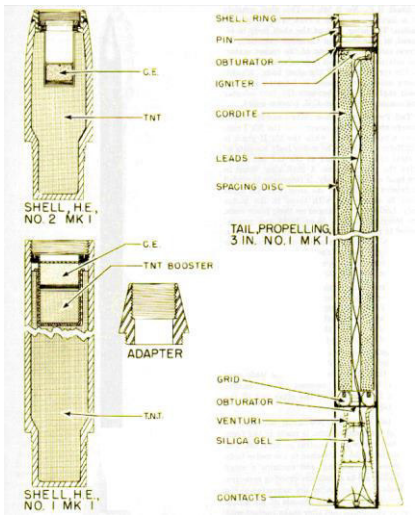




3in Unrotated Projectile (UP) Anti-Aircraft Rocket ("Z" Battery)

HE Projectile Weight	3.4kg (7.6lb)
Explosive Weight	0.96kg (2.13lb)
Filling	High Explosive – TNT. Fitted with aerial burst fuzing
Dimensions of projectile	236 x 83mm (9.29 x 3.25in)
Remarks	As a short range rocket-firing anti-aircraft weapon developed for the Royal Navy. It was used extensively by British ships during the early days of World War II. The UP was also used in ground-based single and 128-round launchers known as Z Batteries. Shell consists of a steel cylinder reduced in diameter at the base and threaded externally to screw into the shell ring of the rocket motor





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Appendix H – 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

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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.

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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 *high probability* that *severe harm* could arise to a designated receptor from an identified hazard at the site without appropriate further action.
High Risk	*Harm* is *likely to arise* to a designated receptor from an identified hazard at the site without appropriate further action.
Moderate Risk	*It is possible* that without appropriate further action *harm could arise* to a designated receptor. It is relatively *unlikely* that any such harm would be *severe,* and if any harm were to occur it is *more likely* that such harm would be *relatively mild.*
Low Risk	*It is possible* that *harm could arise* to a designated receptor from an identified hazard. It is *likely* that, at worst, if any harm was realised any effects would be *mild.*
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.

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