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GROUND INVESTIGATION REPORT

**FOR
TRINITY C OF E HIGH SCHOOL,
HIGHER CAMBRIDGE STREET,
MANCHESTER,**

**PREPARED FOR
TRINITY C OF E HIGH SCHOOL**

**REPORT NO. 7200
MAY 2021**

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**GROUND INVESTIGATION FOR TRINITY C OF E HIGH SCHOOL, HIGHER
CAMBRIDGE STREET, MANCHESTER, M15 6HP**

CLIENT: TRINITY C OF E HIGH SCHOOL

ENGINEER: DAY ARCHITECTURAL LTD

1. INTRODUCTION

This report has been prepared in accordance with Purchase Order No. THA20000547 dated 16th March 2021, from the Client.

The brief was set out in our estimate, ref. E4808 and dated 10th March 2021, with amendments as the investigation proceeded and includes:

- Detailed UXO Risk Assessment
- 2 No. cable percussive boreholes
- Insitu testing
- Geotechnical laboratory testing
- Contamination analysis
- Installation of standpipes followed by groundwater and ground gas monitoring
- Provision of an interpretative report on the above.

Curtins have previously issued a Phase I Preliminary Risk Assessment ref. 076665-CUR-00-XX-RP-GE-001 and dated September 2020 for the site, which should be read in conjunction with this Phase II Ground Investigation Report.

1.1 Site Location and Description

The site is located at Trinity C of E High School, Higher Cambridge Street, Manchester, as indicated on Figure 1. The approximate National Grid Reference of the centre of the site is NGR 84249 86616.

As shown on Figure 2, the irregular shaped site is bounded to the north by two blocks of flats, to the east by Higher Cambridge Street, to the south by Coupland Street and Manchester Rovers Training Ground, and to the west by Boundary Lane. The site comprises of school buildings in the south west, east and north west, sports pitches in the north, a bituminous macadam courtyard in the centre of the site and occasional landscaped areas. The area for investigation is a bituminous macadam surfaced area to the north of the three-storey school building in the east of the site.

1.2 Proposed Development and Purpose of the Ground Investigation

We understand that it is proposed to build a three-storey school building extension, as shown on Figure 3.

The purpose of the investigation was to determine the ground conditions at the positions of the exploratory holes, to assess the likelihood of a general pattern of strata being present below the site and to establish the load bearing characteristics of the strata deriving, if possible, an assessment of the suitability of appropriate founding techniques.

In addition, contamination analysis and assessment was required in order to determine necessary precautions and/or remedial measures required for the proposed development and to ascertain the need for any further sampling and analysis.

Ground gas monitoring and assessment was also required to determine necessary precautions and/or remedial measures.

2. INVESTIGATION

2.1 Investigation Details

Two 150mm diameter boreholes were put down by cable percussive boring techniques at the positions determined and set out by Sub Surface North West, as shown on Figure 4. The boreholes were put down to depths of 8.53 and 9.01 metres, samples taken were logged in accordance with BS EN ISO 14688-1: 2018 and BS EN ISO 14689-1: 2018 and the resulting Borehole Records are appended.

2.2 Sub Surface Detail

Details of the strata encountered in the ground investigation are given on the appended Borehole Records. The exploratory holes generally found Made Ground to depths of 2.50m and 2.80m, overlying brown very sandy gravel, overlying firm to stiff high strength in BH1 and soft low strength becoming firm medium strength in BH2 dark brown clay, overlying medium dense brownish red very silty sand (completely weathered sandstone), overlying extremely weak becoming very weak brownish red sandstone, overlying weak dark red mudstone. The depths of strata found were as follows:

TABLE 1 STRATA

Expl. Hole No.	Depth of Made Ground (m)	Depth of Granular Strata (m)	Depth of Cohesive Strata (m)	Depth to Bedrock (m)	Depth of Hole (m)
BH1	2.50	2.50 – 3.40, 5.30 – 6.00	3.40 – 5.30, -	6.00	9.01
BH2	2.80	2.80 - 3.00, 4.60 – 5.00	3.00 – 4.60, -	5.00	7.53

BH = Borehole

A general summary of the strata found is as follows:

2.2.1 Made Ground

The boreholes recorded Made Ground to depths of 2.50m and 2.80m with a bituminous macadam surfacing to 0.05m, overlying a limestone subbase. The Made Ground consisted of interbedded bands of grey sandy to very sandy fine to coarse gravel sized fragments of stone, brick, concrete and bituminous macadam, dark grey slightly gravelly sandy silty clay and greyish brown to dark grey gravelly clayey fine to coarse sand with cobble sized fragments of concrete, brick and bituminous macadam within the various strata.

2.2.2 Drift Deposits

The boreholes recorded Glaciofluvial Sheet Deposits beneath the Made Ground comprising of brown slightly clayey silty very sandy subangular to subrounded fine to coarse siltstone, sandstone and quartz gravel.

Devensian Till comprising of firm to stiff high strength in BH1 and soft low strength becoming firm medium strength in BH2 dark brown slightly gravelly silty clay was recorded beneath the Glaciofluvial Sheet Deposits.

2.2.3 Bedrock

The Chester Formation (sandstone) underlay the site which was completely weathered to a sand in BH1 from 5.30m and in BH2 from 4.60m, comprising of medium dense brownish red very silty fine to medium sand. The strata became extremely weak and then very weak brownish red fine to medium grained highly weathered sandstone from depths of 6.00m in BH1 and 5.00m in BH2, completely weathered to sand in places.

In BH1, the sandstone was interbedded with mudstone from 8.00m, and became a weak dark red highly weathered mudstone from the Manchester Marls Formation below 8.80m.

2.2.4 Groundwater

No groundwater was encountered in the exploratory holes although it should be noted that they were only left open for a short period of time and groundwater levels and rates of inflow may be subject to seasonal and/ or climatic variations.

Monitoring of standpipes installed in BH1 and BH2 on 14th May 2021 found groundwater to be at 3.05m and 5.10m depth respectively.

3. **SAMPLING, TESTING AND MONITORING**

3.1 **Sampling**

One 100mm diameter undisturbed samples was taken at an appropriate interval in cohesive strata for testing in the laboratory.

Small disturbed and bulk disturbed samples were obtained for the strata encountered and were subjected to careful examination.

The samples will be retained for a period of one month after the issue of this report, for reference purposes, and then disposed of unless otherwise instructed.

3.2 **Field Testing**

Five Cone Penetration Tests (CPTs) and nine Standard Penetration Tests (SPTs) were performed in boreholes, the results of which are recorded on the appended Standard Penetration Test Results Sheet with 'N' values and indicative relative density and shear strength, where appropriate, given on the Borehole Records.

3.3 Installations and Monitoring

On completion of BH1 and BH2, hdpe standpipes were installed to depths of 5.00 metres respectively. The standpipes are slotted from 1.00 metres depth, have an internal diameter of 50mm and have removable quick release gas valves to enable both ground gas and groundwater monitoring and sampling to be undertaken. Details of the installations are given on the Borehole Records.

Monitoring of the standpipes for ground gas and groundwater has been undertaken on one of six scheduled occasions to date using portable equipment. A Gas Data GFM 435 was used for monitoring methane, carbon dioxide, oxygen, gas flows and atmospheric pressure. The results of the monitoring is given on the appended Ground Gas and Groundwater Monitoring Results sheet.

3.4 Laboratory Testing

The following laboratory tests were carried out in accordance with BS.1377: 1990, where applicable, and the results are appended.

- Moisture content, plastic limit and liquid limit tests
- Quick undrained triaxial tests
- Particle size distribution by wet sieve analysis
- Soluble sulphate content and pH value tests.

Contamination analyses have been performed on four soil samples to determine: pH and concentrations of sulphate, sulphide, cyanide, arsenic, boron (soluble), cadmium, chromium, hexavalent chromium, copper, lead, mercury, molybdenum, nickel, selenium, zinc, speciated total petroleum hydrocarbons (TPHs), the speciated polynuclear aromatic hydrocarbons (PAHs) suite, the benzene/ ethylbenzene/ toluene/ xylene (BTEX) suite and phenols. In addition, four soil samples were subjected to an asbestos screen.

The results of the above analyses are appended.

4. APPRAISAL AND RECOMMENDATIONS

4.1 Comments on the Profile

At the outset it should be appreciated that only a small proportion of the area to be developed has been investigated and consequently the recommendations made and opinions expressed in this report can only be applied to such conditions as were encountered in the exploratory holes.

The exploratory holes indicate a nature and degree of similarity to the extent that we consider them likely to be representative of the natural ground conditions. However, no guarantee can be given.

Due to the site having been previously developed, and the nature of Made Ground, localised variations in thickness and composition should be anticipated and hence interpolation or extrapolation from the exploratory holes to adjoining areas should only be undertaken with caution.

Details of the findings of the investigation are given on the appended Borehole Records and a summary of the ground conditions is given in Section 2.2.

4.2 Foundations

We understand that it is proposed to build a three-storey school building extension, as shown on Figure 3. However, at the time of writing this report no specific details regarding the proposed foundations and design loadings were available and consequently the recommendations given are in general terms only.

The ground investigation generally found Made Ground to depths of 2.50m and 2.80m, overlying brown very sandy gravel, overlying firm to stiff high strength in BH1 and soft low strength becoming firm medium strength in BH2 dark brown clay, overlying medium dense brownish red very silty sand (completely weathered sandstone), overlying extremely weak becoming very weak brownish red sandstone, overlying weak dark red mudstone.

We would not recommend founding in the Made Ground in its present condition because of its inherent variability in consistency and compaction, and in parts the nature of its constituents.

Atterberg limit tests on the cohesive strata indicate clays of low to intermediate plasticity which are considered to have a low susceptibility to shrinkage and swelling with varying moisture content. If buildings are to be constructed adjacent to existing trees, trees are to be removed and/or trees are to be planted then the guidelines given in the National House Building Council (NHBC) Standards Chapter 4.2, 'Building Near Trees', should be followed for clays of low shrinkage and swelling potential.

In view of the depth of Made Ground and soft low strength clay to 4.15m, shallow foundations in natural ground are unlikely to be feasible and we would recommend using pile foundations.

With regard to the choice of pile type, we would not recommend using driven piles as any vibrations set up during the driving process are likely to be transmitted to adjacent/ nearby buildings, structures and/or services which as a result may be detrimentally affected. Consequently, we would recommend using continuous flight auger (CFA) piles or cast in-situ bored piles.

Care must be taken to space the piles in any group to ensure the adequate utilisation of skin friction where this has been assumed in the calculation of the load bearing capacity of an individual pile. Checks must also be undertaken to confirm that the underlying ground supporting the pile group is not overstressed.

In determining the final pile design, it should be noted that up to 2.80 metre of the piles will be in Made Ground and due regard should be paid to the lack of lateral restraint over this length in cases where significant lateral forces are to be catered for.

To provide assistance for estimating purposes only, we have undertaken a preliminary pile design calculation for a 9.00m long pile taking into consideration the ground conditions at BH1, as follows:

Preliminary Pile Design based on strata in BH1 (water at 3.05m)

Bored Cast In-situ or CFA Pile Factor of Safety: 2.5 (shaft), 3.0 (end)
Dia. = 0.30m, Perimeter = 0.94m, Cross Section Area = 0.07m², Length = 9.00m

0.00 to 3.40m	Made Ground and GRAVEL	ignore
3.40 to 5.30m	High strength CLAY Allowable Shaft Friction Allowable Shaft Friction Load	$\bar{c} = 80 \text{ kN/m}^2$ $= 19.2 \text{ kN/m}^2$ $= \underline{34 \text{ kN}}$
5.30 to 6.00m	Medium dense very silty fine to medium SAND Allowable Shaft Friction Allowable Shaft Friction Load	(N = 20) $= 11.2 \text{ kN/m}^2$ $= \underline{7 \text{ kN}}$
6.00 to 9.00m	Ex weak to very weak SANDSTONE/MUDSTONE Allowable Shaft Friction Allowable Shaft Friction Load	($\bar{N} = 50/57\text{mm}$) $= 120 \text{ kN/m}^2$ $= \underline{338 \text{ kN}}$
9.00m	Weak MUDSTONE Allowable End Bearing Allowable End Bearing Load	(N = 50/5mm) $= 2000 \text{ kN/m}^2$ $= \underline{140 \text{ kN}}$

Total Allowable Working Load = 34 + 10 + 338 + 140 = 522 kN

In order to use the load carrying capacity attributable to both shaft friction and end bearing, the final design figures should be checked to ensure that the ultimate shaft friction is greater than or equal to the allowable working load, otherwise end bearing only should be used.

There is a possibility that for piles installed through a significant thickness of Made Ground some continuing self-weight and consolidation settlement might take place and exert negative skin friction. Due allowance should be made for this in any pile design.

We recommend that for piles taken down to rockhead, the piles are socketed by at least three pile diameters below rockhead level, and the length of adjacent piles should be carefully checked to ensure that piles are not founded on a steeply sloping rock interface or on rock ledges.

To formulate the most satisfactory and economic scheme we suggest that competitive tenders and designs from Specialist Piling Contractors should be sought using the borehole information obtained.

We recommend that a flexible joint is provided between the existing and proposed buildings to allow for differential movement.

4.3 Floor Slab Construction

With regard to the design and construction of normal ground bearing floor slabs, it should be noted that due to the thickness of Made Ground there will be a risk of significant total and differential settlements, the extent of which will be a matter of chance rather than being assessable by calculation.

To obviate any significant damaging settlements we would recommend using a suspended floor slab with intermediate support designed on the same basis as the main foundations where the spans are too large for economical single suspended slab design.

4.4 Excavations and Groundwater

There should be no particular difficulties in excavating the strata indicated in the exploratory holes utilising an appropriate and suitably sized mechanical excavator. However, the bituminous macadam will need to be broken out prior to excavation.

It is recommended that all excavations to greater than 1.20 metres depth, or for shallower excavations where groundwater is encountered above this level, are closely supported, especially where man entry is required. Alternatively, where space permits, the excavations might be battered back to an appropriate angle.

No groundwater was encountered in the exploratory holes although it should be noted that they were only left open for a short period of time and groundwater levels and rates of inflow may be subject to seasonal and/ or climatic variations.

Monitoring of standpipes installed in BH1 and BH2 on 14th May 2021 found groundwater to be at 3.05m and 5.10m depth respectively.

Given the limited information, groundwater seepages or inflows are not anticipated in shallow excavations. However, should groundwater seepages occur and water accumulate in the excavation it should be able to be removed by pumping from a filtered sump.

4.5 Buried Concrete

For the design of buried concrete the recommendations given in Building Research Establishment (BRE) Special Digest 1 (February 2017 revision), "Concrete in Aggressive Ground", should be followed.

Determination of pH on the soil samples gave values in the range of 8.4 to 9.3 (alkaline).

Soluble sulphate concentrations were also determined for the soil samples and the results ranged from <0.01 to 1.10 g/l. The results indicate that the Design Sulphate Class for the site should be DS-2.

Our knowledge of the site and ground conditions indicates that the site is "brownfield" with potentially mobile groundwater. Consequently, in accordance with the Design Sulphate Class for the site together with the site and groundwater conditions an Aggressive Chemical Environment for Concrete (ACEC) classification of AC-2 should be used as detailed on the appended extract.

4.6 Contamination Considerations

Curtins have previously undertaken a Phase I Preliminary Risk Assessment ref. 076665-CUR-00-XX-RP-GE-001 and dated September 2020 and this Phase II ground investigation has been undertaken to provide an initial contamination risk assessment in accordance with the Phase I Conceptual Ground Model. Based upon the findings of the above additional sampling, analysis and assessment may be required.

It should be appreciated that the suite of determinants analysed for consists of a range of contaminants identified in the Conceptual Ground Model. However, the absence of any other specific contaminants cannot be guaranteed.

4.6.1 Assessment (Soil)

In order to provide an assessment of the presence of contamination four soil samples have been analysed for a suite of determinants and the results are appended.

Levels of the determinants have been compared against the most recently published guideline values. Contaminated Land: Applications in Real Environments (CL:AIRE) published guideline values in December 2009 to supplement previous guideline values. The Department for Environment, Food and Rural Affairs (DEFRA) published in March 2014 Category 4 Screening Levels (C4SLs) for arsenic, cadmium, lead, hexavalent chromium, benzo(a)pyrene and benzene. Land Quality Management Limited (LQM)/ Chartered Institute of Environmental Health (CIEH) then published Suitable for Use Levels (S4ULs) in November 2014, which largely superseded the previous guideline values. Updated S4ULs values for cadmium and phenols were published in July 2015 and for nickel in August 2015. The guideline values (S4ULs and occasionally C4SLs and CL:AIRE) are derived using the Environment Agency's CLEA Model and vary dependent upon the land use; allotment and residential use being the most sensitive and commercial/ industrial use being the least sensitive.

For the purposes of assessment, as the proposed development is school building, contamination analyses have been compared with the guideline values for a standard land use of residential without plant uptake (without homegrown produce).

When compared with published guideline values for a standard land use of residential without plant uptake (without homegrown produce), the contamination analysis determined elevated levels of a number of contaminants with varying distribution, as tabulated below:

TABLE 2 ASSESSMENT OF SOIL CONTAMINATION

Determinant	Expl. Hole No.	Depth (m)	Recorded Level (mg/kg)	Published Guideline Value (mg/kg)
lead	BH1	1.00	330	310
	BH2	0.40 - 1.00	500	310
	BH2	1.20 - 1.65	1100	310
benzo(b)fluoranthene	BH1	1.00	4.1	4.0
benzo(a)pyrene	BH1	1.00	3.5	3.2
dibenzo(ah)anthracene	BH1	1.00	2.2	0.32

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Guideline values for the assessment can be supplied directly to the Regulator, if requested.

The ratios of the Polynuclear Aromatic Hydrocarbons (PAHs): benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(123-cd)pyrene, dibenzo(ah)anthracene and benzo(ghi)perylene have been assessed in the tables appended to the contamination analysis results. The profile of the PAHs was found to match the ratio profile of the coal tar test material studied by Culp et al in 1998 allowing PAHs to be assessed against the C4SL for benzo(a)pyrene as a surrogate marker. The maximum determined benzo(a)pyrene level of 3.5 mg/kg is significantly lower than the published C4SL for residential without plant uptake of 5.3 mg/kg and consequently, in our opinion, the level of PAHs, including benzo(b)fluoranthene, benzo(a)pyrene and dibenzo(ah)anthracene, are within acceptable limits.

Given the above, elevated levels of lead are present in the Made Ground. The pathway from the source to site operatives during earthworks, the end users of the development and any proposed planting (receptors) will need to be removed by precautions and/ or remedial measures.

An asbestos screen was undertaken on four soil samples and no asbestos was detected.

In addition to the above, an assessment of risk to personnel who will come into contact with on-site materials throughout the site has been undertaken.

4.6.2 Conclusions and Recommendations

Section 78a(2) of the Environmental Protection Act: 1990 as amended by the Contaminated Land (England) (Amendment) regulations 2012, and Section 86 of the Water Act 2003, defines CONTAMINATED LAND for the purposes of Part IIA as:

“any land which appears to the LOCAL AUTHORITY in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that:

- (a) SIGNIFICANT HARM is being caused or there is a SIGNIFICANT POSSIBILITY of such harm being caused; or
- (b) SIGNIFICANT POLLUTION OF CONTROLLED WATERS is being, or is likely to be, caused"

Before a LOCAL AUTHORITY can make the judgement that land appears to be CONTAMINATED LAND on the basis that SIGNIFICANT HARM is being caused, or that there is a SIGNIFICANT POSSIBILITY of such harm being caused, the LOCAL AUTHORITY must identify a SIGNIFICANT POLLUTANT LINKAGE. This means that each of the following has to be identified:

- (a) a CONTAMINANT;
- (b) a relevant RECEPTOR (defined as living organisms, ecological systems, controlled waters or property); and
- (c) a PATHWAY by means of which either:
 - (i) the CONTAMINANT is causing SIGNIFICANT HARM to that RECEPTOR, or
 - (ii) there is a SIGNIFICANT POSSIBILITY of such harm being caused by that CONTAMINANT to that RECEPTOR

It should be noted that the words in capitals have a legal definition within the legislation.

Without a clear identification of all three elements of the pollutant linkage, land cannot be identified as contaminated under the regime.

The National Planning Policy Framework states that, "after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990". Therefore, the general principles detailed above apply to this assessment.

Our assessment, based on four soil samples, indicates elevated levels of lead are present in the near surface Made Ground/ soils (source). The pathway from the source to site operatives during earthworks, the end users of the development and any proposed planting (receptors) will need to be removed by precautions and/ or remedial measures.

As much of the contaminated ground will be covered by buildings, hardstandings, car parks and roads for the proposed development we consider that no other surface protection will be necessary. However, if there are any landscaped/ planted borders and open space areas, then in these areas, we recommend that a 450mm blanket of imported clean topsoil/ subsoil should be placed on top of an antidig layer (geotextile membrane or 100mm of single sized stone) to protect the end users of the development and to provide a medium in which plants may grow unhindered. In addition trees and bushes, due to their deeper root system, should be pit planted on and in clean topsoil.

Waste Management

Contaminated materials should, where possible, be retained on site. However, it should be appreciated that contaminated material left on site is the legal responsibility of the landowner, unless the person who created the contamination can be identified.

If waste materials are to be removed from the site, classification of the waste should be undertaken to determine the most appropriate tip to use and the associated costs. It should be noted that significant cost savings can sometimes be made on waste disposal by correct classification of the waste, a service that we can provide.

It should be noted that all vehicles carrying contaminated material should be securely sheeted and the wheels and undercarriages cleaned before leaving site to ensure that hazardous materials are not dropped onto public roads.

Site Operatives

S4ULs, C4SLs and CL:AIRE assume long term contact with contamination and assess chronic health risk. The risk of short term acute exposure to site personnel is dealt with in the remit of the Health and Safety Executive under the Health and Safety at Work Act: 1974 and Regulations made under the Act, including the Control of Substances Hazardous to Health (COSHH) Regulations. The levels of contamination and risk to site personnel should be considered under the Construction Design and Management (CDM) Regulations at the planning stage and in the development of the designers and contractors Health and Safety Plans and Method Statements. The risk of contact with on-site soils should be minimised and the following precautions should be taken as a minimum requirement.

Site personnel involved in earthworks and excavations should wear gloves, overalls, and boots and smoking should be prohibited.

4.7 Ground Gas Considerations

Ground gas monitoring has been undertaken on one of six scheduled occasions to date and the results of the monitoring visit is appended.

Ground gases: methane, carbon dioxide and oxygen and flow rate have been monitored and the ranges of ground gases and flow rate during the monitoring period are as follows:

TABLE 3 GROUND GAS CONCENTRATIONS AND FLOW RATE

Methane (% vol. In air)	Carbon Dioxide (% vol. in air)	Oxygen (% vol. in air)	Gas Flow Rate (litres/ hour)
0.0	0.7 – 1.6	19.2 – 18.0	<0.1

To date, it can be seen from the monitoring that no elevated levels of methane, gas flows or depleted levels of associated oxygen have been detected. However, an elevated level of carbon dioxide has been detected in BH1.

Methane gas when present between 5% volume in air (Lower Explosive Limit - L.E.L.) and 15% volume in air (Upper Explosive Limit - U.E.L.) is potentially explosive and inflammable whilst carbon dioxide in conjunction with depleted oxygen is an asphyxiant. Both methane and carbon dioxide are a by-product of the anaerobic and aerobic decomposition of biodegradable materials.

The levels of gas have been assessed in accordance with British Standard 8485, "Code of practice for the design of protective measures for methane and carbon dioxide gasses for new buildings", published in June 2015 and updated in January 2019 (BS.8485:2015+A1:2019).

The characteristic hazardous gas flow rate (Q_{hgs}) is calculated by dividing the maximum gas (methane or carbon dioxide) concentration by 100 and multiplying by the maximum flow rate in litres per hour (minimum 0.1 l/hr for Sub Surface monitoring equipment). For this site $Q_{hgs} = [1.6 / 100] \times 0.1 = 0.0016$ l/hr

Based on the monitoring to date, BS.8485:2015+A1:2019, Table 2, indicates that the site falls into Characteristic Situation 1 (CS1).

BS.8485:2015+A1:2019, Table 4, indicates that for a CS1 and the type of development proposed a score of zero gives no protection and remedial measures required.

All excavations of greater than 1.20 metres depth should be routinely checked for air quality prior to man entry and appropriate precautions taken.

Any manholes, inspection chambers or other void spaces formed beneath the sites ground surface are potential ground gas traps. Precautions, as per the excavations above, should be taken.

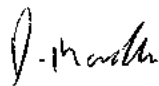
It should be noted that it is our intention to update this section of the report on completion of the ground gas monitoring.

4.8 General

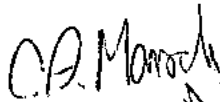
We recommend that consultation should be undertaken with, and the written approval obtained from, the Local Authority Building Control Officer and the Coal Authority prior to commencing development.

We trust that this report fulfils your present requirements but if you have any queries or we can be of further assistance please contact the undersigned or Miss Anna Marsden at our Preston office.

SUB SURFACE CONSULTANTS LIMITED
REPORT No. 7200
MAY 2021



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**DETAILED UNEXPLODED ORDNANCE (UXO)
RISK ASSESSMENT**

Detailed Unexploded Ordnance Risk Assessment

Site: **Trinity C of E High School, Manchester**

Client: **Trinity Church of England High School**

Ref: **8854 RA**

Date: **8th April 2021**

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Glossary of Terms

AAA	Anti-Aircraft Artillery
ARP	Air-raid Precautions
BDO	Bomb Disposal Officer
EOD	Explosive Ordnance Disposal (current term for "bomb" disposal)
HE	High Explosive
HG	Home Guard
IB	Incendiary Bomb
Kg	Kilogram
LM	Land Mine
LSA	Land Service Ammunition (includes grenades, mortars, etc.)
Luftwaffe	German Air Force
m bgl	Metres Below Ground Level
MoD	Ministry of Defence
OB	Oil Bomb
PM	Parachute Mine
RAF	Royal Air Force
SI	Site Investigation
SAA	Small Arms Ammunition (small calibre cartridges used in rifles & machine guns)
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
V-1	"Doodlebug" the first cruise type missile, used against London from June 1944. Also known as 'Flying Bomb'
V-2	The first ballistic missile, used against London from September 1944
WWI	First World War (1914 -1918)
WWII	Second World War (1939 – 1945)

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Executive Summary

THE SITE:	
Address	Trinity High School, Boundary Lane, Manchester M15 6HP
OS National Grid Reference	SJ 84232 96569
Details	The site comprises the Trinity High School complex, with the main structures situated at the south and east of the study area. In addition, much of the site is occupied by hard standing in the form of parking facilities and recreational areas. The north of the site largely consists of playing fields, with an additional multi-storey structure to the north-west. The study area has access onto Boundary Lane in the west and High Cambridge Street to the east. In addition, peripheral wooded vegetation borders much of the study area.
PROPOSED WORKS:	
Proposed works include 3 cable percussive boreholes to depths of 10m bgl.	
Risk Assessment Methodology: In accordance with CIRIA guidelines this assessment has carried out research, analysed the evidence and considered the likelihood that the site has been contaminated with unexploded ordnance; that such items remained on site; the risk that they could be encountered during any intrusive works and the consequences that could result. Appropriate risk mitigation measures have been proposed.	
Explosive Ordnance Risk Rating	LOW and MEDIUM zones
Risk Map	Annex N
ELEVATED THREAT OF UXO CONTAMINATION FROM GERMAN AIR-DELIVERED UXO:	
- Between July 1940 and July 1942, Greater Manchester suffered repeated and widespread bombing, due primarily to the industry located within the city. The Luftwaffe mounted consecutive heavy attacks on the nights of the 22/23rd and 23/24th December 1940, leaving large areas of Manchester devastated. In total these two successive nights became known as the 'Manchester Blitz'. - During the war, the site was predominantly occupied by terraced housing fronting a number of roadways, along with their respective residential gardens. - A Luftwaffe Target Map shows the site lying in close proximity to the Manchester Victoria University, a designated bombing target. Consequently, the site area experienced a moderate bombing density, as confirmed by official statistics and mapping. - This is confirmed by a Damage & Bomb Plot Map of Manchester which records 2 x HE bomb strikes onsite, with a further 19 x large bomb strikes within the immediate vicinity. Anecdotal evidence also suggests	

that the nearby Manchester Royal Infirmary (approximately 600m south-east) received two direct hits, and significant blast damage. • This map additionally records extensive bomb damage to several residential buildings on site as well as further damage within the north of the site. Review of post-war OS mapping shows significant areas of clearance across the study area, with significant redevelopment to the south and east. • As such, at the locations of severe bomb damage, it is likely that a degree of rubble / debris would have occupied the area for some time. Furthermore, seriously damaged structures would likely have been abandoned (along with any associated gardens / open ground) for the remainder of the war. • In such conditions, it is entirely conceivable that had a subsequent UXB fallen onsite, it could have remained undetected and the subsequent entry hole unobserved, particularly as many of these areas would not be subject to formal post-raid checks for UXO. • Note that the entry hole of an SC50 (the most commonly deployed German HE bomb) could have been as little as 20cm in diameter and therefore easily obscured in rubble / debris. This is especially pertinent as nearly all air raids on the city occurred at night. • Had such incidents occurred, a UXB could have eventually come to rest beneath neighbouring undamaged roadways and buildings onsite due to the 'J-Curve Effect'. • A UXB strike to undamaged buildings / hard-standing roadways onsite would have caused substantial / obvious damage (even without detonating) or a persistent, easily identifiable entry hole, which would very likely have been observed and reported at the time and the UXB subsequently removed.	
THREAT OF CONTAMINATION FROM BRITISH / ALLIED UXO:	
Land Service Ammunition / Small Arms Ammunition	• Five HG battalions were based in proximity to the site during WWII; with the 61st Battalion stationed at Burlington Street Drill Hall, approximately 150m south. • Although typically HG battalions would take part in training exercises in areas occupied by open countryside, there are several examples of HG units carrying out invasion training in urban areas. • However, given the density of urban development, the location within the city centre, and the absence of significant open ground, it is highly unlikely that any such HG activity would have occurred onsite.
Anti-Aircraft Projectiles	• 9 x HAA batteries were recorded within 5km of the site, the nearest of which was located approximately 2.3km south-east. • It is also possible that additional temporary LAA batteries may have been brought to the area during the heaviest raids over the city. • At the locations of severe bomb damage onsite, it is likely that a significant volume of rubble / debris would have occupied the area for some time. • In such conditions, an unexploded AA shell falling onsite could easily have been overlooked, particularly as many of these areas would not be subject to formal post-raid checks for UXO. • Furthermore, given the high bombing density of the area and proximity of bombing targets, it is likely that a significant volume of AA shells was expended over the wider area in order to defend such targets from bombing.

	• However, an unexploded AA shell falling on undamaged buildings / hard-standing roadways onsite would have caused obvious damage or a persistent, easily identifiable entry hole, which would have been reported and subsequently removed.	
BOMB PENETRATION ASSESSMENT:		
It has been assessed that a 500kg bomb would have had an approximate maximum bomb penetration depth of between 8-10m below WWII ground level. Penetration depth could potentially have been greater if the UXB was larger (though only 4% of German bombs used in WWII over Britain were of that size). Note that UXBs may be found at any depth between just below the WWII ground level and the maximum penetration depth.		
THE LIKELIHOOD THAT UXO REMAINS ON SITE:		
Within the footprints of the post-war redevelopment / ground works, the risk of shallow buried UXO (especially German 1kg incendiaries) remaining will have been partially mitigated since any such items could have been encountered and removed during soil stripping and levelling. In addition, only within the volume of any post-war basement level bulk excavations and at the precise locations of any post-war pile foundations / boreholes, will the risk from deeper buried German HE UXBs have been completely mitigated. Whilst the site has been significantly developed post-war, the exact footprint or depth of any foundations / piling is unknown. Beyond the maximum depth of, outside the footprint of, and amongst (i.e. between piles) these post-WWII redevelopments, the UXO risk is unmitigated and will remain Medium down to 10m bgl (maximum bomb penetration depth). Within these medium risk areas, we would continue to recommend the UXO mitigation measures detailed within the report prior to any intrusive works.		
THE RISK THAT ORDNANCE MAY BE INITIATED:		
The most violent activity on most construction sites is percussive piling or deep mechanical excavations. If an item is struck with a significant enough impact, be it direct or through friction/vibration, it risks detonation. Drilling of boreholes or similar activities also have the potential to initiate ordnance in this manner, either through impact or vibration. Soil levelling and shallow excavation such as trial pits can pose a similar risk, since UXO can be found at any depth between ground level and the maximum bomb penetration depth. In addition to risk of initiation by violent impact or vibration, detonation can also occur if discovered items are mishandled by unqualified personnel. This is particularly common when onsite personnel are not trained in the recognition of ordnance. For works that are not intrusive, little risk is posed by items of UXO that are buried beneath the ground. However, risk can arise from unburied munitions, particularly items of ordnance discarded in periphery areas of military sites. These items are frequently discovered by onsite personnel and remain live and liable to activate if mishandled.		
RECOMMENDED RISK MITIGATION MEASURES:	Low Risk Zone	Medium Risk Zone
Site Specific Explosive Ordnance Safety and Awareness Briefings (UXO Toolbox Briefing) to all personnel conducting intrusive works	✓	✓

Site Specific Safety Instructions (SSSI)	✓	✓
Explosive Ordnance Disposal (EOD) Engineer On-Site Support	✗	✓
Explosive Ordnance Disposal (EOD) Engineer to support site investigation works	✗	✓
Search & Clear	✗	✗
Non-Intrusive Magnetometer Survey and Target Investigation (greenfield land only)	✗	✗
Intrusive Magnetometer Survey of all pile locations down to the maximum bomb penetration depth	✗	✓
In making this assessment and recommending these risk mitigation measures, the proposed works outlined in the 'Scope of the Proposed Works' section were considered. Should the planned works be modified, or additional intrusive engineering works be considered, SafeLane Global should be consulted to see if re-assessment of the risk or mitigation recommendations is necessary.		

Annexes

Annex A	Site Location Maps
Annex B	Recent Aerial Photograph
Annex C	Proposed Site Plan
Annex D	Pre and Post-WWII OS Maps
Annex E	German Air-Delivered Ordnance
Annex F	Recent WWII-era German UXB Finds in the UK
Annex G	The J-Curve Effect
Annex H	Manchester Damage & Bomb Plot Map
Annex I	Recent UXO Incidents – Home Guard
Annex J	Land Service Ammunition
Annex K	Small Arms Ammunition
Annex L	Anti-Aircraft Artillery
Annex M	UXO Press Articles
Annex N	Risk Map

Detailed Unexploded Ordnance Risk Assessment

In Respect of

Trinity C of E High School, Manchester

1 Introduction

1.1 Background

Trinity Church of England High School has commissioned SafeLane Global to conduct a Detailed Unexploded Ordnance Risk Assessment of Trinity C of E High School, Manchester.

Unexploded Ordnance (UXO) presents a significant risk to construction projects in parts of the UK as a result of enemy actions during the two 20th Century World Wars and historic British and Allied military activity.

One of the legacies of this conflict is buried unexploded air-dropped bombs or anti-aircraft projectiles resulting from the failure of a proportion of the weapons to function as designed. It is commonly accepted that the failure rate of these munitions was approximately 10% and, depending on their shape, weight, velocity and ground conditions, many penetrated the ground and came to rest at depth.

In addition, it is estimated that over 20% of the UK landmass has been used by the military at some point and between 2006 and 2009, over 15,000 items of British / Allied ordnance (excluding small arms ammunition) were found on UK construction sites (CIRIA).

Intensive efforts were made during and after the war to locate and render safe all UXO but, unsurprisingly, not all were found and dealt with. This is evidenced by the regular, on-going discoveries of UXO during construction-related intrusive ground works.

As a result of a generally increased risk awareness amongst professionals involved in ground engineering works and proactive health and safety measures, the risk to life and limb from UXO has been minimised. However even the simple discovery of a suspected device during on-going works can cause considerable disruption to production and cause unwanted delays and expense.

Such risks can be more fully addressed by a better understanding of the site-specific risk and the implementation of appropriate risk mitigation measures.

2 Construction Industry Duties and Responsibilities

2.1 The UK Regulatory Environment

There is no legal requirement for the control and mitigation of UXO risk in the construction industry, but guidelines for good practice, information, and solutions with regards to UXO risk are detailed within CIRIA (C681).

These guidelines provide the construction industry with a set process for the management of risk associated with UXO, from preliminary risk assessment to implementation of site-specific risk mitigation strategies.

Specific legislation does however exist for health and safety, and is addressed under a number of regulatory instruments, as outlined below.

In practice, the regulations impose a responsibility on the construction industry to ensure that they discharge their obligations to protect those engaged in ground-intrusive operations (such as archaeology, site investigation, drilling, piling or excavations) from any reasonably foreseeable UXO risk.

2.2 The Health and Safety at Work Act, 1974

The Act places a duty of care on an employer to put in place safe systems of work to address, as far as is reasonably practicable, all risks (to employees and the general public) that are reasonably foreseeable.

2.3 Construction (Design and Management) Regulations 2015

CDM 2015 ensures that health and safety within the construction industry is continually improved:

- Works are sensibly planned and managed.
- Competent staff are engaged in the works.
- Risks are identified and managed.
- All parties cooperate and coordinate activities.
- Communication flows to those who require it.
- Workers are consulted and engaged about risks and how they are being managed.

In line with CDM 2015 legislation, SafeLane Global are able to assist parties in their discharge of CDM duties as follows:

- Assist Principal Designers with pre-construction information and risk assessments.
- Assist the Designer with the Designer's Risk Assessment.
- Issue UXO risks as have been identified and manage risks accordingly.
- Assist the Principal Contractor with the construction phase information, in particular risk assessments and mitigation strategies.
- Plan, manage and monitor survey and clearance works under SafeLane Global's control.

2.4 Other Legislation

Other relevant legislation includes the "Management of Health and Safety at Work Regulations 1999" and "The Corporate Manslaughter and Corporate Homicide Act 2007".

3 The Role of the Authorities and Commercial Contractors

3.1 The Authorities

The Police have the responsibilities for co-ordinating the emergency services in the case of an ordnance-related incident on a construction site. They will make an initial assessment (i.e. is there a risk that the find is ordnance or not?) and if they judge necessary impose a safety cordon and/or evacuation and call the military authorities (JSEODOC - Joint Services Explosive Ordnance Disposal Operations Centre)

to arrange for investigation and/or disposal. In the absence of an EOD specialist on site many Police Officers will use the precautionary principle, impose cordon(s)/evacuation and await advice from the JSEODOC.

The priority given to the request by JSEODOC will depend on their judgement of the nature of the risk (ordnance, location, people and assets at risk) and the availability of resources. They will respond immediately or as resources are freed up. Depending on the on-site risk assessment the item of ordnance may be removed or demolished (by controlled explosion) in situ. In the latter case additional cordons and/or evacuations may be necessary.

Note, that the military authorities will only carry out further investigations or clearances in very high profile or high-risk situations. If there are regular ordnance finds on a site, the JSEODOC may not treat each occurrence as an emergency and will encourage the construction company to put in place alternative procedures (i.e. the appointment of a commercial contractor) to manage the situation and relieve pressure from the JSEOD disposal teams.

3.2 Commercial Contractors

In addition to pre-construction site surveys and follow-on clearance work, a commercial contractor is able to provide a reactive service on construction sites. The presence of a qualified EOD Engineer with ordnance recognition skills will avoid unnecessary call-outs to the authorities and the contractor will be able to arrange for the removal and disposal of low risk ordnance. If high risk ordnance is discovered actions will be co-ordinated with the authorities with the objective of causing the minimum possible disruption to site operations whilst putting immediate, safe and appropriate measures in place.

4 This Report

4.1 Aims and Objectives

The aim of this report is to examine the possibility of encountering any explosive ordnance during any intrusive works at the site. Risk mitigation measures will be recommended in line with the CIRIA C681 guidelines, to reduce the risk of initiating UXO, and the subsequent risk of harm / damage during the envisaged works to as low as reasonably practicable (ALARP).

4.2 Risk Assessment Methodology

The following issues will be addressed in the report:

- The likelihood that the site was contaminated with unexploded ordnance.
- The likelihood that unexploded ordnance remains on site.
- The likelihood that ordnance may be encountered during any intrusive works.
- The risk that ordnance may be initiated.
- The consequences of initiating or encountering ordnance.

Risk mitigation measures, appropriate to the assessed level of risk and site conditions, will be recommended.

4.3 Approach

In preparing this Unexploded Ordnance Risk assessment, SafeLane Global has considered general and, as far as possible, site specific factors including:

- Evidence of German bombing and delivery of UXBs.
- Site history, occupancy and conditions during WWII.
- The legacy of Allied military activity.
- Details of any known EOD clearance activity.
- The extent of any post war redevelopment.
- Scope of the current proposed works.

4.4 Sources of Information

SafeLane Global has carried out detailed historical research for this Unexploded Ordnance Risk Assessment including accessing military records and archived material held in the public domain and in the MoD.

Material from the following sources has been consulted:

- The National Archives.
- The University of Manchester.
- Greater Manchester Record Office.
- Manchester Evening News.
- Landmark Maps.
- Relevant information supplied by the client.
- Available material from 33 Engineer Regiment (EOD) Archive.
- SafeLane Global's extensive archives built up over many years of research and hands-on Explosive Ordnance Disposal activities in the UK.
- Open sources such as published books, local historical records and the internet.

4.5 Reliability of Historical Records

4.5.1 General Considerations

This report is based upon research of historical evidence. Whilst every effort has been made to locate all relevant material SafeLane Global cannot be held responsible for any changes to the assessed level of risk or risk mitigation measures based on documentation or other information that may come to light at a later date.

The accuracy and comprehensiveness of wartime records is frequently difficult or impossible to verify. As a result, conclusions as to the exact location, quantity and nature of the ordnance risk can never be definitive but must be based on the accumulation and careful analysis of all accessible evidence. SafeLane Global cannot be held responsible for inaccuracies or gaps in the available historical information.

4.5.2 Bombing Records

During WWII, considerable efforts were expended in recording enemy air raids. Air Raid Precautions (ARP) wardens were responsible for making records of bomb strikes either through direct observation or by post-raid surveys. However, their immediate priority was to deal with casualties and limit damage, so it is to be expected that records are often incomplete and sometimes contradictory. Record keeping in the early days of bombing was not comprehensive and details of bombing in the early part of the war were sometimes destroyed in subsequent attacks. Some reports may cover a single attack, others a period of months or the entire war.

Records of raids that took place on sparsely or uninhabited areas were often based upon third party or hearsay information and are not always reliable; records of attacks on military or strategic targets were often maintained separately from the general records and have not always survived.

5 The Site and Scope of Proposed Works

Site Address	Trinity High School, Boundary Lane, Manchester M15 6HP
National Grid Reference Centre Point	SJ 84232 96569
Site Description	The site comprises the Trinity High School complex, with the main structures situated at the south and east of the study area. In addition, much of the site is occupied by hard standing in the form of parking facilities and recreational areas. The north of the site largely consists of playing fields, with an additional multi-storey structure to the north-west. The study area has access onto Boundary Lane in the west and High Cambridge Street to the east. In addition, peripheral wooded vegetation borders much of the study area.
Proposed Works	Proposed works include 3 cable percussive boreholes to depths of 10m bgl.
Maximum Depth of Ground Works	10m bgl.
Site Location Maps, a Recent Aerial Photograph of the site and a Proposed Site Plan are presented in Annexes A, B and C .	

6 Ground Conditions

Data Source		Description
British Geological Survey Borehole	Borehole Reference	SJ89NW19
	Location	180m north
	Date	Unknown
	Recorded Shallow Geology	0.31m of MADE GROUND 0.31m of LOAM

		• 0.31m of CLAY (dark blue) • 0.61m of LOAM • 0.76m of GRAVEL • 2.90m of STIFF CLAY (brown) • 8.99m of RED SANDSTONE
British Geological Survey Mapping	Superficial Deposits	• Glaciofluvial Sheet Deposits, Devensian - Sand and Gravel (northern half of the site). • Till, Devensian - Diamicton (southern half of the site).
	Bedrock	• Chester Formation - Sandstone.

7 Site History

7.1 Pre-WWII

The following pre-WWII OS map was reviewed.

Date	1932 - 1933	Scale	1:2,500	Source	Landmark Maps
Observations	• The site comprises an urban terraced residential area centred around <i>Bridge Street</i>, inclusive of <i>Welbeck Street</i>, <i>Ludlow Street</i> and others. The study area is bordered by <i>Boundary Lane</i> to the west, with the <i>Crown Brewery</i> lying adjacent across the roadway. • In addition, sections of open ground (mostly residential gardens and ambiguous landscaping) are present across the study area. • The surrounding area is densely developed, heavily urbanised in nature.				
A section of the map showing the site and immediate surrounding area is presented in Annex D-1 .					

7.2 Post-WWII

The following post-WWII OS map was reviewed.

Date	1950 - 1951	Scale	1:2,500	Source	Landmark Maps
The following are indicative of serious bomb damage on early post-WWII OS mapping:					
Ruins	✘	n/a			
Clearance	✓	Numerous areas of clearance can be seen on site and in the surrounding area. The most significant of these can be seen within the west of the site, along the western side of <i>Edale Street</i> .			
Redevelopment	✓	Several redeveloped areas are visible in the surrounding area, the largest of these being the <i>Dental Hospital</i> building adjacent to the eastern boundary. Further examples of redevelopment can be seen adjacent to the study area's			

		southern boundary, with the construction of a <i>Warehouse</i> and <i>College Cinema</i> along the south side of <i>Coupland Street</i> .
Further Observations	It should be noted that the nature of singular cleared buildings within rows of terraced housing is indicative of bomb damage on site.	
A section of the map showing the site and immediate surrounding area is presented in Annex D-2 .		

8 The Threat from Aerial Bombing

8.1 General Bombing History of Manchester

8.1.1 First World War

A series of bombing raids took place in the UK during WWI. Zeppelin airships, "Gotha" and "Giant" bombers conducted a succession of attacks in which high explosive bombs and incendiary devices were dropped. Although Zeppelin airship raids were recorded in the north-west, no raids were recorded across the Manchester region specifically.

WWI bombs were generally smaller than those used in WWII and were dropped from a lower altitude, resulting 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. 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.

8.1.2 Second World War

At the start of WWII, the Luftwaffe planned to destroy key military installations, including RAF airfields and Royal Navy bases, during a series of daylight bombing raids in 1940. After the Battle of Britain in the south-east, these tactics were modified to include both economic and industrial sites throughout the UK.

In the north-west the Greater Manchester area was heavily bombed during late 1940 / early 1941, due primarily to the industry located within the city; with targets including dock facilities, railway infrastructure, power stations, weapon manufacturing plants and gas works. The importance of the Manchester Ship Canal and Salford Docks to the Allied war effort was not overlooked and this infrastructure was heavily targeted. Many local companies were involved in vital war production work and putting the city's docks and industry out of action would have had serious consequences for the Allied war effort. As a result of aircraft losses, daylight raids were reduced in favour of attacking targets under the cover of darkness.

A Luftwaffe Target Map of Manchester (not annexed) shows a high density of targets highlighted for bombing by the Luftwaffe. The site itself lies close to Manchester Victoria University (situated 160m east) Further targets are present within the wider area, including a Gas Works approximately 850m north-west. In addition, the Royal Infirmary which was heavily bombed during the war was situated approximately 600m to the south-east.

Between July 1940 and July 1942, Greater Manchester suffered repeated and widespread bombing. The Luftwaffe mounted consecutive heavy attacks on the nights of the 22/23rd and 23/24th December 1940,

leaving large areas of Manchester, Salford and Stretford devastated. In total these two successive nights involved a total of 441 German bombers and became known as the 'Manchester Blitz'.

During these attacks 6 conflagrations, 20 major fires and over 600 smaller fires were reported. This, coupled with concentrated HE bombing, resulted in the total destruction of over 4,000 houses as well as serious damage to a further 12,000.¹ In total, 467 tonnes of HE bombs were dropped over Manchester in December 1940 alone. The damage was so extensive, that the government ordered a ban on damage photographs being by the media. 684 fatalities were recorded across the city and a further 2,364 injured, however full casualty details were not disclosed at the time to deny the Germans any propaganda material.

During 1941 two further large-scale raids occurred on the 9th January and 1st June. Although each involved half as many aircraft as the 22nd December 1940 raid, these two attacks still delivered a further 208 tonnes of HE bombs onto the Manchester area. After June 1941, the raids became more infrequent, but by this time serious damage had been caused to industrial premises, the city centre and the docks. Small scale attacks carried on throughout the rest of 1941 and 1942.

From mid-1944 the "V-weapon" (for Vengeance) campaign, using unmanned rockets and missiles, represented Hitler's final attempt to reverse Germany's imminent defeat. The V1 (Flying Bomb or Doodlebug) and the V2 (Long Range Rocket) were launched from bases in occupied France, Belgium and Holland as well as from Germany itself. In December 1944, after a two-year lull in bombing, several V1s fell in Greater Manchester. One landed in Oldham killing 27 people, the region's last bombing casualties of the war.

Although these weapons caused considerable destruction their relatively low numbers allowed accurate records of strikes to be maintained and these records have mostly survived. There is a negligible risk from unexploded V-weapons today since even if an unexploded 1,000kg warhead had survived impact the remains of the munition's body would have left incontrovertible evidence of the strike and it would have been dealt with at the time.

8.2 Generic Types of WWII German Air-delivered Ordnance

The nature and characteristics of the ordnance used by the Luftwaffe allows an informed assessment of the hazards posed by any unexploded items that may remain today. Detailed illustrations of German air-delivered ordnance are presented in **Annex E**.

- **HE Bombs:** In terms of weight of ordnance dropped, HE bombs were the most frequent weapon deployed. Most bombs were 50kg, 250kg or 500kg (overall weight, about half of which was the high explosive) though large bombs of up to 2,000kg were also used. HE bombs had the weight, velocity and shape to easily penetrate the ground intact if they failed to explode. Post-raid surveys would not always have spotted the entry hole or other indications that a bomb penetrated the ground and failed to explode, and contemporary ARP documents describe the danger of assuming that damage, actually caused by a large UXB, was due to an exploded 50kg bomb. Unexploded HE bombs therefore present the greatest risk to present-day intrusive works.
- **Blast Bombs/Parachute Mines:** Blast bombs generally had a slow rate of descent and were extremely unlikely to have penetrated the ground. Non-retarded mines would have shattered on

¹ P. J. C. Smith, *Luftwaffe Over Manchester*

most ground types, if they had failed to explode. There have been extreme cases when these items have been found unexploded, but this was where the ground was either very soft or where standing water had reduced the impact. SafeLane Global does not consider there to be a significant risk from this type of munition on land.

- Large incendiary bombs: This type of bomb ranged in size from 36kg to 255kg and had a number of inflammable fill materials (including oil and white phosphorus), and a small explosive charge. They were designed to explode and burn close to the surface, but their shape and weight meant that they did have penetration capability. If they penetrated the ground, complete combustion did not always occur, and, in such cases, they remain a risk to intrusive works.
- 1kg Incendiary Bombs (IB): These bombs, which were jettisoned from air-dropped containers, were just over 30cm in size and therefore highly likely to go unnoticed. They had the potential to penetrate soft ground and left a very small entry hole. Furthermore, if bombs did not initiate and fell in water or dense vegetation or became mixed with rubble in bomb damaged areas, they could have remained hidden to this day. Some variants had explosive heads, and these present a risk of detonation during intrusive works, particularly due to their shape, which leads them to often be misidentified.
- Anti-personnel (AP) Bomblets: AP bombs 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.
- Specialist Bombs (smoke, flare, etc): These types do not contain high explosive and therefore a detonation consequence is unlikely. They were not designed to penetrate the ground.

8.3 German Air-delivered Ordnance Failure Rate

Based on empirical evidence, it is generally accepted that 10% of the German HE bombs dropped during WWII failed to explode as designed. This estimate is probably based on the statistics of wartime recovered UXBs and therefore will not have taken account of the unknown numbers of UXBs that were not recorded at the time and is probably an underestimate.

The reasons for failures include:

- Fuze or gaine malfunction due to manufacturing fault, sabotage (by forced labour) or faulty installation.
- Clockwork mechanism failure in delayed action bombs.
- Failure of the bomber aircraft to arm the bombs (charge the electrical condensers which supplied the energy to initiate the detonation sequence) due to human error or equipment defect.
- Jettison of the bomb before it was armed or from a very low altitude. Most likely if the bomber was under attack or crashing.

War Office Statistics document that a daily average of 84 bombs which failed to function were dropped on civilian targets in Great Britain between 21st September 1940 and 5th July 1941. 1 in 12 of these (probably mostly fitted with time delay fuzes) exploded sometime after they fell; the remainder were unintentional failures.

From 1940 to 1945 bomb disposal teams dealt with a total of 50,000 explosive items of 50kg and over (i.e. German bombs), 7,000 AAA shells and 300,000 beach mines. These operations resulted in the deaths of 394 officers and men. However, UXO is still regularly encountered across the UK (see recent press articles, **Annex F**).

8.4 UXB Ground Penetration

8.4.1 General Considerations

The actual penetration depth of aerial delivered bombs into the ground will have been determined by the mass and shape of the bomb, the velocity and angle of the bomb on impact (dependent on the height of release) and the nature of the ground and ground cover; the softer the ground, the greater the potential penetration. Peat, alluvium and soft clays are easier to penetrate than gravel and sand. Bombs are brought to rest or are commonly deflected by bedrock or large boulders.

8.4.2 The "j" Curve Effect

An air-dropped bomb released from normal bombing altitude (approx. 5,000m) on its curved trajectory can reach a terminal velocity of between 350-400 ms⁻¹. In this case of high-level bombing, the angle of which the bomb enters the earth is approx. 15° from the perpendicular and its exact path is difficult to trace. The bomb is being driven by its kinetic energy can unless deflected, will continue its line of flight and can turn in an upwards curve towards the ground surface as it comes to rest. The upwards curve is caused by the transfer of energy as the bomb travels through the ground. The nose of the bomb travels slower than the rear of the bomb due to the drag/friction of it passing through the ground. The rear of the bomb, having more energy due to less drag/friction is travelling much quicker.

The location of the bomb is thus "offset" from the hole of entry. This "offset" from vertical is generally understood to be about one third of the penetration depth but can reach up to (and have been found at) 15m/50 ft from point of entry, dependent on ground conditions and the bomb's angle of impact.

Annex G depicts the various paths of UXB through homogenous ground, showing how the J-curve effect can lead to a UXB coming to rest beneath undamaged buildings.

8.4.3 Second World War Bomb 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, mostly in the London area. They then came to conclusions as to the likely average and maximum depths of penetration of different sized bombs in different geological strata.

The median penetration of 430 x 50kg German bombs in London Clay was 4.6m and the maximum penetration observed for the SC50 bomb was 9m.

They concluded that the largest common German bomb, 500kg, had a likely penetration depth of 6m in sand or gravel but 8.7m in clay. The maximum observed depth for a 500kg bomb was 10.2m and for a 1,000kg bomb 12.7m. Theoretical calculations suggested that significantly greater penetration depths were probable.

8.5 Second World War Bombing Statistics

The following table summarises the quantity of German bombs (excluding 1kg incendiaries and anti-personnel bombs) falling on the County Borough of Manchester between 1940 and 1945:

Record of German Ordnance Dropped on the County Borough of Manchester	
Area Acreage	27,255
High Explosive Bombs (all types)	712

Parachute Mines	18
Oil Bombs	7
Phosphorus Bombs	-
Fire Pots	-
Pilotless Missile (V1)	1
Long Range Rocket (V2)	-
Total	738
Items Per 1,000 Acres	27.1

Source: Home Office Statistics

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 incendiaries are not particularly significant in the risk they pose, they nevertheless are items of ordnance that were designed to cause damage and inflict injury and should not be overlooked in assessing the general risk to personnel and equipment. The anti-personnel bombs were used in much smaller quantities and are rarely found today but are potentially more dangerous. This table does not include UXO found during or after WWII.

8.6 Site Specific WWII Bombing Records

8.6.1 Manchester Damage & Bomb Plot Map

A review was conducted of the Manchester bomb damage maps, compiled by Manchester City Council and obtained from the University of Manchester. These maps records bomb damage of the city, as well as the location of HE bomb and fire bomb strikes.

These maps were created between 1940-1941. It therefore does not record any incidents or damage following 1941 and should not be considered a consolidated record of bombing. Note, the degree of some damage is not specified; however, properties outlined in red are likely those that suffered minor / blast damage.

Nearest incident to site	Onsite (2 x HE bomb strike)
Damage on site	✓
Number of local incidents (≤ 300m)	19
Weapon(s)	17 x Fire bomb 4 x HE bomb

Further comments	• Damage onsite consists of a destroyed section of housing in proximity to the bomb strike lying on the western boundary. In addition, a damaged structure is visible nearer to the north of the site. • Further damage is present within and adjacent to the north of the site. • Several fire-bomb strikes are recorded in the surrounding area.
A section of this map, showing the site and the surrounding area, is presented in Annex H .	

8.6.2 Manchester Blitz Civilian Deaths Map – 25th December 1940

A review was conducted of an interactive Manchester Blitz Civilian Deaths Map, obtained from Manchester Evening News. The map provides the locations of all reported bombing incidents during the 1940 Christmas Blitz that resulted in civilian deaths. The data for this map was provided by the Commonwealth War Graves Commission.

Nearest Death to site	Approx. 30m north
Further comments	• Five civilian deaths were recorded within the immediate area to the site, in the vicinity of Higher Cambridge Street, Burlington Street and Cowcill Street. • It should be noted however that only incidents which resulted in fatalities have been plotted, and the map only records fatalities for a single raid in December 1940. • Consequently, this should not be considered a comprehensive record of bombing.
This map is not annexed, however can be viewed on the website of Manchester Evening News . ²	

8.6.3 Original ARP Bombing Incident Records

Throughout WWII, records of bombing incidents were kept by the ARP and Civil Defence Office. These records were kept in the form of typed or hand-written notes and/or presented on bomb plot maps. Some other organisations, such as port authorities and railways, maintained separate records.

ARP written records were reviewed for:	County Borough of Manchester
Source:	Greater Manchester Record Office
Records of bombing on / near the site were found	✓

² <https://www.manchestereveningnews.co.uk/news/greater-manchester-news/manchester-blitz-bomb-sites-map-10465447>

Date	Weapon	Details
Unknown	HE bomb	HE bombs recorded in Oxford Street, possibly within 300m of the site.

8.6.4 Secondary Source / Anecdotal Evidence

Anecdotal evidence of local bombing incidents was sought from publications and web resources. The following references to incidents on site or in the surrounding area were found.

Date	Weapon	Details
Unknown	Delayed Action HE bomb	<i>"Manchester Royal Infirmary had to endure a number of visitations from Nazi bombs, one of which destroyed the new Nurses home and its contents. During the blaze the infirmary lost many of its windows from blast, while a delayed action bomb fell outside and, exploding later, caused considerable damage".³</i> (Exact location unknown; likely within 600m of site)

8.6.5 WWII-era RAF Aerial Photography

Due to current industry-wide disruption, it was not possible to obtain WWII-era images of this site within the timeframe of this report.

8.6.6 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 were 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, nor 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.

SafeLane Global holds records of officially registered abandoned bombs at or near the site.		x
Additional comments:	n/a	

³ *ibid*

8.7 Site Specific Bomb Penetration Considerations

When considering an assessment of the bomb penetration at the site, the following parameters would be used:

- Geology – 0.31m of MADE GROUND, 0.31m of LOAM, 0.31m of CLAY (dark blue), 0.61m of LOAM, 0.76m of GRAVEL, 2.90m of STIFF CLAY (brown), 8.99m of RED SANDSTONE.
- Impact Angle and Velocity – 80-90° from horizontal and 267 metres per second.
- Bomb Mass and Configuration – The 500kg SC (General Purpose) HE bomb, without retarder units or armour piercing nose. This was the largest of the common bombs used against Britain.

Taking into account the above-mentioned factors it has been assessed that a 500kg bomb would have had an approximate maximum bomb penetration depth of between **8-10m** below WWII ground level. Penetration depth could potentially have been greater if the UXB was larger (though only 4% of German bombs used in WWII over Britain were of that size). Note that UXBs may be found at any depth between just below the WWII ground level and the maximum penetration depth.

8.8 Likelihood of Post-raid UXO Detection

Utilising the available historical bombing records as reviewed in *Section 8.6*, it is possible to make an assessment of the likelihood that evidence of UXO would have been noted on a site during the war and the incident dealt with or recorded at the time. Factors such as bombing density, frequency of access, ground cover, damage and failure rate have been taken into consideration.

8.8.1 Density of Bombing Assessment:

Bombing density is an important consideration for assessing the possibility that UXBs remain in an area. A very high density of bombs will have increased the likelihood of errors in record keeping at the time, as civil defence personnel and emergency services may have been overwhelmed. A higher density of bombing also increases the number of UXBs actually occurring in a given area.

The type and specific location of recorded bomb strikes is also an important consideration. If a stick of bombs (one individual aircraft's bomb load) is plotted in line with a site or is shown to straddle a site, then this raises the possibility that an unrecorded UXB from the same stick struck that site.

Density of Bombing Assessment	
Based on wartime records or secondary source information, what was the bombing density over the site?	Moderate
Was the site ever subjected to one or more large-scale (>100 tons of ordnance) night time Blitz raids?	✓
Were any HE bomb strikes recorded on site?	✓
What is the distance between the site boundary and the closest recorded large bomb strike?	Onsite
How many HE, Parachute Mine, Oil Incendiary, Phosphorus Incendiary or Fire Pot bombs (large bombs) were recorded within a 300m radius of the site?	21

Were any nearby sticks of large bombs recorded in line with the site?	✓
Were any 1kg incendiary bomb showers recorded over the site?	Possibly
Additional comments:	n/a

8.8.2 Bomb Damage Assessment:

In Blitzed cities / towns throughout Britain, bomb sites were often not cleared of rubble until after the war and mid-war repairs to buildings were only carried out on the most vital facilities (power stations, gas works, weapons factories etc.). However, if a building only sustained bomb damage to its upper floors, any subsequent UXB strike to the structure will still have caused obvious damage, at ground floor level, which would have been reported and dealt with at the time.

HE bomb strikes to open ground will have resulted in a large crater and local soil disturbance. Any subsequent UXB strike will not have resulted in an easily identifiable entry hole and as such is likely to have gone unnoticed amongst the disturbed ground.

In London and south-east England, the German V1 Flying Bomb and V2 Long Range Rocket campaigns caused widespread devastation. However, as these weapons began to be utilised after the final significant Luftwaffe air raids had occurred, any serious damage caused by such weapons does not necessarily indicate an increased risk of Luftwaffe freefall UXB contamination. However, it is quite possible that serious damage inflicted during the 1940-1944 campaigns by Luftwaffe freefall bombs could have been erased by a subsequent V Weapon strike.

Bomb Damage Assessment	
A comparison of the historical records confirms that buildings within the site boundary sustained serious bomb damage.	✓
Direct or indirect evidence of HE bomb craters in open ground (within the site boundary) has been found.	✗
Buildings on site were seriously damaged by a V1 and / or V2 strike.	✗
Buildings on site could have been seriously damaged prior to the nearby V1 or V2 strike?	n/a
Additional comments:	Due to the lack of available photography, it has not been possible to accurately assess the extent of structural bomb damage / blast damage on site.

8.8.3 Frequency of Access Assessment:

A UXB strike at a site where human access was infrequent would have had a lower chance of being observed, reported and recorded compared to a site which was developed and subject to regular access. UXB strikes during night time raids (when German planes could more easily evade anti-aircraft defences) are also more likely to have fallen unobserved than ones dropped during a daylight attack.

In frequently bombed cities / towns, ARP Wardens were tasked with carrying out searches for UXBs within recently bombed residential areas and schools. Similarly, many important home front facilities (factories, gas works, power stations, docks etc.) had their own dedicated ARP teams or Fire Watchers tasked with observing local air raids. Fire Watchers were mainly responsible for extinguishing 1kg incendiary bombs as well as reporting any UXB strikes. Anecdotal evidence however indicates that Fire Watchers did not always turn up for their shifts and therefore such UXB mitigating activities should not be assumed in the absence of site-specific evidence. Less important buildings sustaining bomb damage would have been abandoned until after the German bombing campaign in that area had ceased and repairs could be made, greatly decreasing the level of access to that site.

Schools closed due to the evacuation of children were often requisitioned by the Civil Defence authorities to be utilised as night time First Aid posts and reception centres (providing emergency accommodation for bombed out civilians). Therefore, an increased level of access is likely at these locations.

Frequency of Access Assessment	
The site was situated in a densely populated urban area during WWII and therefore would have been accessed at the outbreak of WWII.	✓
The site was exclusively or partially developed during WWII.	✓
Buildings on site survived WWII intact and therefore likely remained inhabited or in use, suggesting these localities and their immediate environs were accessed throughout the war.	✓
The site was crossed by roads / pavements or footpaths which would have been regularly used / subject to daily footfall.	✓
The site was occupied by small residential back yards / gardens, likely to have been put to use for cultivation as a result of the government's Dig for Victory Campaign.	✓
The site was occupied by a school during WWII.	✗
Part of the site is likely to have been subject to post-raid searches for UXO.	✗
Buildings on site sustained serious bomb damage and as a result were likely abandoned (along with any associated gardens / open ground) for the remainder of the war.	✓
The site was occupied by peripheral open ground / wasteland, with no apparent use, which may have been neglected.	✗
The site may have been occupied by recreational land / sports fields which may have only experienced seasonal access.	✗
The site was occupied by a graveyard which would have experienced limited access.	✗
The site was occupied by agricultural land, rural countryside or woodland which would not have been accessed in full, either regularly or frequently.	✗

The site was occupied by railway sidings which may not have been as regularly checked for buckling as mainline railway tracks.	x
The site was occupied by soft railway embankments which are likely to have been neglected during the war.	x
Additional comments:	n/a

8.8.4 Ground Cover Assessment:

The entry hole of a 50kg UXB (the most commonly deployed German HE bomb) could have been as little as 20cm in diameter. Wartime records also confirm that small German Incendiary Bombs, weighing just 1kg, were capable of significant penetration into soil, resulting in very small entry holes (5cm) or complete burial.

The quantity and type of ground cover present on a site during WWII would have had a significant effect, at ground level, on the visual evidence of buried UXO.

Evidence of UXO could be obscured in dense vegetation, soft ground, rubble, railway ballast or amongst stockpiled material (such as aggregate, coal or refuse heaps). A UXB strike to waterlogged ground or open water would have been immediately obscured from view beneath the waterline. Had such an incident occurred within a tidal mudflat or river bank, the resulting entry hole will have remained only temporarily, before becoming in-filled by water and sediment. Any HE UXB strike to elevated risk ground cover could potentially have come to rest beneath neighbouring undamaged buildings or hard-standing due to the 'J-Curve' Effect.

UXB strikes to undamaged/superficially damaged buildings and hard-surfaced ground will still have caused substantial damage or an easily identifiable and persistent entry hole. Similarly, it is unlikely that an HE UXB entry hole on well-maintained / manicured lawns (tennis courts, bowling greens, golf course fairways / greens, gardens in affluent areas etc), would have been overlooked. Such incidents would have been reported and the UXB subsequently removed.

Ground Cover Assessment	
The site was partially or entirely abandoned, due to bomb damage, resulting in associated open ground likely becoming overgrown.	✓
The site was occupied by dense, inaccessible vegetation during WWII.	x
The site may have been susceptible to waterlogged conditions during WWII.	x
The site was occupied by (possibly) unmaintained grass field during WWII.	x
The site was part occupied by a canal, river, dock basin, lake or reservoir during WWII.	x
The site was occupied by tidal mud or marshland during WWII.	x

The site was occupied by railway tracks crossing soft ground during WWII.	✘
The site was occupied by stockpiled material during WWII.	✘
The site was occupied by buildings, hard-standing or other manmade structures that did not sustain any degree of bomb damage.	✓
A comparison of the historical records confirms that buildings on site sustained inconsequential minor / moderate damage.	Likely
The site was occupied by well-maintained, manicured lawn during WWII.	✘
Undamaged, developed parts of the site would have been vulnerable to the J-Curve Effect.	✓
Additional comments:	Due to the lack of available photography, it has not been possible to accurately assess the ground conditions on site.

8.8.5 Bomb Failure Rate Assessment:

Based on empirical evidence, it is generally accepted that 10% of the German HE bombs dropped during WWII failed to explode as designed.

Note, due to manufacturing fault or failure of the bomber crew to correctly arm their munitions, whole bomb loads often failed to detonate. Therefore, the presence of reported UXBs increases the likelihood of an additional unrecorded UXB in the vicinity.

Bomb Failure Rate Assessment	
Evidence has been found which suggests that the bomb failure rate in the vicinity of the site would have been different from the "approximately 10%" figure normally used.	✘
Additional comments:	n/a

9 The Threat from Allied Military Ordnance

The following potential historical and modern sources of UXO contamination on site or in the surrounding area have been considered:

Potential Source of Contamination on Site	
Army, Navy and RAF Bases / Installations	✘
Military Training Areas / Weapons Ranges	✘

Ordnance / Explosives Factories and Storage Depots	x
Sites Requisitioned for Military Use	✓
Military Fortifications and Coastal Defences	x
Locations of Army Explosive Ordnance Clearance Tasks	x
WWII Anti-Aircraft Batteries	✓
WWII Pipe Mined Locations and Beach Minefields	x

The risk of contamination from Allied UXO on site is discussed below.

9.1 Home Guard Activity

The Home Guard (HG) was a defence organisation of the British Army, operational between 1940 and 1944. It comprised 1.5 million local volunteers, otherwise ineligible for military service and acted as a secondary defence force in case of enemy invasion. The HG guarded the coastal areas of Britain and other important facilities such as airfields, factories and explosives stores. They were also active in county towns and cities.

Official records were rarely kept by the HG and therefore any present-day evidence is usually anecdotal. However, it is known that HG personnel often carried out training (including weapons training) in open countryside on the outskirts of cities / towns. Today, items of ordnance related to the HG are occasionally encountered by members of the public and the construction industry in the British countryside. This suggests a culture of ill-discipline regarding live ammunition within HG units.

HG personnel are known to have purposefully buried caches of ammunition and weapons in tactical positions, to be exhumed and used in case of invasion. Records of such caches were not rigorously kept, and some were therefore forgotten about. This is substantiated by several recent HG UXO finds (see Annex I).

Home Guard Activity	
Nearest HG Battalion to the site.	48 th Lancashire (Manchester; Ardwick) Battalion 61 st Lancashire (Manchester University) Battalion 57 th – 59 th Lancashire (21-23 GPO) Battalion
Site Specific Details:	- Five HG battalions were based in proximity to the site during WWII; with the 61st Battalion stationed at Burlington Street Drill Hall, approximately 150m south. - Although typically HG battalions would take part in training exercises in areas occupied by open countryside, there are several examples of HG units carrying out invasion training in urban areas. - However, given the density of urban development, the location within the city centre, and the absence of significant open ground, it is highly unlikely that any such HG activity would have occurred onsite.

There is evidence to suggest an elevated risk of land service / small arms ammunition contamination on site.	x
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9.2 Anti-Aircraft Gun Batteries

At the start of the war two types of AAA guns were deployed: Heavy Anti-Aircraft Artillery (HAA) and Light Anti-Aircraft Artillery (LAA). The LAA batteries were intended to engage fast low flying aircraft and were typically deployed around airfields or strategic installations. These batteries were mobile and could be moved to new positions with relative ease when required. With four guns per battery firing several rounds per minute, AA batteries could expel numerous shells in even the shortest engagements. Numerous unexploded AAA shells were recovered during and following WWII and are still occasionally encountered on sites today.

The maximum ceiling height of fire at that time was around 11,000m however, as the war progressed, improved variants of the 3.7" gun were introduced and, from 1942, large 5.25-inch weapons were brought into service. These had significantly improved ceiling heights of fire reaching over 18,000m.

When the supply of clockwork fuses from Switzerland was cut off, Britain was forced to make its own. After four years of war, the country still lacked the engineering skills to produce a reliable fuse. This resulted in a considerable number of AA projectiles exploding prematurely, killing the gunners or failing to explode at all and falling to the ground as UXBs. In January 1944, more people in London were killed by HAA shells than by German bombs.

Anti-Aircraft Gun Batteries	
Number of HAA batteries within 5km of the site.	9
Additional Comments:	- The nearest permanent HAA battery was located approximately 2.3km south-east. - It is also possible that additional temporary LAA batteries may have been brought to the area during the heaviest raids over the city. - At the locations of severe bomb damage onsite, it is likely that a significant volume of rubble / debris would have occupied the area for some time. - In such conditions, an unexploded AA shell falling onsite could easily have been overlooked, particularly as many of these areas would not be subject to formal post-raid checks for UXO. - Furthermore, given the high bombing density of the area and proximity of bombing targets, it is likely that a significant volume of AA shells was expended over the wider area in order to defend such targets from bombing. - However, an unexploded AA shell falling on undamaged buildings / hard-standing roadways onsite would have caused obvious damage or a persistent, easily identifiable entry hole, which would have been reported and subsequently removed.
There is evidence to suggest an elevated risk of unexploded AA shells contamination on site.	✓

9.3 The Threat Posed by Allied Unexploded Ordnance

9.3.1 Land Service Ammunition (LSA)

9.3.1.1 General

The term Land Service Ammunition covers all items of ordnance that are propelled, placed or thrown during land warfare. They may be filled or charged with explosives, smoke, incendiary or pyrotechnics. They can be broken into five main groups:

- a. Mortars
- b. Grenades
- c. Projectiles
- d. Rockets
- e. Landmines

Unexploded or partially unexploded Mortars and Grenades are among the most common items of UXO encountered in the UK and therefore the possibility cannot be discounted that they were stores on site. They are commonly encountered in areas used by the military for training and are often found discarded on or near historic military bases. Examples of Grenades, Mortars and Home Guard weapons are presented in **Annex J**.

9.3.1.2 Mortars

A mortar bomb is a fin-stabilised munition, normally nose-fuzed and fitted with its own propelling charge (primary cartridge). Range is increased by adding extra propellant (augmenting charges). They are either HE or Carrier and generally identified by their tear-dropped shape (older variants however are parallel sided) and a finned 'spigot tube' screwed or welded to the rear end of the body housing the propellant charge.

A mortar relies on a striker hitting a detonator for explosion to occur. It is possible that the striker may already be in contact with the detonator and that only a slight increase in pressure would be required for initiation. Discarded augmenting charges are often encountered around mortar firing areas/bases.

9.3.1.3 Grenades

A grenade is a short-range weapon which may be thrown by hand, fired from the end of a rifle or projected/propelled from a special purpose grenade launcher. They are divided into two categories; HE and Carrier (generally smoke). As with mortars, a grenade striker may either be in contact with the detonator or still be retained by a spring under tension, and therefore shock may cause it to function. A grenade can have an explosive range of 15-20m. Common older variants have a classic 'pineapple' shape; modern grenades tend to be smooth-sided.

9.3.2 Small Arms Ammunition (SAA)

The most likely type of ordnance to be encountered on site are items of SAA (bullets), especially .303" ammunition which was the standard British and Commonwealth military cartridge from 1889 until the 1950s.

However even if an item such as this functioned, the explosion would not be contained within a barrel and detonation would only result in local overpressure and very minor fragmentation from the cartridge case.

Some LAA guns and RAF fighter cannons in use with British forces during WWII utilised the 20mm round. These bullets had a small fuse and a ~4gram HE or incendiary charge. Although small, this fill quantity still has the potential to cause serious injury. Images of SAA are presented in **Annex K**.

9.3.3 Anti-Aircraft Shells

At the start of the war two types of AAA guns were deployed: Heavy Anti-Aircraft Artillery (HAA) using large calibre weapons such as the 3.7" QF (Quick Firing) gun and Light Anti-Aircraft Artillery (LAA) using smaller calibre weapons such as 40mm Bofors gun which could fire up to 120 x 40mm HE shells per minute to over 1,800m. During the early war period there was a severe shortage of AAA so older WWI 3" and modified naval 4.5" guns were also deployed.

These shells are frequently mistakenly identified as small German air-delivered bombs but are differentiated by the copper driving band found in front of the base. Although the larger unexploded projectiles could enter the ground they did not have great penetration ability and are therefore likely to be found close to WWII ground level. With a HE fill and fragmentation hazard these items of UXO also present a significant risk if encountered.

The smaller 40mm projectiles are similar in appearance and effect to small arms ammunition and, although still dangerous, present a lower risk. Pictures of AAA projectiles are presented in **Annex L**. Details of the most commonly deployed WWII AAA projectiles are shown below:

Gun type	Calibre	Shell Dimensions	Shell Weight	HE Fill Weight
3.7 Inch	94mm	94mm x 438mm	12.7kg	1.1kg
4.5 Inch	114mm	114mm x 578mm	24.7kg	1.7kg
40mm	40mm	40mm x 311mm	0.84kg	70g

10 Ordnance Clearance and Post-WWII Ground Works

10.1 General

The extent to which any ordnance clearance activities have taken place on site or extensive ground works have occurred is relevant since they may indicate previous ordnance contamination but also may have reduced the risk that ordnance remains undiscovered.

10.2 EOD Bomb Disposal and Clearance Tasks

SafeLane Global holds a number of official records of explosive ordnance disposal operations during and following WWII, obtained from the Explosive Ordnance Disposal (EOD) Archive Information Office at 33 Engineer Regiment (EOD), British Army.

Records were found to indicate that Army EOD tasks have taken place on / in the vicinity of the site.		x
Further Comments:	n/a	

Records of recent local ordnance finds were found.		x
Further Comments:	n/a	
SafeLane Global have encountered UXO in the local area.		x
Further Comments:	n/a	

10.3 Post War Redevelopment

The nature of post-WWII ground works, redevelopment and construction has been considered. Significant structural redevelopment on site can, in some cases, provide a level of mitigation, particularly from shallow buried items. However, if a site has not undergone any extent of redevelopment, the likelihood of UXO remaining within its boundaries can remain.

The site has been redeveloped post-WWII.		✓
Further details:	Extensive redevelopment works have taken place within the study area post-war. An investigation into additional post-war mapping (not annexed) indicates that the site was cleared of housing and the school constructed by the mid 1970s. In recent years, the school buildings at the centre of the site have been demolished circa. 2012, with a new structure built at the east of the study area. ⁴	

11 The Overall Unexploded Ordnance Risk Assessment

11.1 General Considerations

Taking into account the quality of the historical evidence, the assessment of the overall risk to any intrusive works from UXO must evaluate the following factors:

- That the site was contaminated with unexploded ordnance
- That UXO remains on site
- That such items could be encountered during any intrusive works
- That ordnance may be activated by the works operations
- The consequences of encountering or initiating ordnance

11.2 The Likelihood that the Site was Contaminated with Unexploded Ordnance

The below is a generalised table of factors used to determine the level of UXO risk on a site. Note that additional site-specific information can increase UXO risk beyond these criteria:

⁴ <https://www.old-maps.co.uk/#/Map/384303/396545/10/101322>

Low Risk	Medium Risk	High Risk
German Air Dropped Ordnance / Allied Anti-Aircraft Shells		
No evidence of bombing / bomb damage on site coupled with low local bombing density.	Moderate to High local bombing density or evidence of bombing / bomb damage on or close to the site.	High local bombing density or evidence of bombing / bomb damage on or adjacent to the site. Confirmed finds of WWII UXB.
Ground conditions that would prevent UXB penetration or lead to easily identifiable entry holes.	Ground conditions that allow for bomb penetration.	Ground conditions that would have immediately and completely obscured the existence of UXB.
Site was occupied and accessed fully throughout the bombing campaign.	Site located in an area that was infrequently observed or accessed, with a low likelihood that a UXB strike would have been noticed.	Site may be completely obscured from view or subject to very infrequent access.
Allied Ordnance		
No evidence of Allied military activity on or near the site.	Evidence of military activity on or near the site. This can include Home Guard activities, ground defence structures, munitions factories or military sites such as airfields.	Evidence of weapons testing or disposal on or adjacent to the site.
Developed areas that are unlikely to have been used for military exercises.	Open or unmaintained ground that may have been used for disposal or caching of munitions.	Evidence of UXO finds on or in the vicinity of the site.

For the reasons discussed in *Section 8 and 9* SafeLane Global believes that there is an elevated likelihood that UXO contaminated the study area. This is based on the following:

GERMAN AIR-DELIVERED UXO
- Between July 1940 and July 1942, Greater Manchester suffered repeated and widespread bombing, due primarily to the industry located within the city. The Luftwaffe mounted consecutive heavy attacks on the nights of the 22/23rd and 23/24th December 1940, leaving large areas of Manchester devastated. In total these two successive nights became known as the 'Manchester Blitz'. - During the war, the site was predominantly occupied by terraced housing fronting a number of roadways, along with their respective residential gardens. - A Luftwaffe Target Map shows the site lying in close proximity to the Manchester Victoria University, a designated bombing target. Consequently, the site area experienced a moderate bombing density, as confirmed by official statistics and mapping. - This is confirmed by a Damage & Bomb Plot Map of Manchester which records 2 x HE bomb strikes onsite, with a further 19 x large bomb strikes within the immediate vicinity. Anecdotal evidence also suggests

that the nearby Manchester Royal Infirmary (approximately 600m south-east) received two direct hits, and significant blast damage. • This map additionally records extensive bomb damage to several residential buildings on site as well as further damage within the north of the site. Review of post-war OS mapping shows significant areas of clearance across the study area, with significant redevelopment to the south and east. • As such, at the locations of severe bomb damage, it is likely that a degree of rubble / debris would have occupied the area for some time. Furthermore, seriously damaged structures would likely have been abandoned (along with any associated gardens / open ground) for the remainder of the war. • In such conditions, it is entirely conceivable that had a subsequent UXB fallen onsite, it could have remained undetected and the subsequent entry hole unobserved, particularly as many of these areas would not be subject to formal post-raid checks for UXO. • Note that the entry hole of an SC50 (the most commonly deployed German HE bomb) could have been as little as 20cm in diameter and therefore easily obscured in rubble / debris. This is especially pertinent as nearly all air raids on the city occurred at night. • Had such incidents occurred, a UXB could have eventually come to rest beneath neighbouring undamaged roadways and buildings onsite due to the 'J-Curve Effect'. • A UXB strike to undamaged buildings / hard-standing roadways onsite would have caused substantial / obvious damage (even without detonating) or a persistent, easily identifiable entry hole, which would very likely have been observed and reported at the time and the UXB subsequently removed.	
BRITISH / ALLIED UXO	
Land Service Ammunition / Small Arms Ammunition	• Five HG battalions were based in proximity to the site during WWII; with the 61st Battalion stationed at Burlington Street Drill Hall, approximately 150m south. • Although typically HG battalions would take part in training exercises in areas occupied by open countryside, there are several examples of HG units carrying out invasion training in urban areas. • However, given the density of urban development, the location within the city centre, and the absence of significant open ground, it is highly unlikely that any such HG activity would have occurred onsite.
Anti-Aircraft Projectiles	• 9 x HAA batteries were recorded within 5km of the site, the nearest of which was located approximately 2.3km south-east. • It is also possible that additional temporary LAA batteries may have been brought to the area during the heaviest raids over the city. • At the locations of severe bomb damage onsite, it is likely that a significant volume of rubble / debris would have occupied the area for some time. • In such conditions, an unexploded AA shell falling onsite could easily have been overlooked, particularly as many of these areas would not be subject to formal post-raid checks for UXO.

	• Furthermore, given the high bombing density of the area and proximity of bombing targets, it is likely that a significant volume of AA shells was expended over the wider area in order to defend such targets from bombing. • However, an unexploded AA shell falling on undamaged buildings / hard-standing roadways onsite would have caused obvious damage or a persistent, easily identifiable entry hole, which would have been reported and subsequently removed.
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11.3 The Likelihood that Unexploded Ordnance Remains on Site

Within the footprints of the post-war redevelopment / ground works, the risk of shallow buried UXO (especially German 1kg incendiaries) remaining will have been partially mitigated since any such items could have been encountered and removed during soil stripping and levelling.

In addition, only within the volume of any post-war basement level bulk excavations and at the precise locations of any post-war pile foundations / boreholes, will the risk from deeper buried German HE UXBs have been completely mitigated.

Whilst the site has been significantly developed post-war, the exact footprint or depth of any foundations / piling is unknown. Beyond the maximum depth of, outside the footprint of, and amongst (i.e. between piles) these post-WWII redevelopments, the UXO risk is unmitigated and will remain Medium down to 10m bgl (maximum bomb penetration depth). Within these medium risk areas, we would continue to recommend the UXO mitigation measures detailed within the report prior to any intrusive works.

11.4 The Likelihood that Ordnance may be Encountered during the Works

The most likely scenarios under which a 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.

Since an air-dropped bomb may come to rest at any depth between just below ground level and its approximate penetration depth there is also a chance that such an item could be encountered during shallow excavations (for services or site investigations) into the original WWII ground level.

If the proposed works are due to be undertaken within post war fill material / made ground, the risk of encountering WWII UXBs is low. However, if works are to be undertaken below WWII ground level this risk is significantly higher.

11.5 The Risk that Ordnance may be Initiated

Items of ordnance do not become inert or lose their effectiveness with age. Time can indeed cause items to become more sensitive and less stable. This applies equally to items submerged in water or embedded in silts, clays or similar materials. The greatest risk occurs when an item of ordnance is struck or interfered with. This is likely to occur when mechanical equipment is used or when unqualified personnel pick up munitions.

11.5.1 Initiation of Unexploded Bombs

In the case of unexploded German bombs discovered within the construction site environment, there are a number of potential initiation mechanisms:

- Direct impact onto the main body of the bomb: Unless the fuze or fuze pocket is struck, there needs to be a significant impact to initiate a buried iron bomb.
- Re-starting the clock timer in the fuze: Only a small proportion of German WWII bombs employed clockwork fuzes. It is probable that significant corrosion has taken place within the fuze mechanism over the last 60 years that would prevent clockwork mechanisms from functioning, nevertheless it was reported that the fuze in a UXB dealt with by 33 EOD Regiment in Surrey in 2002 did re-commence.
- Induction of a static charge, causing a current in an electric fuze: The majority of German WWII bombs employed electric fuzes. It is probable that significant corrosion has taken place within the fuze mechanism over the last 60 years such that the fuze circuit could not be activated.
- Friction impact initiating the (shock-sensitive) fuze explosive: This is the most likely scenario resulting in the bomb detonating.

11.5.2 Activities that may Result in the Initiation of Unexploded Ordnance

Unexploded bombs do not spontaneously explode. All high explosive requires significant energy to create the conditions for detonation to occur. The risk that UXO could be initiated if encountered will depend on its condition, how it is found and the energy with which it is struck. However certain activities pose a greater risk than others.

The most violent activity on most construction sites is percussive piling or deep mechanical excavations. If an item is struck with a significant enough impact, be it direct or through friction/vibration, it risks detonation. Drilling of boreholes or similar activities also have the potential to initiate ordnance in this manner, either through impact or vibration.

Soil levelling and shallow excavation such as trial pits can pose a similar risk, since UXO can be found at any depth between ground level and the maximum bomb penetration depth. In addition to risk of initiation by violent impact or vibration, detonation can also occur if discovered items are mishandled by unqualified personnel. This is particularly common when onsite personnel are not trained in the recognition of ordnance.

For works that are not intrusive, little risk is posed by items of UXO that are buried beneath the ground. However, risk can arise from unburied munitions, particularly items of ordnance discarded in periphery areas of military sites. These items are frequently discovered by onsite personnel and remain live and liable to activate if mishandled.

11.6 The Consequences of Encountering or Initiating Ordnance

Clearly the consequences of an inadvertent detonation of UXO during construction operations would be catastrophic with a serious risk to life, damage to plant and a total site shutdown during follow-up investigations.

Since the risk of initiating ordnance is significantly reduced if appropriate mitigation measures are undertaken, the most important consequence of the discovery of ordnance will be economic. This would be particularly so in the case of high-profile locations and could involve the evacuation of the public.

The unexpected discovery of ordnance may require the closing of the site for any time between a few hours and a week with a potentially significant cost in lost time. Note also that the suspected find of ordnance, if handled solely through the authorities, may also involve loss of production since the first

action of the Police in most cases will be to isolate the locale whilst awaiting military assistance, even if this turns out to have been unnecessary.

Annex M-1 details UXB incidents where intrusive works have caused UXBs to detonate, resulting in death or injury and damage to plant. Whilst these recent incidents occurred internationally, there is still reason to believe that such incidents are possible in the UK without the implementation of suitable risk mitigation measures. **Annex M-2** details incidents on construction sites in the UK, at which delays, site shut-downs, evacuations and disruptions have occurred.

11.7 SafeLane Global's Assessment

Taking into consideration the findings of this study, SafeLane Global considers the UXO risk at the site to be heterogeneous and can therefore be divided into areas of **Low** and **Medium** risk.

Low Risk:

- Undamaged buildings
- Roadways likely to have been repaired

Type of Ordnance	Level of Risk		
	Low	Medium	High
German High Explosive Bombs	✓		
German 1kg Incendiary Bombs	✓		
Allied Anti-Aircraft Shells	✓		
British / Allied Small Arms and Land Service Ammunition	✓		

Medium Risk:

- Areas of heavy damage during WWII
- Buffer area to account for the J-Curve Effect

Type of Ordnance	Level of Risk		
	Low	Medium	High
German High Explosive Bombs		✓	
German 1kg Incendiary Bombs	✓		
Allied Anti-Aircraft Shells		✓	
British / Allied Small Arms and Land Service Ammunition	✓		

12 Proposed Risk Mitigation Strategy

SafeLane Global recommends the following minimum risk mitigation measures be deployed to support the proposed ground works at the site:

Scope-Specific Recommended Risk Mitigation Measures	Low Risk Zone	Med Risk Zone
Site Specific Explosive Ordnance Safety and Awareness Briefings (UXO Toolbox Briefing) to all personnel conducting intrusive works These briefings are intended to make site operatives aware of the nature of explosive ordnance that may be encountered on their project site. - Delivered by a specialist Explosive Ordnance Disposal Engineer. - Provides information on the site-specific explosive ordnance risk - Basic ordnance identification. - What to do in the event of an encounter with a suspicious object. - Provide UXO response procedures.	✓	✓
Site Specific Safety Instruction (SSSI) For longer term projects that require Explosive Ordnance Safety and Awareness Briefings as part of the Explosive Ordnance Risk Mitigation measures for the project, SSSIs can be provided to allow nominated site representatives to deliver these briefings after initial training. 2-3 hour presentation and training course. - Delivered by a fully qualified senior EOD Engineer. - Suitable for Project Site Manager HSE representative and supervisors. - Includes briefing pack. This provides a cost-effective solution to ensure that the Explosive Ordnance Safety and Awareness Briefings can be delivered effectively and efficiently to the required standard.	✓	✓
Explosive Ordnance Disposal (EOD) Engineer On-Site Support In areas where the risk posed by the potential presence of explosive ordnance is low or where the conditions are not suitable for pro-active survey, EOD On-Site Support can provide a reactive response to any suspicious object that may be encountered during open excavation works. The presence of the EOD Engineer on-site in support of shallow intrusive work allows for a direct monitoring of works using visual recognition and instrumentation and provides an immediate response to reports of suspicious objects or suspected items of ordnance that have been recovered by ground workers.	x	✓

SafeLane Global EOD personnel on-site also have the additional benefit of providing Explosive Ordnance Safety and Awareness briefings (UXO TBB) to any staff that have not received them earlier and can advise staff of the need to modify working practices to take account of the ordnance threat. The EOD Engineer will also aid potential incident management which would involve liaison with the local authorities and police should ordnance that presents an explosive hazard be identified. • Specialist Explosive Ordnance Disposal Engineer. • Maintains a watching brief over all excavations. • Provides safety and awareness briefings to construction personnel as required. • Provides immediate identification of any suspicious item that is encountered. • Identifies whether any UXO item is live or inert. • Provides liaison assistance with the relevant authorities when dealing with any live UXO. • Avoids on site delays which can be caused by the incorrect identification of a suspect item being potential UXO.		
Explosive Ordnance Disposal (EOD) Engineer to support site investigation works For cost effective Explosive Ordnance Risk Mitigation for site investigation work, the EOD Engineer can survey ahead of trial pits, monitor excavations when the ground conditions are not suitable for a pro-active survey and conduct intrusive surveys for borehole and window sample locations working in conjunction with the site investigation team. The On-Site Support will also provide a reactive response to any suspicious object that may be encountered during open excavation works. SafeLane Global EOD personnel on-site also have the additional benefit of providing Explosive Ordnance Safety and Awareness briefings to any staff that have not received them earlier and can advise staff of the need to modify working practices to take account of the ordnance threat. The EOD Engineer will also aid potential Incident Management which would involve liaison with the local authorities and police should ordnance be identified and present an explosive hazard. • Specialist Explosive Ordnance Disposal Engineer. • Maintains a watching brief over all trial pit excavations. • Provides safety and awareness briefings to construction personnel as required. • Works in conjunction with the drilling team to survey all borehole and window sample locations in real-time using a staged drilling and magnetometer survey procedure. • Provides immediate identification of any suspicious item that is encountered. • Identifies whether any UXO item is live or inert.	x	✓

- Provides liaison assistance with the relevant authorities when dealing with any live UXO. - Avoids on site delays which can be caused by the incorrect identification of a suspect item being potential UXO. <i>Technical Information</i> - In optimum ground conditions each survey using the borehole technique will have a 1 metre look ahead capability. - Any steel casing used for borehole surveys will need to be retracted by 3 metres to allow the magnetometer survey to be conducted. - Non-ferrous pipe will be required to support the borehole during the survey minimum diameter 60mm (to be supplied by the client).		
Search & Clear Where a non-intrusive magnetometer survey is not possible (e.g. wooded areas) SafeLane Global can deploy a two-man Explosive Ordnance Disposal Engineer team using handheld magnetometer equipment who will proactively survey either in search lanes or boxes, investigating each reading with the support of an operated excavator. The survey is suited to detecting suspicious ferro-magnetic buried objects that may be munitions and/or explosive ordnance related. All SafeLane Global personnel involved with the Search and Clearance Works will be former military personnel who have gained formal NATO Military Explosive Ordnance Disposal Qualifications, having completed training at the Defence Explosive Ordnance Disposal School (DEODS) Chattenden, Kent or similar establishment throughout their military service. The client will be responsible for: - Demarcating the areas to be searched. - Providing services clearance and permit to dig. - Providing operated excavator to access deeper targets if required (SafeLane Global can provide this service at additional cost). - Providing coordinates of positions where debris have been identified (if information required in report). - Providing storage for recovered debris. - Output will depend upon terrain and contamination (number of readings to be investigated).	x	x
Non-Intrusive Magnetometer Survey and Target Investigation (greenfield land only) Non-Intrusive Survey This survey type is designed for use on magnetically 'clean' land commonly referred to as 'greenfield'. Brownfield land is often described as that which has had previous industrial or commercial use. In this context it specifically encompasses sites with are underlain by 'made ground' which may contain metallic contamination. Non-intrusive magnetometry or electromagnetic	x	x

equipment which is used in the search for buried UXO relies upon the detection of small changes between clear ground and that containing UXO. The technique operates very successfully in environments where there is minimal ground contamination from other sources such as fired bricks, reinforced concrete, discarded scrap metal and buried services. There are also man-made ambient effects on magnetic and electromagnetic non-intrusive survey systems which include moving plant vehicles, power cables, electric trains etc. Non-Intrusive survey is carried out using either total-field or gradiometer magnetometry, dependent upon site conditions. Data is recorded and then interpreted using advanced AGSPRoc software in order to map magnetic fields and model discrete magnetic anomalies (variations in the Earth's magnetic field caused by ferro-magnetic objects electrical fields or geology). The location of such anomalies is determined, and mathematical modelling used to estimate their mass and depth. The survey will also locate any buried services with a magnetic signature and indicate any areas of gross magnetic "contamination" which may indicate the presence of unknown obstructions. Additionally, the survey can provide information on archaeological features. The system can detect the magnetic field from a 50kg WWII air-dropped bomb at a depth of 4m and smaller items such as Land Service Ammunition to depths of up to 1.5m in ground with a low ambient magnetic field. In the case of soft geology, it should be noted that a 50kg high explosive bomb may be buried greater than 4 metres below ground level and therefore may not be detected by the survey. In this instance intrusive surveys may be required. The non-intrusive survey system will be deployed utilising the pedestrian survey frame. The output for the pedestrian frame is estimated at up to 2Ha per day. <i>Technical information:</i> • Client to clearly demarcate area to be surveyed prior to start and highlight any known services/underground obstructions. • Ground must be level, free of obstacles / obstructions and clear of undergrowth. Height of any crops should be no more than 400mm and where crops are present SafeLane Global would require written approval from the landowner or client to walk over the site area. • When working adjacent to existing infrastructure the survey may be ineffective due to the ferro magnetic interference caused by passing vehicles and the presence of underground buried services. A site visit may be recommended prior to commencement. • Note: the survey will be ineffective on Brownfield sites due to the magnetic nature of building rubble, which typically masks the weaker magnetic signatures of buried objects. If parts of the site are contaminated, then alternative risk mitigation measures may need to be considered. Target Investigation If a buried anomaly is detected that cannot be discounted as a potential UXO / UXB then the object will need to be investigated to positively identify the item. The process will include: • Specialist two-man Explosive Ordnance Disposal Team.		
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- Combination of manual and mechanical excavation techniques. - Excavator shafting, shoring and dewatering equipment can be provided by SafeLane Global if required. - Excavation techniques will be defined and agreed prior to the commence. - A factual report with clearance certificate will be issued on completion of the investigation.		
Intrusive Magnetometer Survey of all pile locations down to the maximum bomb penetration depth SafeLane Global can deploy a range of intrusive magnetometry techniques to clear ahead of all the pile locations. The appropriate technique is governed by a number of factors, but most importantly the site's ground conditions. The appropriate survey methodology would be confirmed once the enabling works have been completed. A site meeting would be required between SafeLane Global and the client to determine the methodology suitable for this site. Target investigation or avoidance will be recommended as appropriate.	x	✓
In making this assessment and recommending these risk mitigation measures, the proposed works outlined in the 'Scope of the Proposed Works' section were considered. Should the planned works be modified, or additional intrusive engineering works be considered, SafeLane Global should be consulted to see if re-assessment of the risk or mitigation recommendations is necessary.		

SafeLane Global

8th April 2021

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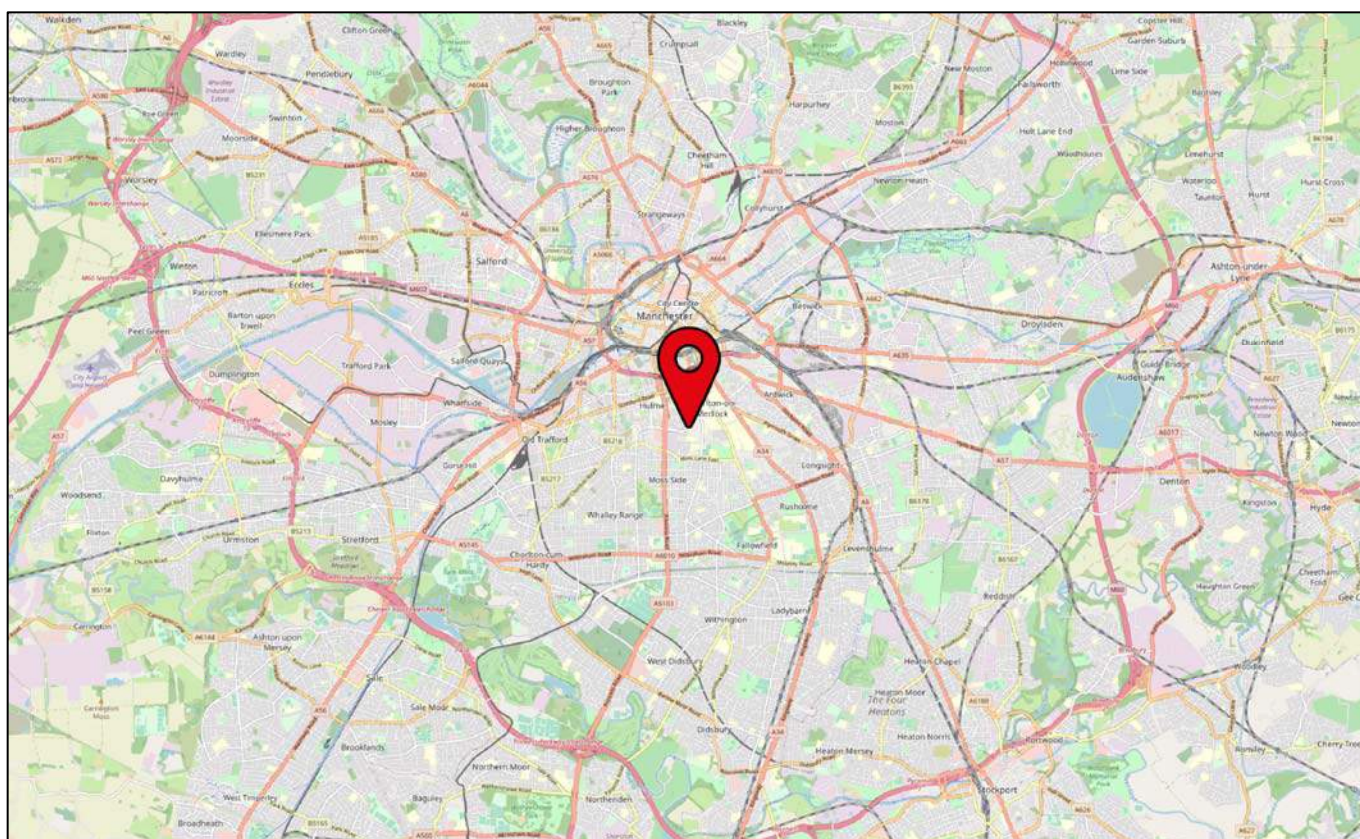
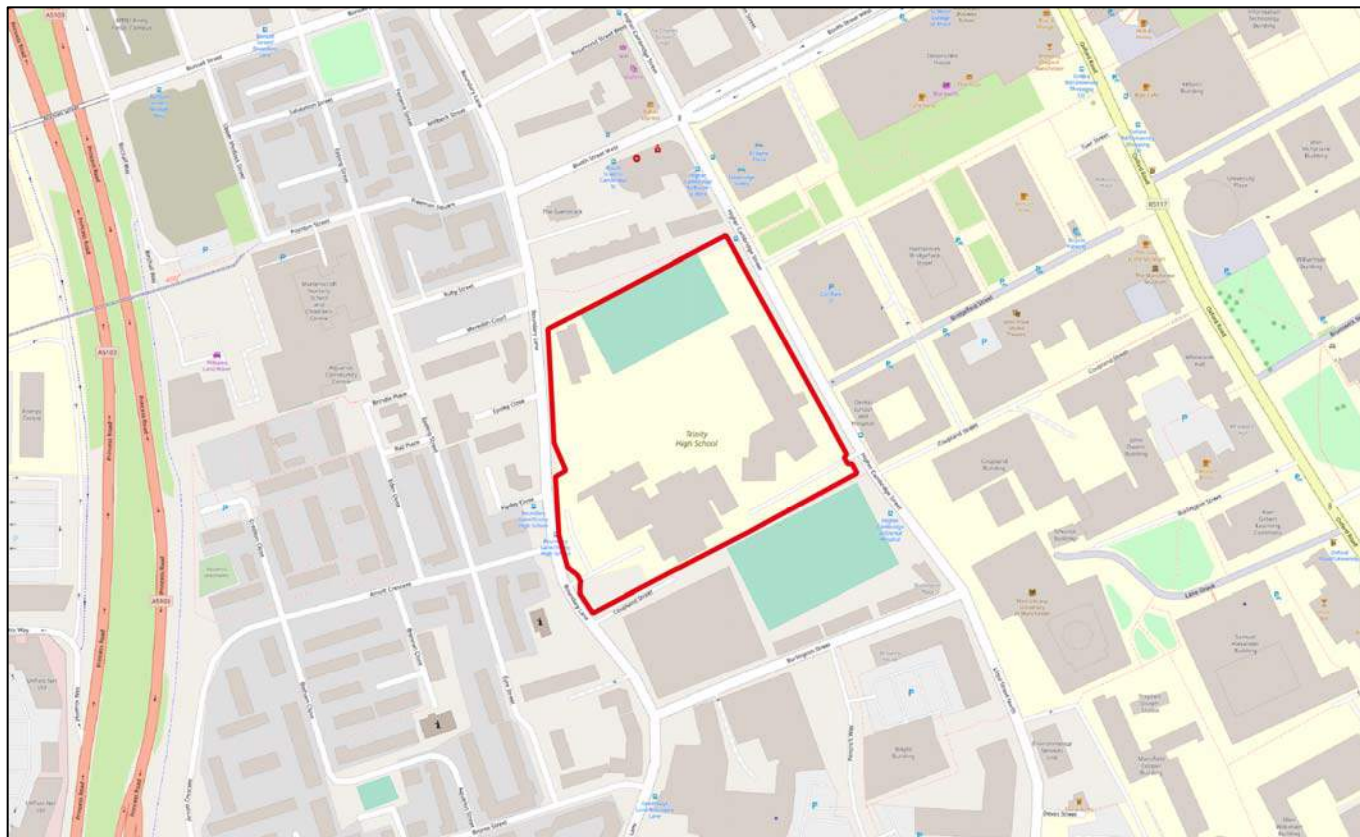
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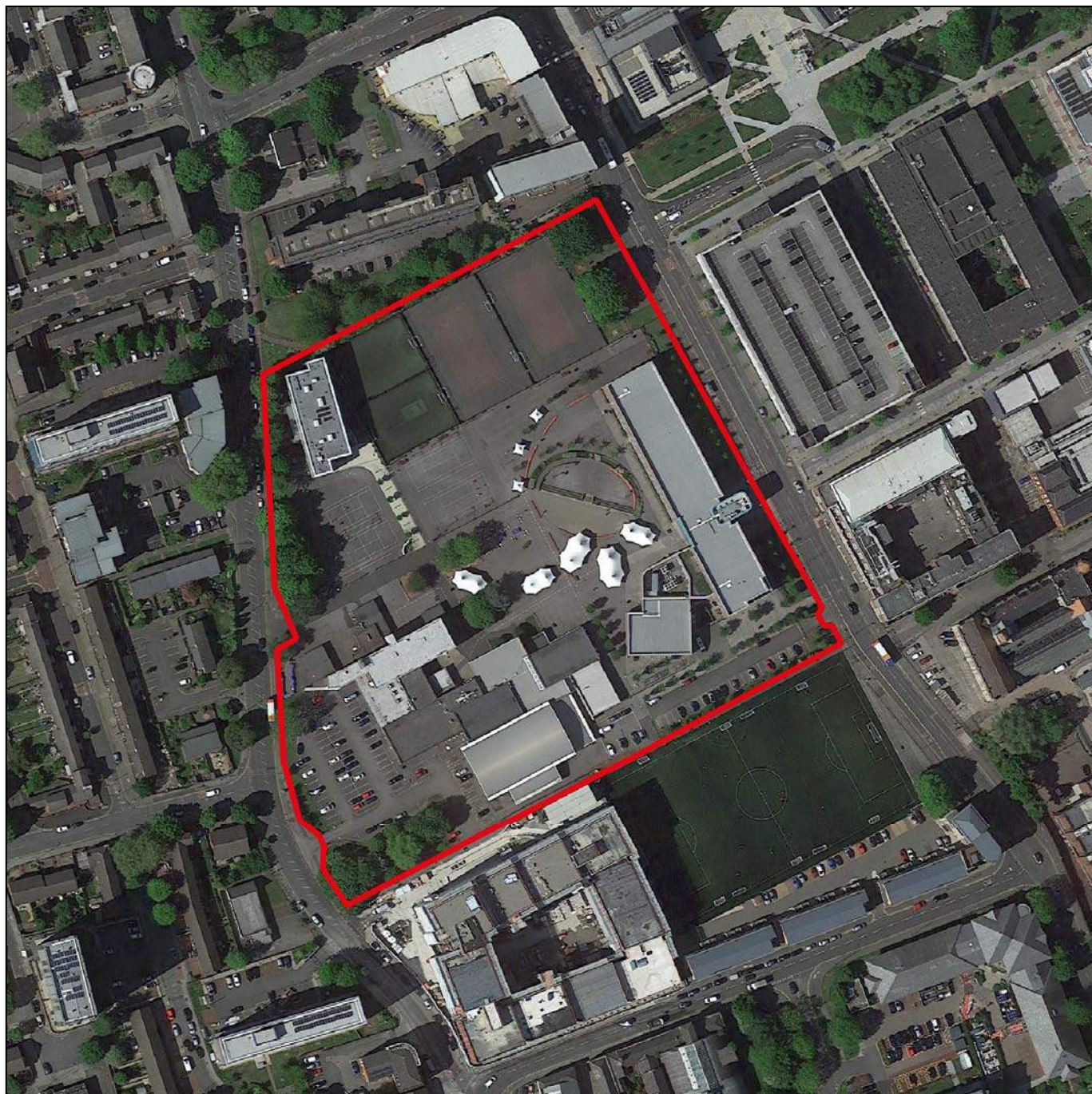
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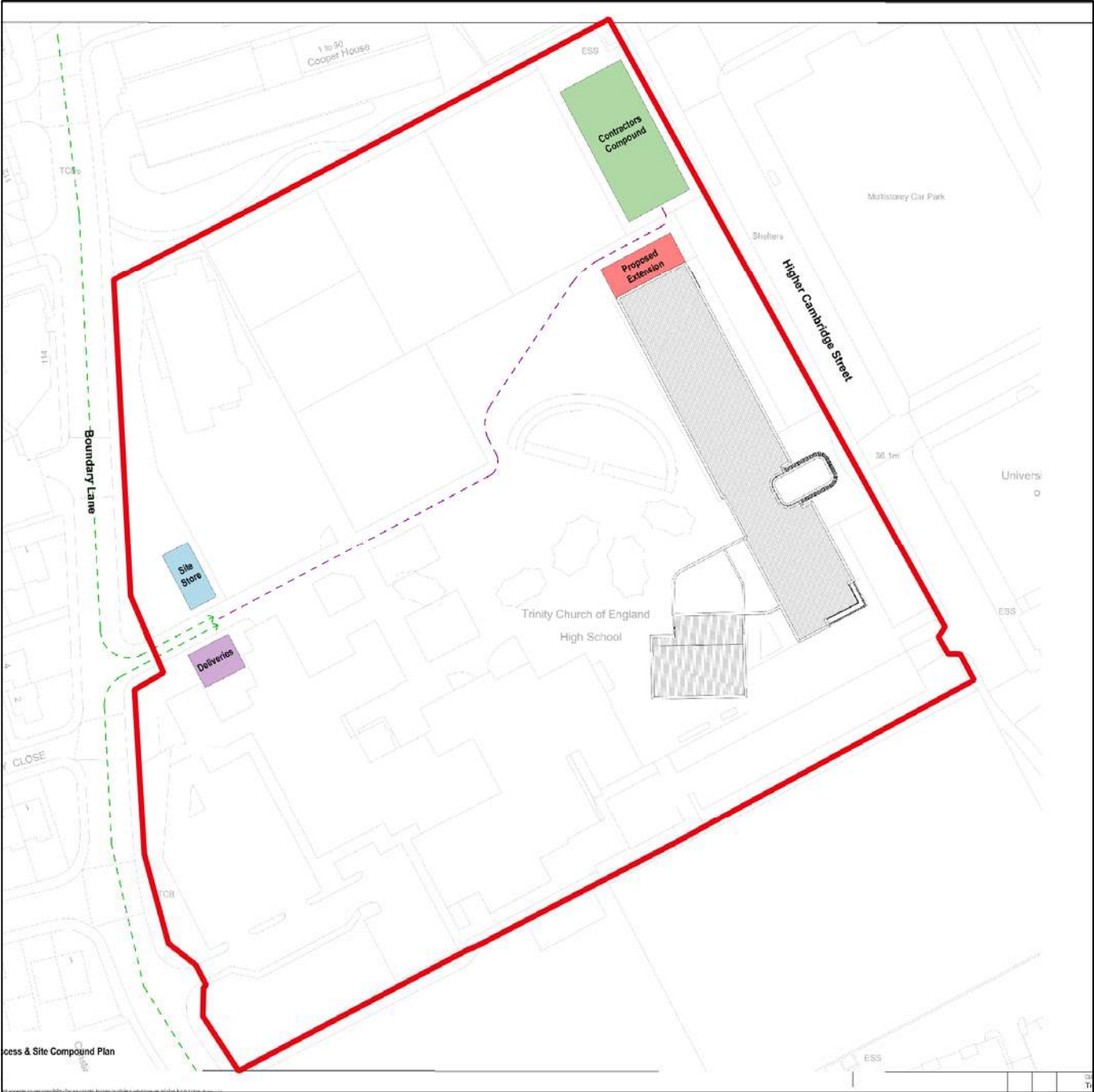
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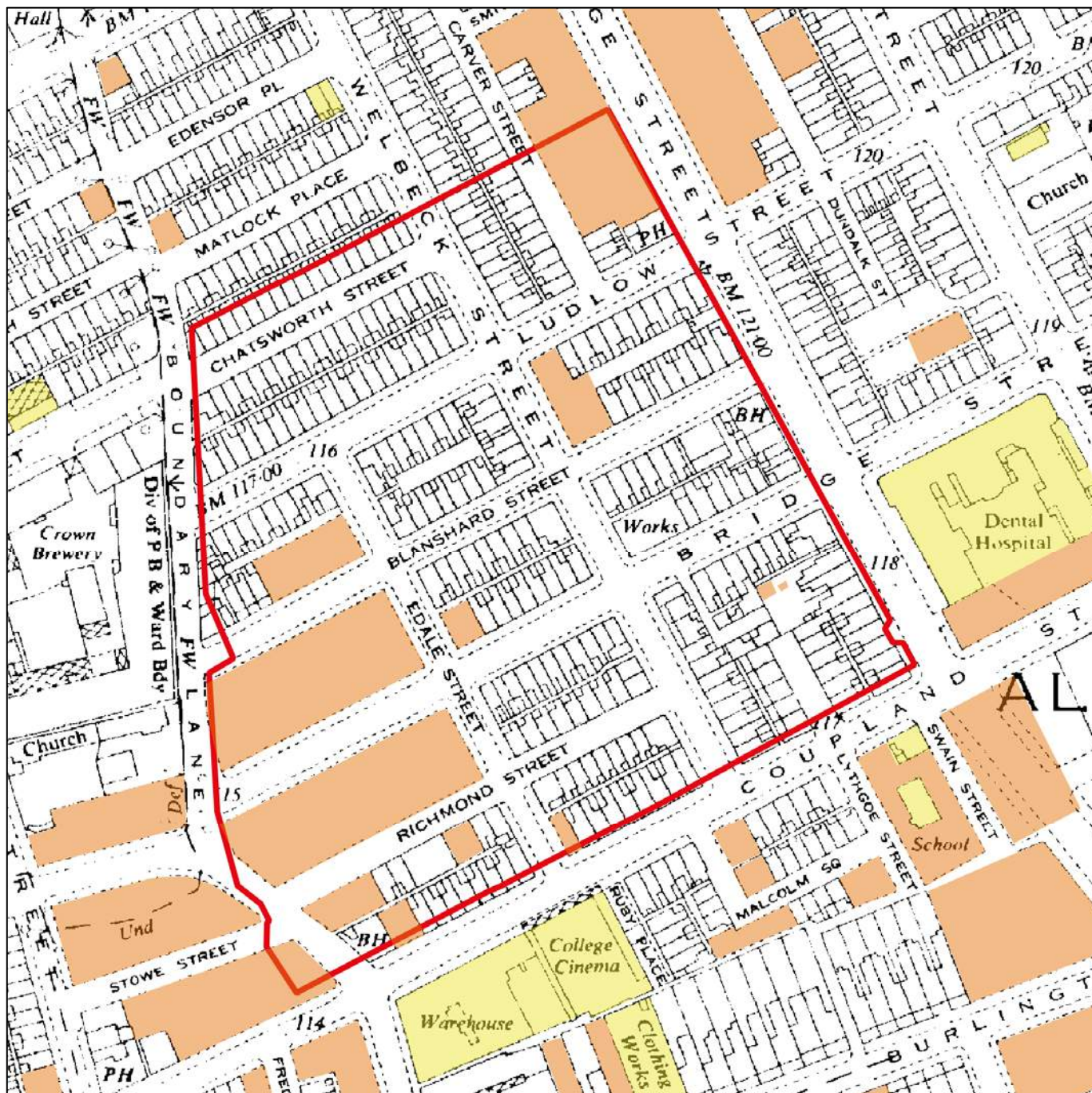
— Approximate site boundary



— Site boundary



— Approximate site boundary



- Approximate site boundary
- Clearance
- Redevelopment

Most Commonly Deployed German HE Bombs

SC 50

Bomb Weight: 40-54kg (110-119lb)

Explosive Weight: c25kg (55lb)

Fuze Type: Impact fuze/electro-mechanical time delay fuze

Bomb Dimensions: 1,090 x 280mm (42.9 x 11.0in)

Body Diameter: 200mm (7.87in)

Use: Against lightly damageable materials, hangars, railway rolling stock, ammunition depots, light bridges and buildings up to three stories.

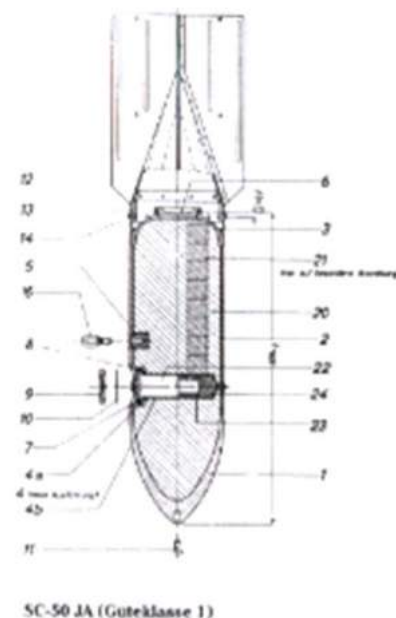
Remarks: The smallest and most common conventional German bomb. Nearly 70% of bombs dropped on the UK were 50kg.



50kg bomb, London Docklands



50kg bomb, minus tail section



SC 250

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)

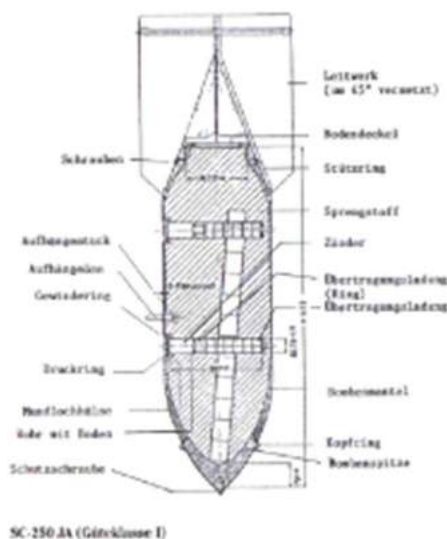
Use: Against railway installations, embankments, flyovers, underpasses, large buildings and below-ground installations.



250kg bomb, Hawkinge



SC250 attached to undercarriage of Messerschmitt Bf109



1kg Incendiary Bomb

Bomb weight: 1.0 and 1.3kg (2.2 and 2.87lb)

Filling: 680gm (1.3lb) Thermite

Fuze type: Impact fuze

Bomb dimensions: 350 x 50mm (13.8 x 1.97in)

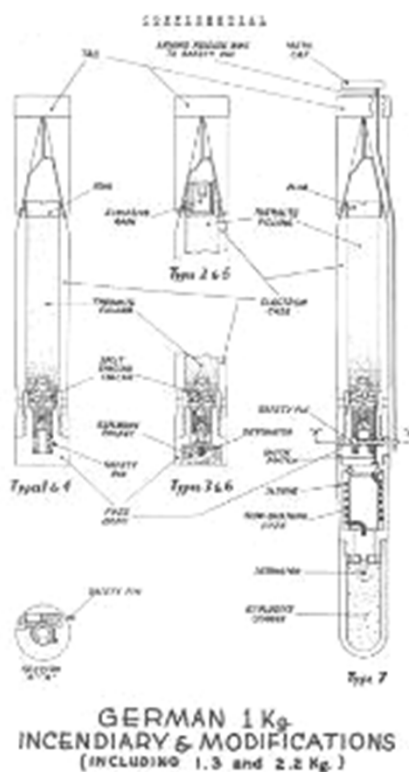
Body diameter: 50mm (1.97in)

Use: As incendiary – dropped in clusters against towns and industrial complexes

Remarks: Jettisoned from air-dropped containers. Magnesium alloy case. Sometimes fitted with high explosive charge



1. Ordinary scaffold pipe
2. 1kg incendiary bomb
3. Incendiary bomb recently found on site in UK



1kg German Incendiary Bomb next to a 30cm ruler

EveningStandard.

Pictured: Unexploded World War II bomb found in Brondesbury Park



EveningStandard.

Bomb disposal expert reveals dramatic details of how huge WW2 bomb found in Thames was detonated



Top Left: 500lb UXB found in Brondesbury Park, London – March 2017.

Bottom Left: UXB discovered in the Thames near the Houses of Parliament – February 2017.

Top Right: The discovery of a 250kg UXB near Kingston University resulted in the closure of the University and nearby homes – May 2019

Middle Right: A 400m cordon was established after a 1,000lb UXB was found in Grange Walk, Bermondsey – March 2015

Bottom Right: 500lb UXB discovered in Lansdown, Bath – May 2016

BBC

NEWS

Kingston University campus evacuated over 'WW2 bomb'



The Telegraph

Giant WWII bomb dug up by builders in London



MailOnline

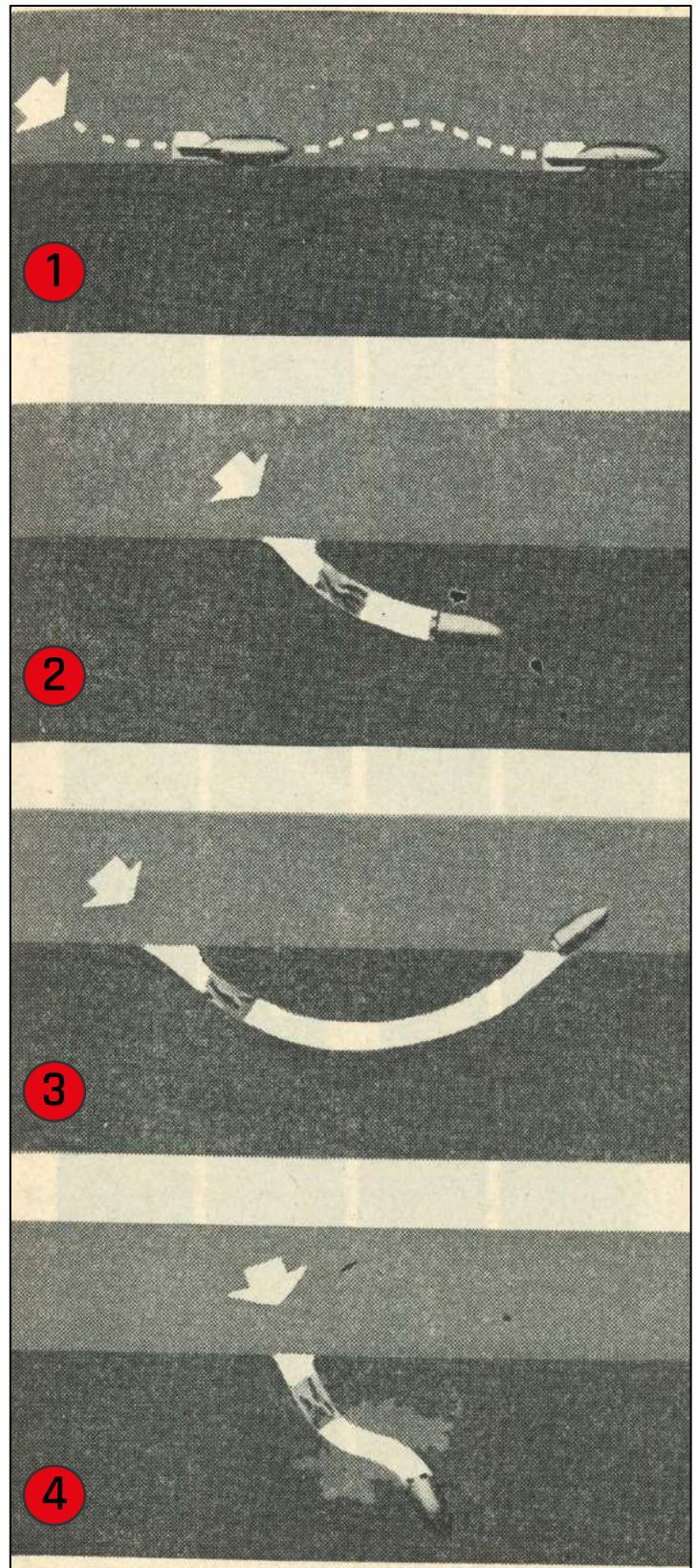
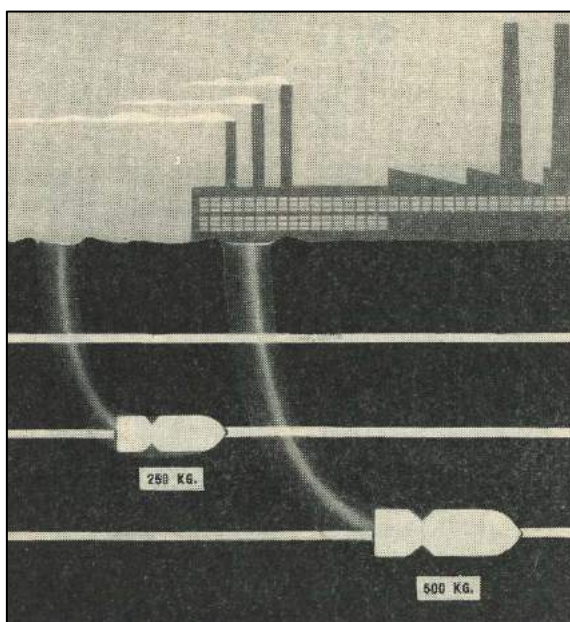
Hundreds of people evacuated after a massive WWII bomb was found in the grounds of a Bath school face a weekend away from their homes



Path of UXB in soft ground

1. **Ricochet resulting from low level attack:** UXB stays perpendicular to ground and rests at surface.
2. **Buried UXB with J-Curve:** Bomb curves horizontally and rests perpendicular to surface.
3. **UXB returning to surface due to J-Curve:** Bomb points towards surface but may remain partially or completely below ground level.
4. **UXB deflected by buried objects:** Results in unpredictable path and unusual shaft.

Below: UXB can come to rest beneath undamaged buildings due to the J-Curve effect if it lands in nearby soft ground.





	Approximate site boundary		HE bomb strike
	Demolished buildings		Fire bomb strike
	Damaged buildings		Parachute Mine
	Unspecified damage		Unidentified bomb strike

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23 July 2010 Last updated at 18:28

Covert British troops 'could have buried' WWII devices

World War II incendiary devices found on a building site in Gloucestershire could have been left by covert British troops, according to researchers.

More than 20 phosphorus bombs were unearthed in Birdlip after a digger hit one, causing it to burst into flames.

A former worker at the site said he saw a Home Guard officer burying objects there 65 years ago.

The Coleshill Auxiliary Research Team said auxiliary officers often used Home Guard uniforms as cover.



Thursday, September 10 2015

KM KentOnline
The UK's fastest-growing regional news network

Army bomb disposal team called to Blacksole Bridge in Herne Bay

by Aidan Barlow abarlow@thekmgroupp.co.uk

08 July 2015

It was like a scene from Dad's Army when Army bomb disposal experts found wartime explosives made by the Home Guard in makeshift bottles.

A team was called to the Blacksole Bridge in Herne Bay after the wartime bombs were found.

The team from the Royal Logistics Corps set up a 30 metre exclusion zone for pedestrians around the railway embankment after the suspected homemade phosphorus bombs were found.



EAST ANGLIAN DAILY TIMES

WATCH: Bomb squad detonate 24 Second World War grenades found buried in Suffolk field

Adam Howlett adam.howlett@archant.co.uk @EADTadam
PUBLISHED: 12:08 28 May 2019 | UPDATED: 13:39 28 May 2019



SIP Grenades were discovered and detonated in Sibton by British Army Bomb Disposal Experts, Suffolk Police and Suffolk Fire & Rescue Picture: SUFFOLK FIRE & RESCUE SERVICE

The bomb squad safely detonated dozens of incendiary grenades found buried in a field in Sibton near Saxmundham on Bank Holiday Monday.

Eastbourne Herald
10/09/15 11°C to 21°C Sunny Like us Follow us Place your Ad Subscribe

VIDEO: Explosion after 80 grenades detonated in Eastbourne

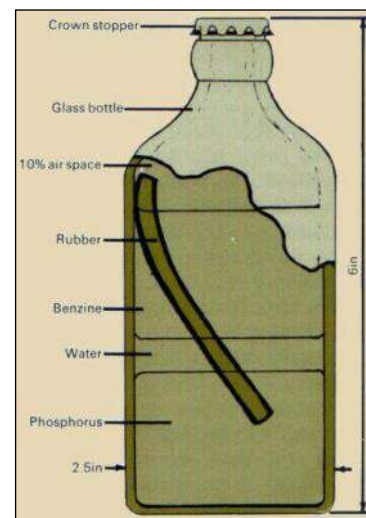


Marked 'AW Bomb 1940' the grenades were thought to have been phosphorus incendiary grenades created as improvised anti-tank weapons when Britain was facing invasion following the army's evacuation from Dunkirk in 1940.

He said, "I remember the grenades being buried. It was part of the Home Guard stash, it was put there in case we were invaded. It had to be in 1943. There were a lot of them [stashes], they were all over the place."

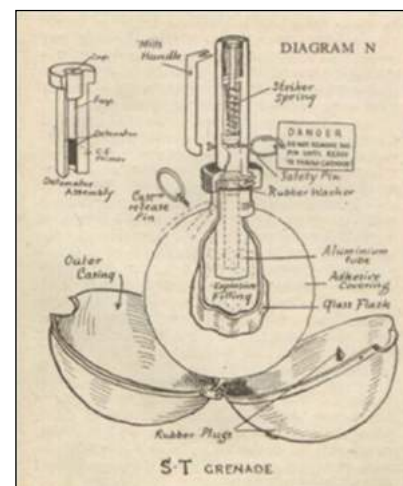
Self Igniting Phosphorous (SIP) Grenades

The grenade comprised a glass bottle with a total volume of approximately one pint. It was filled with White Phosphorus, benzene, a piece of rubber and water. Over time the rubber dissolved to create a sticky fluid which would self ignite when the bottle broke. Fired by hand or Northover Projector. Sometimes called the "A & W" (Albright & Wilson) grenade.



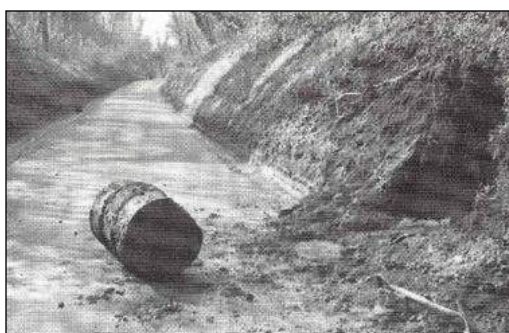
No 74 Grenade (Sticky Bomb)

Designed as an anti-tank grenade and used by the Home Guard. The grenade consisted of a glass ball on the end of a Bakelite (plastic) handle. Inside the glass ball was an explosive filling whilst on the outside was a very sticky adhesive covering. Until used, this adhesive covering was encased in a metal outer casing.



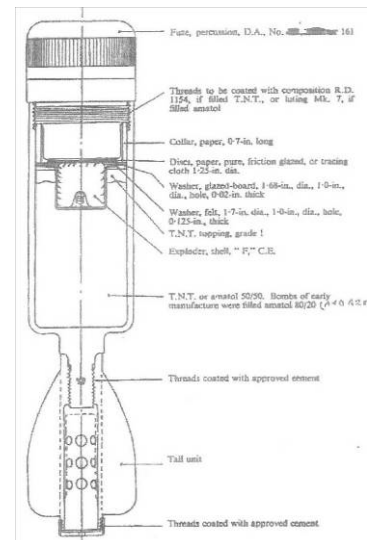
Flame Fougasse Bomb

A Flame Fougasse was a weapon in which the projectile was a flammable liquid, typically a mixture of petrol and oil. It was usually constructed from a 40-gallon drum dug into the roadside and camouflaged. Ammonal provided the propellant charge which, when triggered, caused the weapon to shoot a flame 3m (10ft) wide and 27m (30 yards) long. Initially a mixture of 40% petrol and 60% gas oil was used, this was later replaced by an adhesive gel of tar, lime and petrol known as 5B.



Typical 2 inch High Explosive Mortar

Bomb Weight: 1.02kg (2.25lb)
Type: High Explosive
Dimensions: 51 x 290mm (2in x 11.4in)
Filling: 200g RDX/TNT
Maximum Range: 457m (500yds)
Remarks: Fitted with an impact fuze which detonates the fuze booster charge (exploder) and, in turn, the high explosive charge. The main charge shatters the mortar bomb body, producing near optimum fragmentation and blast effect at the target.



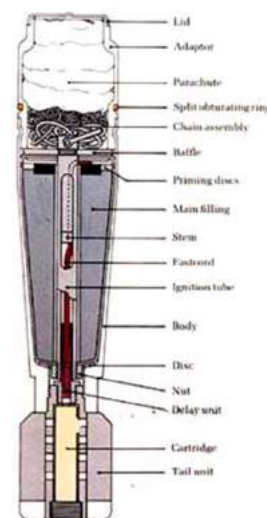
Typical 3 inch Smoke Mortar

Type: Smoke
Dimensions: c490 x 76mm (19.3in x 3in)
Filling: Typically white phosphorous
Maximum Range: 2515m (2,750yds)
Remarks: On impact, the fuze functions and initiates the bursting charge. The bursting charge ruptures the mortar bomb body and disperses the white phosphorous filler. The white phosphorous produces smoke upon exposure to the air.



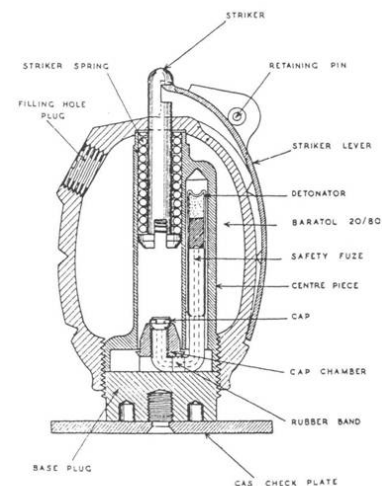
Typical 2 inch Illuminating Mortar

Type: Illum.
Dimensions: 51 x 290mm
Filling: Various
Remarks: The expulsion charge ignites and ejects the candle assembly. A spring ejects the parachute from the tail cone. The parachute opens, slowing the descent of the burning candle which illuminates the target.



No. 36 'Mills' Grenade

Weight: 0.7kg filled (1lb 6oz)
Type: Hand or discharger, fragmentation
Dimensions: 95 x 61mm (3.7 x 2.4in)
Filling: Alumatol, Amatol 2 or TNT
Remarks: 4 second hand-throwing fuse with approximate 30m range. First introduced May 1918.



Grenade, .303 inch rifle, No. 36M, Mark I.

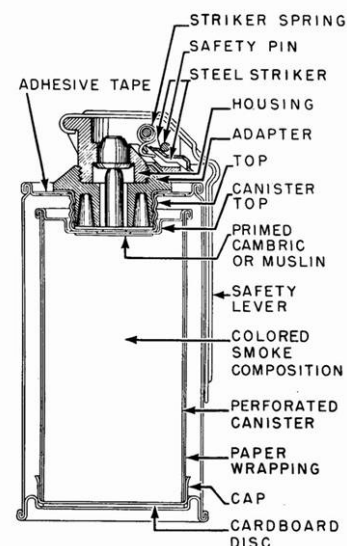
No. 69 Grenade

Weight: 0.38kg filled (0.8lb)
Type: Percussion/Blast
Date Introduced: December 1940
Remarks: Black Bakelite body. Blast rather than fragmentation type. After unscrewing the safety cap, a tape is held when throwing the grenade releasing the safety bolt in the throwing motion. Detection is problematic due to its very low metal content.



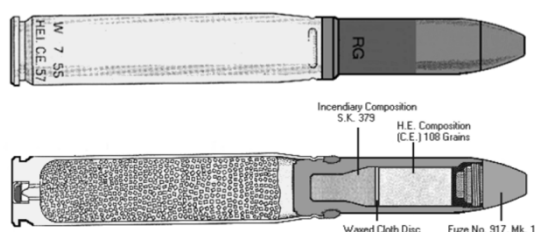
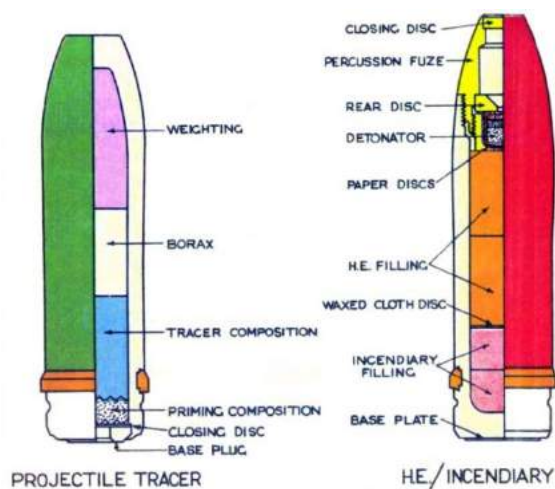
Typical Smoke Grenade

Dimensions: Approx. 65 x 115mm (2.5 x 4.5in)
Type: Smoke
Date Introduced: Current MoD issue
Remarks: Smoke grenades are used as ground-to-ground or ground-to-air signalling devices, or landing zone marking devices, and screening devices for unit movement.
target



20mm Hispano HEI Ammunition

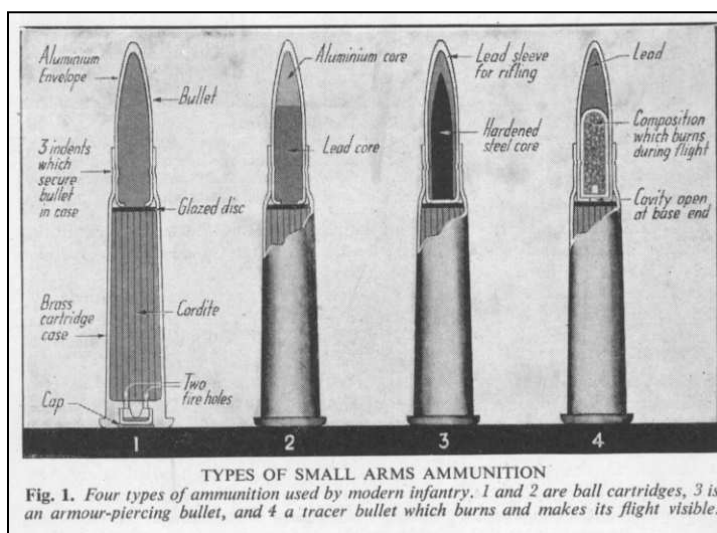
Type:	Live cannon round
Markings:	Upper half of projectile painted 'buff' colour, lower half is red.
Cartridge Weight:	256 grams
Dimensions:	Total cartridge / projectile length - 182mm
Fuzed:	Contact fuze - No.253, No.254 or No.917
Filling:	108 grains of contact explosive + 68 grains of SR.379 incendiary composition.
Threat:	Explosives within unspent cartridge as well as the projectile.
Deployment:	Royal Navy, RAF and British Army Light Anti- Aircraft guns. Also RAF aircraft canons.
Remarks:	Cartridges are belted or supplied loose in cartons.



COLOUR IDENTIFICATION		
BRITISH		
NATURE OF SHELL	H.E. FILLING	COLOUR
H.E. TRACER	T.N.T.	Blue
H.E.	T.N.T.	Orange
PROJ. PRACTICE		Purple
PROJ. TRACER		Green
H.E. INCENDIARY	T.N.T.	Red
H.E. INCENDIARY TRACER	T.N.T.	Yellow

.303" Ammunition

Type:	Rifle / machine gun round
Markings:	Regular round - none. Tracer round - red Primer
Bullet Weight:	150 - 180 grams
Dimensions:	Total cartridge /projectile length - 78mm
Filling:	Regular round - none. Tracer round - small incendiary fill
Threat:	Explosive cordite within unspent cartridge
Deployment:	Royal Navy, RAF and British Army Light Anti-Aircraft guns, machine guns and rifles. Standard British and Commonwealth military cartridge from 1889 until the 1950s.
Remarks:	Cartridges are belted or supplied loose in cartons.



3.7 inch Anti-Aircraft Projectile

Weight:	12.7kg (28lb)
Dimensions:	94 x 360mm (3.7 x 14.7in)
Carriage:	Mobile and Static Versions
Rate of Fire:	10-20 rounds per minute
Ceiling:	9-18,000m (29-59,000ft)
Muzzle Velocity:	792m/s (2,598ft/s)
Remarks:	4.5 inch projectiles were also commonly utilised



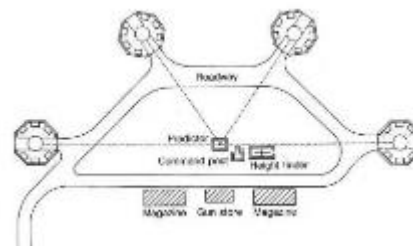
Hyde Park 1939 3.7 Inch QF gun on mobile mounting.



This AA shell was uncovered on a construction site in North London in February 2009.



3.7 inch AA Projectile, Minus Fuze.



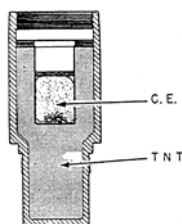
Layout plan for a typical HAA battery site.

Rockets / Un-rotating Projectiles

Weight:	Overall: 24.5kg (54lb)
Warhead::	1.94kg (4.28lb)
Dimensions:	1930mm x 82.6mm (76 x 3.25in)
Carriage:	Mobile - transported on trailers
Ceiling:	6770m (22,200ft)
Maximum Velocity:	457mps (1,500 fps)



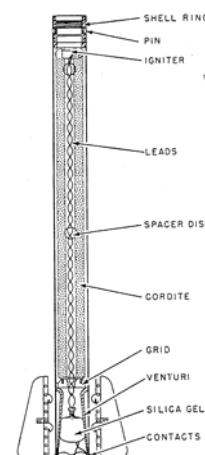
Rocket Battery in action.



MK II HE Shell (3.5kg).



Home Guard soldiers load an anti-aircraft rocket at a 'Z' Battery.



2" U.P. AA Rocket.

40mm Bofors Gun Projectile

Weight:	0.86kg (1.96lb)
Dimensions:	40mm x 310mm (1.6in x 12.2in)
Rate of Fire:	120 rounds per minute
Ceiling:	23,000ft (7000m)
Muzzle Velocity:	2,890 ft/s (881m/s)
Remarks:	Mobile batteries - normally few records of where these guns were located



Unexploded 40mm Bofors projectile



40mm Bofors gun and crew at Stanmore in Middlesex, 28 June 1940.





RESCUE workers search for survivors after a Second World War bomb exploded at a building site in Berlin, killing three people and injuring at least eight others. A fire brigade spokesman said he feared the final death toll could be higher. One worker was still missing, believed to be trapped under a machine. "We've

Blown up by history

found human remains 100 metres away but we can't tell if they belong to the dead already found," the spokesman said. The blast, set off by drilling work on Frankfurter Allee, one of east Berlin's busiest avenues, trapped

workers under building machinery and sent huge chunks of concrete tumbling through the air. A large office block was being built on the site of the explosion which sent shoppers scrambling for shelter and paralysed

dense afternoon traffic. One eyewitness said: "There was a bang, then silence, and then it started raining stones and dirt." Dozens of cars within a 250-metre radius were wrecked and the top two floors of a nearby apartment block caved in. Radio reports claimed that the total number of injured stood at 14.



World War II bomb kills three in Germany

Three people have been killed and six injured trying to defuse a World War II bomb in central Germany.

Workers building a sports stadium had earlier unearthed the bomb in the town of Goettingen.

It was not immediately clear why the bomb, reportedly weighing 500kg (1,100lb), had detonated.



A World War Two bomb has exploded at a construction site near a west German town, killing a man and injuring eight others, police say.

The explosion occurred after a digger accidentally struck the device during excavation work in Euskirchen in the state of North Rhine-Westphalia.

Top Left: WWII bomb killed 3 and injured 8 in Berlin - 1994.

Middle Left: WWII bomb killed 3 in Goettingen, Germany - 2010.

Bottom Left: Excavator operator killed by WWII bomb in Euskirchen, Germany - 2014.

Top Right: A highway construction worker in Germany accidentally struck a WWII bomb, killing himself and wrecking several passing cars - 2006.

Middle Right (Top): Destroyed piling rig and dump truck after detonation of WWII UXB in Austria - 2006.

Middle Right (Bottom): WWII bomb injures 17 at construction site in Hattingen, Germany - 2008.

Bottom Right: A buried WWII-era bomb exploded during construction works in Bandar Malaysia, Kuala Lumpur - 2017.



1 dead, 2 critical after explosion at Malaysia MRT construction site caused by WWII bomb

Various News Sources

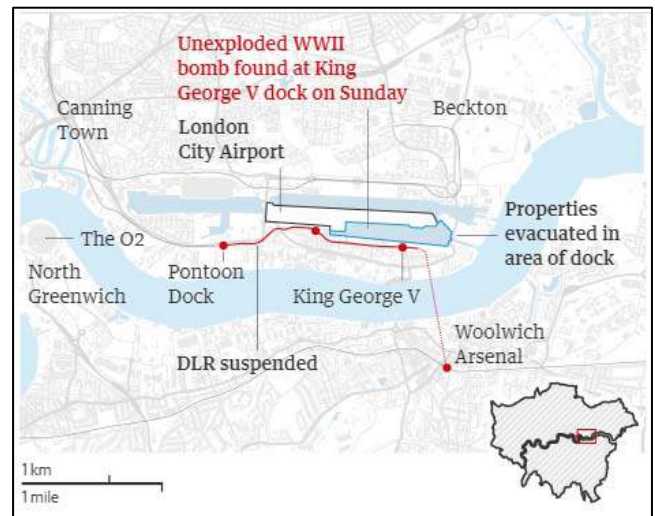
London City Airport shut: Flights cancelled after Second World War bomb found in River Thames dock

London City Airport has been closed after the discovery of an unexploded Second World War bomb, affecting tens of thousands of passengers.

All flights into and out of the airport, in east London, will be stopped on Monday after the device was found nearby in the River Thames on Sunday.

The closure led to the cancellation of more than 100 departures and was affecting up to 16,000 passengers, according to a spokeswoman. A 700ft (214-metre) exclusion zone was put in place on Sunday evening to ensure the device could be dealt with safely.

People living inside the zone were evacuated from their homes overnight, while police said a number of road cordons have been put in place in Newham.



Unexploded WW2 bomb found in Birmingham

An unexploded Second World War bomb was found in Birmingham this afternoon, causing a construction site to be evacuated.



Aston Expressway bomb: Controlled explosion carried out on Second World War shell

A Second World War bomb found near the Aston Expressway has been safely detonated, bringing 30 hours of drama to an end.

The explosion meant a gradual return to normality for the 200 residents who had been evacuated from the 1,600ft (500 metre) cordon put in place on the advice of explosives experts.

However, although the M6 was reopened after the blast, the key Aston Expressway stayed shut until 6pm - extending traffic disruption which had added 90 minutes onto many people's journeys.

The A38(M) and slip roads off Spaghetti Junction had all been shut since the large German bomb was found on Monday morning, while nearby rail services were also disrupted.



Bath WW2 bomb scare: Hundreds of homes evacuated

Up to 1,000 homes have been evacuated and a 300m exclusion zone is in place following the find in Lansdown Road.

According to reports, a 500lb (228kg) bomb was found just a metre beneath a playground at the former Royal High Junior School.



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Please Note: image for reference only

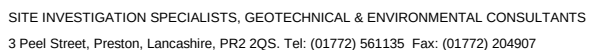


Low Risk Zone

Medium Risk Zone

INSITU TEST RESULTS

S S SUB SURFACE SITE INVESTIGATION SPECIALISTS, GEOTECHNICAL & ENVIRONMENTAL CONSULTANTS 3 Peel Street, Preston, Lancashire, PR2 2QS. Tel: (01772) 561135 Fax: (01772) 204907							Standard Penetration Test Results						
Site : TRINITY C OF E HIGH SCHOOL, HIGHER CAMBRIDGE STREET, MANCHESTER											Job Number 7200		
Client : TRINITY C OF E HIGH SCHOOL											Sheet		
Engineer: DAY ARCHITECTURAL LTD											1 / 1		
Borehole Number	Base of Borehole (m)	End of Seating Drive (m)	End of Test Drive (m)	Test Type	Seating Blows per 75mm		Blows for each 75mm penetration				Result	Comments	
					1	2	1	2	3	4			
BH1	1.20	1.35	1.65	CPT	1	1	1	1	1	2	N=5		
BH1	2.00	2.15	2.45	CPT	1	2	3	2	1	1	N=7		
BH1	4.00	4.15	4.45	SPT	3	4	5	5	5	6	N=21		
BH1	5.00	5.15	5.45	SPT	3	4	5	5	5	5	N=20		
BH1	6.00	6.15	6.26	SPT	8	8	33	17			50/105mm		
BH1	7.50	7.54	7.55	SPT	25		50				25*/40mm 50/10mm		
BH1	9.00	9.01	9.01	SPT	25		50				25*/7mm 50/5mm		
BH2	1.20	1.35	1.65	CPT	1	2	2	2	2	3	N=9		
BH2	2.00	2.15	2.45	CPT	2	3	2	2	3	2	N=9		
BH2	3.00	3.15	3.45	CPT	2	2	2	2	2	3	N=9		
BH2	4.00	4.15	4.45	SPT	3	4	4	4	4	4	N=16		
BH2	5.00	5.15	5.37	SPT	6	7	20	20	10		50/220mm		
BH2	6.00	6.08	6.10	SPT	25		50				25*/75mm 50/25mm		
BH2	7.50	7.52	7.53	SPT	25		50				25*/20mm 50/10mm		



Site:	TRINITY C OF E HIGH SCHOOL, HIGHER CAMBRIDGE STREET, MANCHESTER	Job Number:	7200
Client:	TRINITY C OF E HIGH SCHOOL	Sheet:	1 / 1
Engineer:	DAY ARCHITECTURAL LIMITED		

[illegible]

Water samples taken from BH1, Sample number: 259, 260, 261. BH2 dry.

LABORATORY TEST RESULTS



Site : TRINITY C OF E HIGH SCHOOL, HIGHER CAMBRIDGE STREET, MANCHESTER Client : TRINITY C OF E HIGH SCHOOL Engineer: DAY ARCHITECTURAL LTD	Job Number 7200
	Sheet 1 / 1

Borehole/ Trial Pit	Depth (m)	Sample	Natural Moisture Content %	Sample Passing 425µm Sieve		Liquid Limit %	Plastic Limit %	Plasticity Index %	Liquidity Index	Group Symbol	Laboratory Description
				Percentage %	Moisture Content %						
BH1	3.40	U	19	74	26	38	18	20	0.40	CI	Dark brown slightly gravelly silty CLAY. Gravel is subangular to subrounded fine to medium siltstone and sandstone.
BH2	3.00	B	14	93	15	28	15	13	0.00	CL	Dark brown slightly gravelly silty CLAY. Gravel is subrounded fine to medium siltstone, mudstone and sandstone.

Remarks :



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Laboratory Test Results

Site : TRINITY C OF E HIGH SCHOOL, HIGHER CAMBRIDGE STREET, MANCHESTER

 Client : TRINITY C OF E HIGH SCHOOL

 Engineer : DAY ARCHITECTURAL LTD

Job Number
7200

 Sheet
1 / 1

DETERMINATION OF DENSITY, MOISTURE CONTENT AND UNDRAINED SHEAR STRENGTH
 IN TRIAXIAL COMPRESSION WITHOUT MEASUREMENT OF PORE PRESSURE

Borehole/ Trial Pit	Depth (m)	Sample	Moisture Content %	Bulk Density (Mg/m³)	Dry Density (Mg/m³)	Cell Pressure (kN/m²)	Deviator Stress (kN/m²)	Apparent Cohesion (kN/m²)	Angle of Shearing Resistance (degrees)	Laboratory Description
BH1	3.40	U#	19	2.14	1.80			78		Dark brown slightly gravelly silty CLAY. Gravel is subangular to subrounded fine to medium siltstone and sandstone.

Method of Preparation : BS 1377:PART 1:1990:7.4.2 Moisture content 1990: Preparation of undisturbed samples for testing BS 1377:PART 2:1990:7.2

Method of Test : BS 1377:PART 2:1990:3 Determination of moisture content 1990:7 Determination of density BS 1377:PART 7:1990:8 Undrained shear strength 1990:9 Multistage loading

Remarks : #Hand Shear Vane test



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Laboratory Test Results

Site : TRINITY C OF E HIGH SCHOOL, HIGHER CAMBRIDGE STREET, MANCHESTER

Client : TRINITY C OF E HIGH SCHOOL

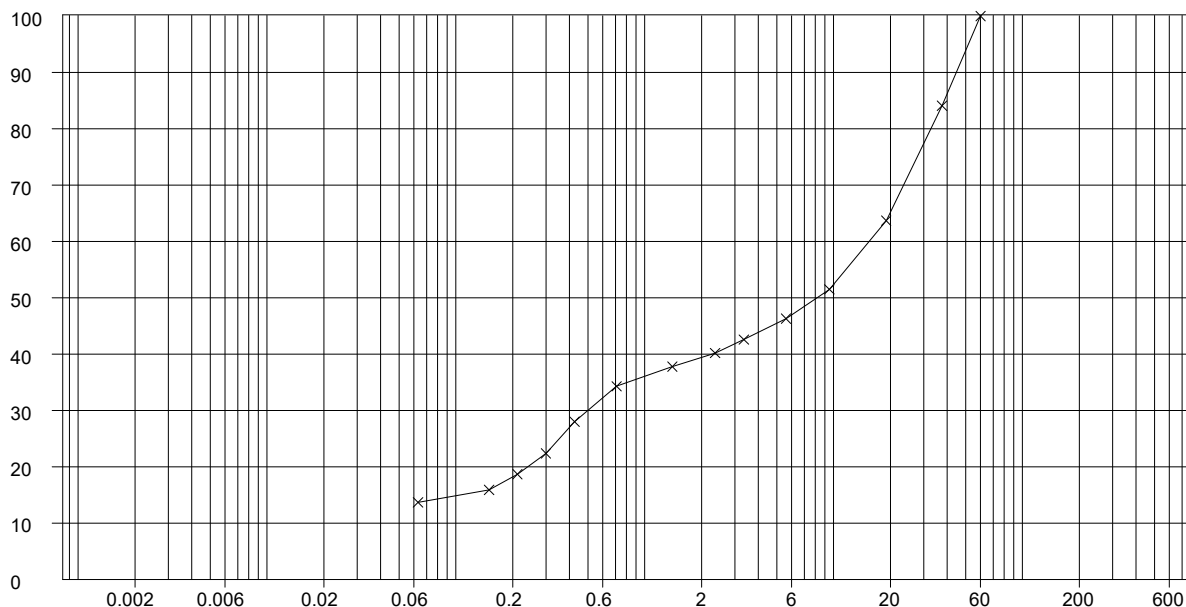
Engineer : DAY ARCHITECTURAL LTD

Job Number
7200

Sheet
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DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Laboratory Description
BH1	2.50 - 3.00	B	Brown slightly clayey silty very sandy subangular to subrounded fine to coarse siltstone, sandstone and quartz GRAVEL.



Sieve / Particle Size	% Passing
60 mm	100.0
37.5 mm	84.1
19 mm	63.7
9.5 mm	51.5
5.6 mm	46.3
3.35 mm	42.6
2.36 mm	40.2
1.4 mm	37.8
710 µm	34.3
425 µm	28.0
300 µm	22.4
212 µm	18.7
150 µm	15.9
63 µm	13.7

CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES	BOULDERS
	SILT			SAND			GRAVEL				

Grading Analysis	
D85	38.8 mm
D60	16.1 mm
D10	<63.0 µm
Uniformity Coefficient	-

Particle Proportions	
Cobbles + Boulders	-
Gravel	60.6%
Sand	25.7%
Silt	-
Clay	-

Method of Preparation : BS 1377:PART 1:1990:7.3 Initial preparation 1990:7.4.5 Particle size tests

Method of Test : BS 1377:PART 2:1990:9 Determination of particle size distribution

Remarks :



2/3

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Laboratory Test Results

Site : TRINITY C OF E HIGH SCHOOL, HIGHER CAMBRIDGE STREET, MANCHESTER

Client : TRINITY C OF E HIGH SCHOOL

Engineer : DAY ARCHITECTURAL LTD

Job Number

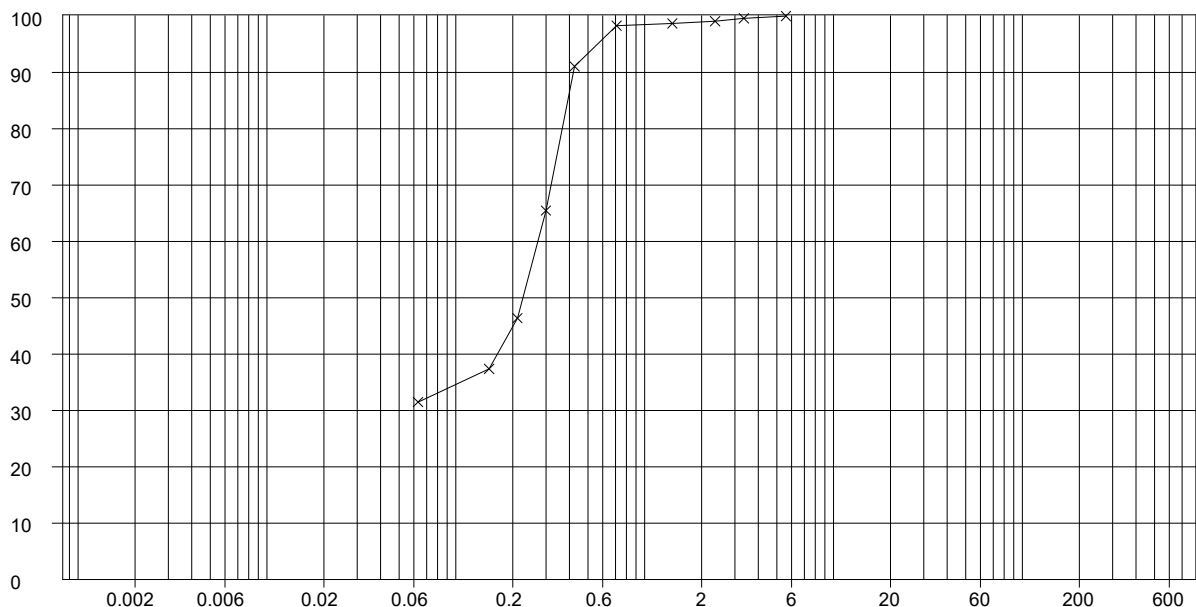
7200

Sheet

3/3

DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Laboratory Description
BH2	4.60 - 5.00	B	Brownish red very silty fine to medium SAND (completely weathered sandstone).



Sieve / Particle Size	% Passing
5.6 mm	100.0
3.35 mm	99.6
2.36 mm	99.1
1.4 mm	98.7
710 μm	98.3
425 μm	91.1
300 μm	65.5
212 μm	46.4
150 μm	37.4
63 μm	31.5

CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES	BOULDERS
	SILT			SAND			GRAVEL				

Grading Analysis	
D85	395.2 μm
D60	274.7 μm
D10	<63.0 μm
Uniformity Coefficient	-

Particle Proportions	
Cobbles + Boulders	-
Gravel	1.0%
Sand	67.5%
Silt	-
Clay	-

Method of Preparation : BS 1377:PART 1:1990:7.3 Initial preparation 1990:7.4.5 Particle size tests

Method of Test : BS 1377:PART 2:1990:9 Determination of particle size distribution

Remarks :

S S SUB SURFACE SITE INVESTIGATION SPECIALISTS, GEOTECHNICAL & ENVIRONMENTAL CONSULTANTS 3 Peel Street, Preston, Lancashire, PR2 2QS. Tel: (01772) 561135 Fax: (01772) 204907							Laboratory Test Results						
Site : TRINITY C OF E HIGH SCHOOL, HIGHER CAMBRIDGE STREET, MANCHESTER												Job Number 7200	
Client : TRINITY C OF E HIGH SCHOOL												Sheet 1 / 1	
Engineer: DAY ARCHITECTURAL LTD													
DETERMINATION OF pH, SULPHATE CONTENT AND TOTAL SULPHUR OF SOIL AND GROUNDWATER AND MAGNESIUM, CHLORIDE, AMMONIA AND NITRATE CONTENT													
Borehole/ Trial Pit	Depth (m)	Sample	Concentration of Sulphate			Total Sulphur %	Magnesium mg/l	Ammonium NH4 mg/l	Water Soluble Chloride mg/l	Water Soluble Nitrate mg/l	pH	Design Class	Laboratory Description
			Soil		Ground Water g /l								
			Total S03 %	S04 in 2:1 water:soil g /l									
BH1	1.00	D		0.17							8.5	DS-1	MADE GROUND: dark grey slightly gravelly sandy silty clay. Gravel sized fragments are fine to coarse brick, slag and concrete.
BH1	2.50	B		0.19							8.4	DS-1	Brown slightly clayey silty very sandy subangular to subrounded fine to coarse siltstone, sandstone and quartz GRAVEL.
BH1	4.00	D		0.01							8.6	DS-1	Dark brown slightly gravelly silty CLAY. Gravel is subangular to subrounded fine to medium siltstone and stone.
BH1	7.50	D		<0.01							8.6	DS-1	Brownish red fine to medium highly weathered SANDSTONE, completely weathered to sand in places.
BH2	0.40	D		0.12							8.5	DS-1	MADE GROUND: dark grey gravelly slightly clayey fine to coarse sand. Gravel sized sized fragments are fine to coarse concrete, brick and glass.
BH2	2.00	B		1.10							8.8	DS-2	MADE GROUND: dark grey gravelly slightly silty fine to coarse sand. Gravel sized fragments fine to coarse brick, concrete and slag.
BH2	4.00	D		0.06							8.6	DS-1	Dark brown slightly gravelly silty CLAY. Gravel is subrounded fine to medium siltstone, mudstone and sandstone.
BH2	5.40	D		<0.01							9.1	DS-1	Brownish red fine to medium highly weathered SANDSTONE, completely weathered to sand in places.
Method of Preparation : BS 1377:PART 1:1990:7.5 Preparation of soil for chemical tests BS 1377:PART 3:1990:5.2, 5.3, 5.4 & 9.4													
Method of Test : Lab in-house methods based on BS1377: Part 3 for contents of water sol sulphate, pH, chloride and magnesium. Lab in-house method based on MEWAM (EA, 2006) for total sulphur													
Remarks : Classification relates to Design Sulphate Class of BRE Special Digest 1 (2005)													



SUB SURFACE

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BRE Special Digest I

AGGRESSIVE CHEMICAL ENVIRONMENT FOR CONCRETE (ACEC) SITE CLASSIFICATION.

Table C1 Aggressive Chemical Environment for Concrete (ACEC) classification for natural ground locations^a

Sulfate Design Sulfate Class for location	2:1 water/soil extract ^b	Groundwater	Total potential sulfate ^c	Groundwater Static water	Mobile water	ACEC Class for location
1	2 (SO ₄ mg/l)	3 (SO ₄ mg/l)	4 (SO ₄ %)	5 (pH)	6 (pH)	7
DS-1	< 500	< 400	< 0.24	≥ 2.5	> 5.5 ^d 2.5-5.5	AC-1s AC-1 ^d AC-2z
DS-2	500-1500	400-1400	0.24-0.6	> 3.5 2.5-3.5	> 5.5 2.5-5.5	AC-1s AC-2 AC-2s AC-3z
DS-3	1600-3000	1500-3000	0.7-1.2	> 3.5 2.5-3.5	> 5.5 2.5-5.5	AC-2s AC-3 AC-3s AC-4
DS-4	3100-6000	3100-6000	1.3-2.4	> 3.5 2.5-3.5	> 5.5 2.5-5.5	AC-3s AC-4 AC-4s AC-5
DS-5	> 6000	> 6000	> 2.4	> 3.5 2.5-3.5	≥ 2.5	AC-4s AC-5

Notes

- a Applies to locations on sites that comprise either undisturbed ground that is in its natural state (ie is not brownfield - Table C2) or clean fill derived from such ground.
- b The limits of Design Sulfate Classes based on 2:1 water/soil extracts have been lowered relative to previous Digests (Box C7).
- c Applies only to locations where concrete will be exposed to sulfate ions (SO₄) which may result from the oxidation of sulfides (eg pyrite) following ground disturbance (Appendix A1 and Box C8).
- d For flowing water that is potentially aggressive to concrete owing to high purity or an aggressive carbon dioxide level greater than 15 mg/l (Section C2.2.3), increase the ACEC Class to AC-2z.

Explanation of suffix symbols to ACEC Class

- Suffix 's' indicates that the water has been classified as static.
- Concrete placed in ACEC Classes that include the suffix 'z' primarily have to resist acid conditions and may be made with any of the cements or combinations listed in Table D2 on page 42.

Table C2 Aggressive Chemical Environment for Concrete (ACEC) classification for brownfield locations^a

Sulfate and magnesium				Groundwater locations			ACEC	
Design Sulfate	2:1 water/soil extract ^b		Groundwater		Total potential sulfate ^c	Static water	Mobile water	Class for location
Class for location								
1	2	3	4	5	6	7	8	9
	{SO ₄ mg/l}	{Mg mg/l}	{SO ₄ mg/l}	{Mg mg/l}	{SO ₄ %}	{pH} ^e	{pH} ^d	
DS-1	< 500		< 400		< 0.24	≥ 2.5	> 6.5 ^e 5.5-6.5 4.5-5.5 2.5-4.5	AC-1s AC-1 AC-2z AC-3z AC-4z
DS-2	500-1500		400-1400		0.24-0.6	> 5.5 2.5-5.5	> 6.5 5.5-6.5 4.5-5.5 2.5-5.5	AC-1s AC-2 AC-2s AC-3z AC-4z AC-5z
DS-3	1600-3000		1500-3000		0.7-1.2	> 5.5 2.5-5.5	> 6.5 5.5-6.5 2.5-5.5	AC-2s AC-3 AC-3s AC-4 AC-5
DS-4	3100-6000	≤ 1200	3100-6000	≤ 1000	1.3-2.4	> 5.5 2.5-5.5	> 6.5 2.5-6.5	AC-3s AC-4 AC-4s AC-5
DS-4s	3100-6000	> 1200 ^e	3100-6000	> 1000 ^e	1.3-2.4	> 5.5	> 6.5 2.5-5.5	AC-3s AC-4m AC-4ms AC-5m
DS-5	> 6000	≤ 1200	> 6000	≤ 1000	> 2.4	> 5.5 2.5-5.5	≥ 2.5	AC-1s AC-5
DS-5m	> 6000	> 1200 ^e	> 6000	> 1000 ^e	> 2.4	> 5.5 2.5-5.5	≥ 2.5	AC-4ms AC-5m

Notes

- a Brownfield locations are those sites, or parts of sites, that might contain chemical residues produced by or associated with industrial production (Section C5.1.3).
- b The limits of Design Sulfate Classes based on 2:1 water/soil extracts have been lowered from previous Digests (Box C7).
- c Applies only to locations where concrete will be exposed to sulfate ions (SO₄) which may result from the oxidation of sulfides such as pyrite, following ground disturbance (Appendix A1 and Box C8).
- d An additional account is taken of hydrochloric and nitric acids by adjustment to sulfate content (Section C5.1.3).
- e The limit on water-soluble magnesium does not apply to brackish groundwater (chloride content between 12 000 mg/l and 17 000 mg/l). This allows 'm' to be omitted from the relevant ACEC classification. Seawater (chloride content about 18 000 mg/l) and stronger brines are not covered by this table.

Explanation of suffix symbols to ACEC Class

- Suffix 's' indicates that the water has been classified as static.
- Concrete placed in ACEC Classes that include the suffix 'z' have primarily to resist acid conditions and may be made with any of the cements in Table D2 on page 42.
- Suffix 'm' relates to the higher levels of magnesium in Design Sulfate Classes 4 and 5.

CONTAMINATION ANALYSIS RESULTS

Site: TRINITY C OF E HIGH SCHOOL, HIGHER CAMBRIDGE STREET, MANCHESTER

Job Number:	7200
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Client: TRINITY C OF E HIGH SCHOOL

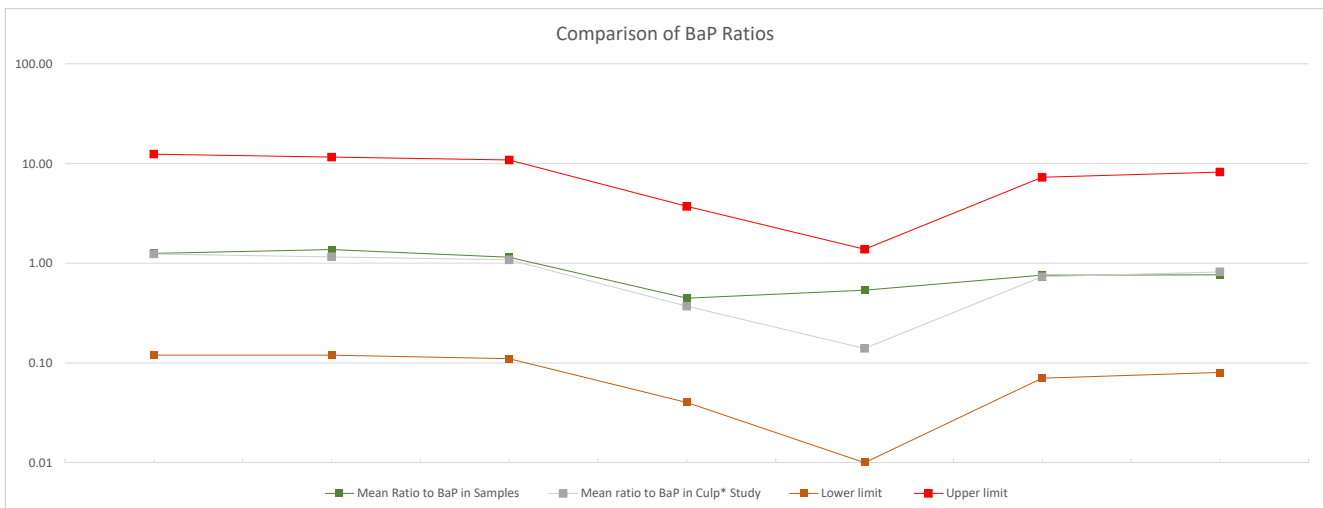
Sheet: 1 / 1

Engineer: DAY ARCHITECTURAL LTD

Benzo(a)pyrene Surrogate Marker Test

		Ratio to BaP							
		Benzo(a)pyrene	Benzo(b)anthracene	Chrysene	Benzo(b)fluoranthene	Benzo(k)fluoranthene	Dibenz(a,h)anthracene	Indeno(1,2,3-cd)pyrene	Benzo(ghi)perylene
Exp. Hole No./ Depth (m)	Units								
BH1 1.00m	mg/kg	3.50	4.30	4.10	4.10	1.50	2.20	2.70	2.60
BH2 0.40m - 1.00m	mg/kg	1.10	0.32	0.65	1.20	0.49	0.22	0.76	0.89
BH2 1.20m - 1.65m	mg/kg	0.10	1.30	1.70	0.10	0.10	0.10	0.10	0.10
	mg/kg								
	mg/kg								
	mg/kg								
	mg/kg								
	mg/kg								
	mg/kg								
	mg/kg								
	mg/kg								
	mg/kg								
	mg/kg								
	mg/kg								
	mg/kg								
	mg/kg								
Mean Concentrations	mg/kg	1.57	1.97	2.15	1.80	0.70	0.84	1.19	1.20

PAH	Units	Mean Concentrations in samples	Mean Ratio to BaP in Samples	Mean ratio to BaP in Culp* Study	Lower limit	Upper limit
Benzo(a)pyrene	mg/kg	1.566666667	1.00	–	–	–
Benz[a]anthracene	mg/kg	1.973333333	1.26	1.24	0.12	12.43
Chrysene	mg/kg	2.15	1.37	1.16	0.12	11.61
Benzo[b]fluoranthene	mg/kg	1.8	1.15	1.08	0.11	10.85
Benzo[k]fluoranthene	mg/kg	0.696666667	0.44	0.37	0.04	3.72
Dibenz[ah]anthracene	mg/kg	0.84	0.54	0.14	0.01	1.38
Indeno[123-cd]pyrene	mg/kg	1.186666667	0.76	0.73	0.07	7.27
Benzo[ghi]perylene	mg/kg	1.196666667	0.76	0.82	0.08	8.22



Comments:

*CULP, S.J., GAYLOR, D.W., SHELDON, W.G. GOLDSTEIN, L.W., BELAND, F.A., 1998. A comparison of the tumors induced by coal tar and benzo(a)pyrene in a 2-year bioassay. Assessed in accordance with Development of Category 4 Screening Levels for assessment of land affected by contamination - SP1010 Appendix E



Final Report

Report No.: 21-13854-1
Initial Date of Issue: 07-May-2021
Client Sub Surface
Client Address: 3 Peel Street
Preston
Lancashire
PR2 2QS
Contact(s): Simon Gabbatt
Project 7200 Trinity C of E High School,
Cambridge Street

Quotation No.:	Date Received:	28-Apr-2021
Order No.:	Date Instructed:	28-Apr-2021
No. of Samples:		10
Turnaround (Wkdays):	Results Due:	07-May-2021
Date Approved:		07-May-2021

Approved By:

Details: Glynn Harvey, Technical Manager

Results - Soil

Project: 7200 Trinity C of E High School, Cambridge Street

Client: Sub Surface	Chemtest Job No.:				21-13854	21-13854	21-13854	21-13854	21-13854	21-13854	21-13854	21-13854	21-13854
Quotation No.:	Chemtest Sample ID.:				1188776	1188777	1188778	1188779	1188780	1188781	1188782	1188783	1188784
	Client Sample ID.:				880 881 882	883 884 885	564	565	572	877 878 879	550	551	554
	Sample Location:				BH1	BH1	BH1	BH1	BH1	BH2	BH2	BH2	BH2
	Sample Type:				SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
	Top Depth (m):				0.25	1.00	2.50	4.00	7.50	0.40	1.20	2.00	4.00
	Bottom Depth (m):				0.50		3.00	4.45	7.95	1.00	1.65	2.45	4.45
	Date Sampled:				16-Apr-2021	16-Apr-2021	16-Apr-2021	16-Apr-2021	16-Apr-2021	16-Apr-2021	16-Apr-2021	16-Apr-2021	16-Apr-2021
	Asbestos Lab:				COVENTRY	COVENTRY				COVENTRY	COVENTRY		
Determinand	Accred.	SOP	Units	LOD									
ACM Type	U	2192		N/A	-	-				-	-		
Asbestos Identification	U	2192		N/A	No Asbestos Detected	No Asbestos Detected				No Asbestos Detected	No Asbestos Detected		
ACM Detection Stage	U	2192		N/A	-	-				-	-		
Moisture	N	2030	%	0.020	6.3	13	12	15	16	13	13	15	13
pH	U	2010		4.0	8.6	8.5	8.4	8.6	8.6	8.5	9.3	8.8	8.6
Boron (Hot Water Soluble)	U	2120	mg/kg	0.40	0.41	1.0				0.57	< 0.40		
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010		0.17	0.19	0.010	< 0.010	0.12		1.1	0.057
Cyanide (Total)	U	2300	mg/kg	0.50	< 0.50	0.50				< 0.50	0.90		
Sulphide (Easily Liberatable)	N	2325	mg/kg	0.50	3.9	3.3				3.4	0.79		
Sulphate (Total)	U	2430	%	0.010	< 0.010	0.19				0.39	0.79		
Arsenic	U	2450	mg/kg	1.0	3.6	14				12	16		
Cadmium	U	2450	mg/kg	0.10	0.21	0.31				0.23	0.30		
Chromium	U	2450	mg/kg	1.0	4.8	16				17	25		
Molybdenum	U	2450	mg/kg	2.0	< 2.0	2.2				< 2.0	< 2.0		
Copper	U	2450	mg/kg	0.50	7.0	35				26	30		
Mercury	U	2450	mg/kg	0.10	< 0.10	0.32				0.18	0.25		
Nickel	U	2450	mg/kg	0.50	6.6	17				12	16		
Lead	U	2450	mg/kg	0.50	19	330				500	1100		
Selenium	U	2450	mg/kg	0.20	< 0.20	< 0.20				< 0.20	< 0.20		
Zinc	U	2450	mg/kg	0.50	21	86				120	170		
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50	< 0.50				< 0.50	< 0.50		
TPH >C6-C10	N	2670	mg/kg	1.0	< 1.0	< 1.0				< 1.0	< 1.0		
TPH >C10-C21	N	2670	mg/kg	1.0	24	< 1.0				31	25		
TPH >C21-C40	N	2670	mg/kg	1.0	640	< 1.0				390	76		
Total TPH >C6-C40	U	2670	mg/kg	10	670	< 10				420	100		
Naphthalene	U	2700	mg/kg	0.10	< 0.10	< 0.10				< 0.10	< 0.10		
Acenaphthylene	U	2700	mg/kg	0.10	< 0.10	< 0.10				< 0.10	< 0.10		
Acenaphthene	U	2700	mg/kg	0.10	< 0.10	< 0.10				< 0.10	< 0.10		
Fluorene	U	2700	mg/kg	0.10	< 0.10	< 0.10				< 0.10	< 0.10		
Phenanthrene	U	2700	mg/kg	0.10	2.4	5.0				1.5	2.0		
Anthracene	U	2700	mg/kg	0.10	0.79	1.3				0.41	0.51		
Fluoranthene	U	2700	mg/kg	0.10	4.0	8.5				2.3	2.5		
Pyrene	U	2700	mg/kg	0.10	4.1	8.7				2.4	2.8		
Benzo[a]anthracene	U	2700	mg/kg	0.10	< 0.10	4.3				0.32	1.3		
Chrysene	U	2700	mg/kg	0.10	< 0.10	4.1				0.65	1.7		

Results - Soil

Project: 7200 Trinity C of E High School, Cambridge Street

Client: Sub Surface	Chemtest Job No.:		21-13854	21-13854	21-13854	21-13854	21-13854	21-13854	21-13854	21-13854	21-13854
Quotation No.:	Chemtest Sample ID.:		1188776	1188777	1188778	1188779	1188780	1188781	1188782	1188783	1188784
	Client Sample ID.:		880 881 882	883 884 885	564	565	572	877 878 879	550	551	554
	Sample Location:		BH1	BH1	BH1	BH1	BH1	BH2	BH2	BH2	BH2
	Sample Type:		SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
	Top Depth (m):		0.25	1.00	2.50	4.00	7.50	0.40	1.20	2.00	4.00
	Bottom Depth (m):		0.50		3.00	4.45	7.95	1.00	1.65	2.45	4.45
	Date Sampled:		16-Apr-2021	16-Apr-2021	16-Apr-2021	16-Apr-2021	16-Apr-2021	16-Apr-2021	16-Apr-2021	16-Apr-2021	16-Apr-2021
	Asbestos Lab:		COVENTRY	COVENTRY				COVENTRY	COVENTRY		
Determinand	Accred.	SOP	Units	LOD							
Benzo[b]fluoranthene	U	2700	mg/kg	0.10	< 0.10	4.1		1.2	< 0.10		
Benzo[k]fluoranthene	U	2700	mg/kg	0.10	< 0.10	1.5		0.49	< 0.10		
Benzo[a]pyrene	U	2700	mg/kg	0.10	< 0.10	3.5		1.1	< 0.10		
Indeno(1,2,3-c,d)Pyrene	U	2700	mg/kg	0.10	< 0.10	2.7		0.76	< 0.10		
Dibenz(a,h)Anthracene	U	2700	mg/kg	0.10	< 0.10	2.2		0.22	< 0.10		
Benzo[g,h,i]perylene	U	2700	mg/kg	0.10	< 0.10	2.6		0.89	< 0.10		
Total Of 16 PAH's	U	2700	mg/kg	2.0	11	49		12	11		
Benzene	U	2760	µg/kg	1.0	< 1.0	< 1.0		< 1.0	< 1.0		
Toluene	U	2760	µg/kg	1.0	< 1.0	< 1.0		< 1.0	< 1.0		
Ethylbenzene	U	2760	µg/kg	1.0	< 1.0	< 1.0		< 1.0	< 1.0		
m & p-Xylene	U	2760	µg/kg	1.0	< 1.0	< 1.0		< 1.0	< 1.0		
o-Xylene	U	2760	µg/kg	1.0	< 1.0	< 1.0		< 1.0	< 1.0		
Methyl Tert-Butyl Ether	U	2760	µg/kg	1.0	< 1.0	< 1.0		< 1.0	< 1.0		
Total Phenols	U	2920	mg/kg	0.10	< 0.10	< 0.10		< 0.10	< 0.10		

Results - Soil

Project: 7200 Trinity C of E High School, Cambridge Street

Client: Sub Surface	Chemtest Job No.:		21-13854		
Quotation No.:	Chemtest Sample ID.:		1188785		
	Client Sample ID.:		556		
	Sample Location:		BH2		
	Sample Type:		SOIL		
	Top Depth (m):		5.40		
	Bottom Depth (m):		5.95		
	Date Sampled:		16-Apr-2021		
	Asbestos Lab:				
Determinand	Accred.	SOP	Units	LOD	
ACM Type	U	2192		N/A	
Asbestos Identification	U	2192		N/A	
ACM Detection Stage	U	2192		N/A	
Moisture	N	2030	%	0.020	5.5
pH	U	2010		4.0	9.1
Boron (Hot Water Soluble)	U	2120	mg/kg	0.40	
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	< 0.010
Cyanide (Total)	U	2300	mg/kg	0.50	
Sulphide (Easily Liberatable)	N	2325	mg/kg	0.50	
Sulphate (Total)	U	2430	%	0.010	
Arsenic	U	2450	mg/kg	1.0	
Cadmium	U	2450	mg/kg	0.10	
Chromium	U	2450	mg/kg	1.0	
Molybdenum	U	2450	mg/kg	2.0	
Copper	U	2450	mg/kg	0.50	
Mercury	U	2450	mg/kg	0.10	
Nickel	U	2450	mg/kg	0.50	
Lead	U	2450	mg/kg	0.50	
Selenium	U	2450	mg/kg	0.20	
Zinc	U	2450	mg/kg	0.50	
Chromium (Hexavalent)	N	2490	mg/kg	0.50	
TPH >C6-C10	N	2670	mg/kg	1.0	
TPH >C10-C21	N	2670	mg/kg	1.0	
TPH >C21-C40	N	2670	mg/kg	1.0	
Total TPH >C6-C40	U	2670	mg/kg	10	
Naphthalene	U	2700	mg/kg	0.10	
Acenaphthylene	U	2700	mg/kg	0.10	
Acenaphthene	U	2700	mg/kg	0.10	
Fluorene	U	2700	mg/kg	0.10	
Phenanthrene	U	2700	mg/kg	0.10	
Anthracene	U	2700	mg/kg	0.10	
Fluoranthene	U	2700	mg/kg	0.10	
Pyrene	U	2700	mg/kg	0.10	
Benzo[a]anthracene	U	2700	mg/kg	0.10	
Chrysene	U	2700	mg/kg	0.10	

Results - Soil

Project: 7200 Trinity C of E High School, Cambridge Street

Client: Sub Surface	Chemtest Job No.:		21-13854	
Quotation No.:	Chemtest Sample ID.:		1188785	
	Client Sample ID.:		556	
	Sample Location:		BH2	
	Sample Type:		SOIL	
	Top Depth (m):		5.40	
	Bottom Depth (m):		5.95	
	Date Sampled:		16-Apr-2021	
	Asbestos Lab:			
Determinand	Accred.	SOP	Units	LOD
Benzo[b]fluoranthene	U	2700	mg/kg	0.10
Benzo[k]fluoranthene	U	2700	mg/kg	0.10
Benzo[a]pyrene	U	2700	mg/kg	0.10
Indeno(1,2,3-c,d)Pyrene	U	2700	mg/kg	0.10
Dibenz(a,h)Anthracene	U	2700	mg/kg	0.10
Benzo[g,h,i]perylene	U	2700	mg/kg	0.10
Total Of 16 PAH's	U	2700	mg/kg	2.0
Benzene	U	2760	µg/kg	1.0
Toluene	U	2760	µg/kg	1.0
Ethylbenzene	U	2760	µg/kg	1.0
m & p-Xylene	U	2760	µg/kg	1.0
o-Xylene	U	2760	µg/kg	1.0
Methyl Tert-Butyl Ether	U	2760	µg/kg	1.0
Total Phenols	U	2920	mg/kg	0.10

Report Information

Key

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"
SOP	Standard operating procedure
LOD	Limit of detection

Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

Uncertainty of measurement for the determinands tested are available upon request

None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis

All Asbestos testing is performed at the indicated laboratory

Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

- A - Date of sampling not supplied
- B - Sample age exceeds stability time (sampling to extraction)
- C - Sample not received in appropriate containers
- D - Broken Container
- E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 45 days from the date of receipt

All water samples will be retained for 14 days from the date of receipt

Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.com

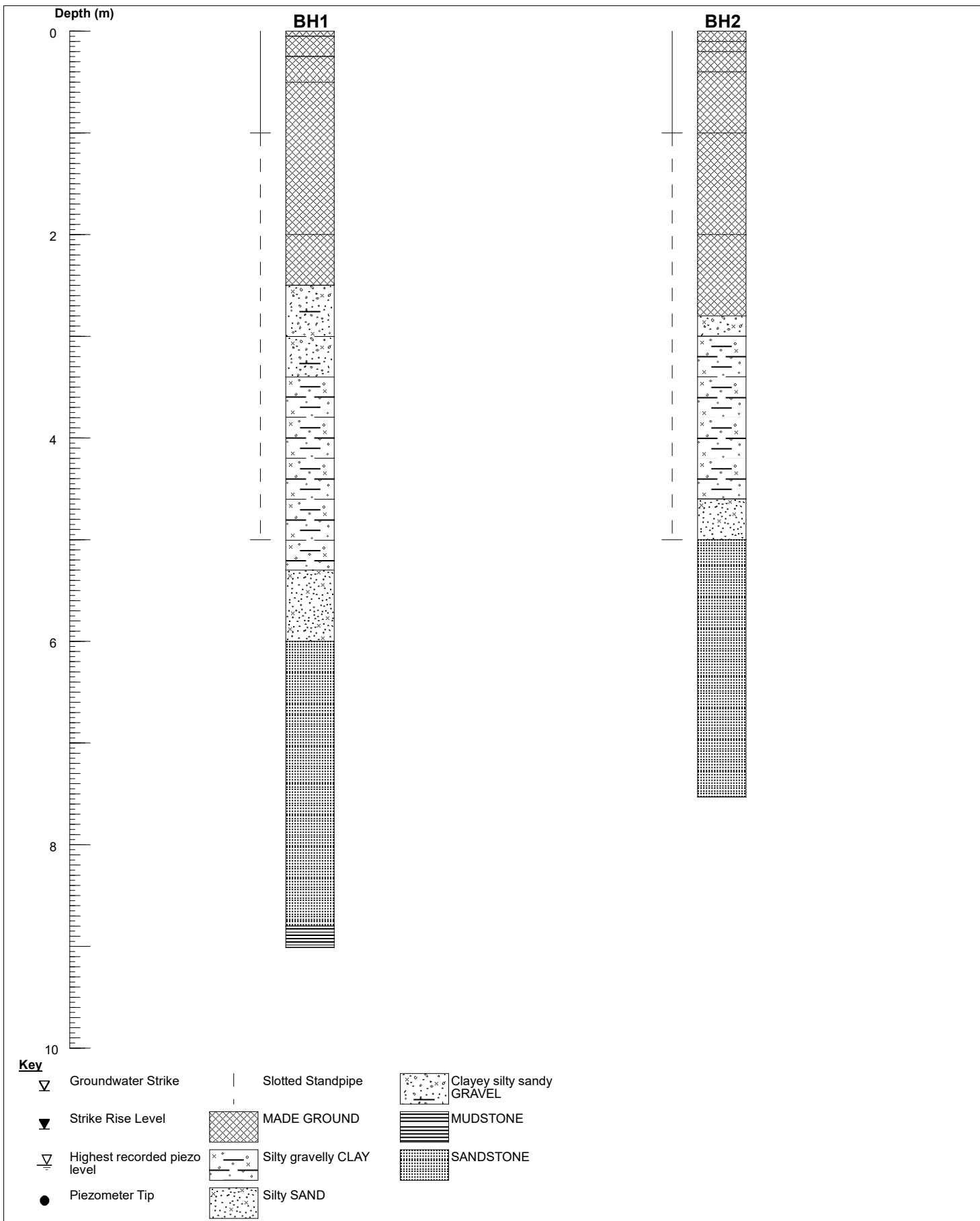
BOREHOLE RECORD SHEETS

S S SUB SURFACE SITE INVESTIGATION SPECIALISTS, GEOTECHNICAL & ENVIRONMENTAL CONSULTANTS 3 Peel Street, Preston, Lancashire, PR2 2QS. Tel: (01772) 561135 Fax: (01772) 204907						Site TRINITY C OF E HIGH SCHOOL, HIGHER CAMBRIDGE STREET, MANCHESTER			Borehole Number BH1		
Boring Method LIGHT CABLE PERCUSSIVE		Casing Diameter 150mm to 9.00m			Ground Level (mOD)		Client TRINITY C OF E HIGH SCHOOL			Job Number 7200	
		Location AS PLAN			Dates 15/04/2021-16/04/2021		Engineer DAY ARCHITECTURAL LTD			Sheet 1/2	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr	
0.25-0.50	B					0.05 (0.20)	MADE GROUND: bituminous macadam surfacing.				
						0.25 (0.25)	MADE GROUND: light grey sandy fine to coarse gravel sized fragments of limestone and concrete.				
0.50-1.00	B					0.50	MADE GROUND: grey slightly clayey sandy fine to coarse gravel sized fragments of brick and concrete.				
							MADE GROUND: soft dark grey slightly gravelly sandy silty clay with low cobble sized fragments of brick. Gravel sized fragments are fine to coarse brick, slag and concrete.				
1.20-1.65 1.20-1.65	SPT(C) N=5 B			1,1/1,1,1,2		(1.50)					
2.00-2.45 2.00-2.45	SPT(C) N=7 B			1,2/3,2,1,1		2.00 (0.50)	MADE GROUND: greyish brown gravelly clayey fine to coarse sand with low cobble sized fragments of brick and concrete. Gravel sized fragments are fine to coarse concrete and brick.				
2.50-3.00	B					2.50 (0.90)	Brown slightly clayey silty very sandy subangular to subrounded fine to coarse siltstone, sandstone, quartz GRAVEL.				
3.40-3.85	U NTP			HV@3.40m, c=78kPa 15/04/2021: 16/04/2021:		3.40	Firm to stiff high strength dark brown slightly gravelly silty CLAY. Gravel is subangular to subrounded fine to medium siltstone and sandstone.				
4.00-4.45 4.00-4.45	SPT N=21 D			3,4/5,5,5,6		(1.90)					
4.50-5.00	B										
5.00-5.45	SPT N=20			3,4/5,5,5,5							
Remarks Hand dug inspection pit from GL to 1.20m to check for services - 1hr On completion backfilled with arisings and installed a 50mm dia slotted standpipe with a gas valve and a gravel surround to 5.00m, a Bentonite seal from 1.00m to 0.20m and a concreted in lockable steel protective cover from 0.20m to GL. NTP = No Test Possible HV = Hand Shear Vane test								Scale (approx) 1:25	Logged By SCB/SJ		
								Figure No. 7200.BH1			

SUB SURFACE SITE INVESTIGATION SPECIALISTS, GEOTECHNICAL & ENVIRONMENTAL CONSULTANTS 3 Peel Street, Preston, Lancashire, PR2 2QS. Tel: (01772) 561135 Fax: (01772) 204907							Site TRINITY C OF E HIGH SCHOOL, HIGHER CAMBRIDGE STREET, MANCHESTER		Borehole Number BH1	
Boring Method LIGHT CABLE PERCUSSIVE		Casing Diameter 150mm to 9.00m			Ground Level (mOD)		Client TRINITY C OF E HIGH SCHOOL		Job Number 7200	
		Location AS PLAN			Dates 15/04/2021-16/04/2021		Engineer DAY ARCHITECTURAL LTD		Sheet 2/2	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
5.00-5.45	D						Firm to stiff high strength dark brown slightly gravelly silty CLAY. Gravel is subangular to subrounded fine to medium siltstone and sandstone.			
						5.30	Medium dense brownish red very silty fine to medium SAND (completely weathered sandstone).			
						(0.70)				
6.00-6.26 6.00-6.26	SPT 50/105 D			8,8/33,17		6.00	Extremely weak becoming very weak brownish red fine to medium grained highly weathered SANDSTONE, completely weathered to sand in places.			
						(2.80)				
7.50-7.55 7.50-7.55	SPT 25*/40 50/10 D			25/50			 below 7.50m : very weak			
8.00-8.50	B						 below 8.00m : sandstone interbedded with mudstone			
8.80-9.00	D					8.80 (0.21)	Weak dark red highly weathered MUDSTONE.			
9.00-9.01 9.00-9.01	SPT 25*/7 50/5 D			25/50 16/04/2021:DRY		9.01	Complete at 9.01m			
Remarks								Scale (approx) 1:25	Logged By SCB/SJ	
								Figure No. 7200.BH1		

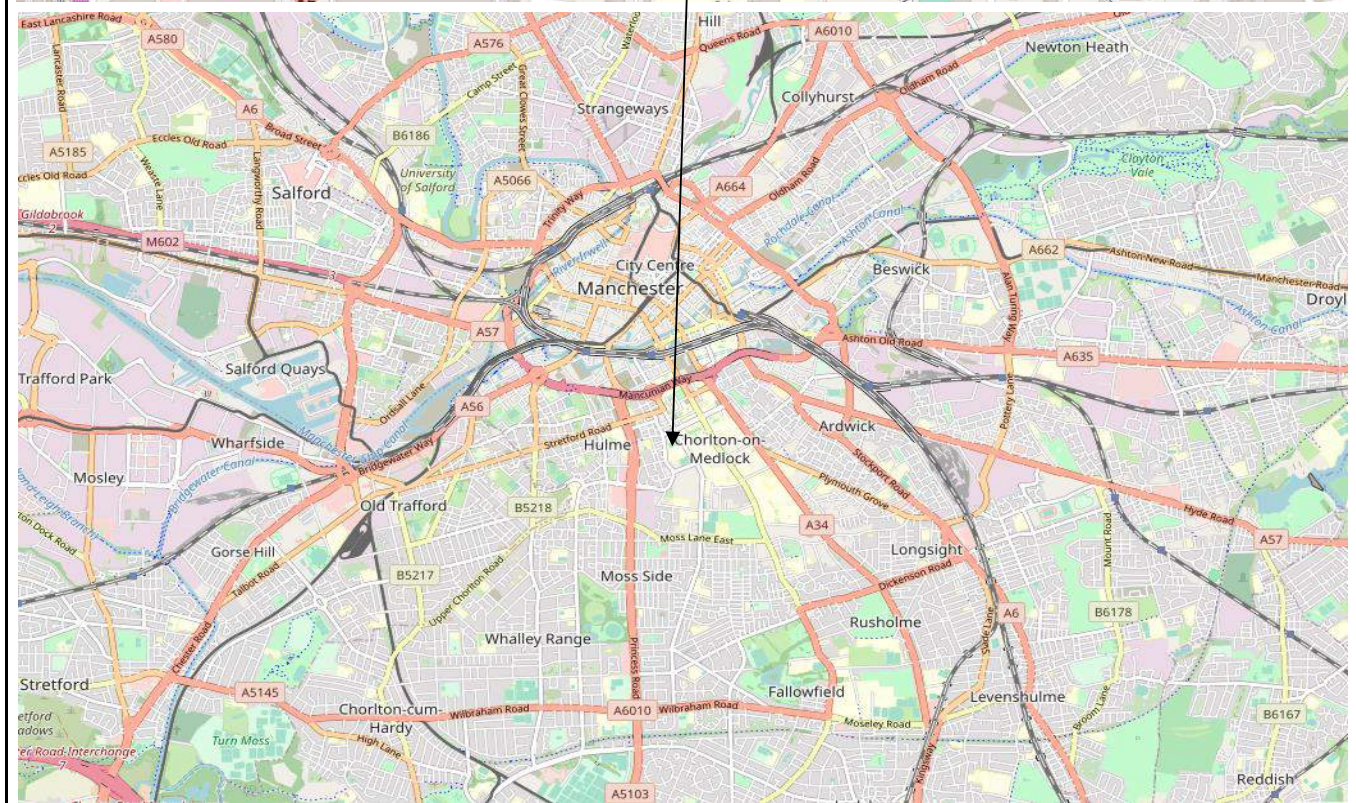
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S S SUB SURFACE SITE INVESTIGATION SPECIALISTS, GEOTECHNICAL & ENVIRONMENTAL CONSULTANTS 3 Peel Street, Preston, Lancashire, PR2 2QS. Tel: (01772) 561135 Fax: (01772) 204907						Site TRINITY C OF E HIGH SCHOOL, HIGHER CAMBRIDGE STREET, MANCHESTER			Borehole Number BH2		
Boring Method LIGHT CABLE PERCUSSIVE		Casing Diameter 150mm to 7.50m			Ground Level (mOD)		Client TRINITY C OF E HIGH SCHOOL			Job Number 7200	
		Location AS PLAN			Dates 15/04/2021		Engineer DAY ARCHITECTURAL LTD			Sheet 2/2	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr	
5.00-5.37	D					5.00	Extremely weak becoming very weak brownish red fine to medium grained highly weathered SANDSTONE, completely weathered to sand in places.				
5.40-5.65	D										
6.00-6.10 6.00-6.10 6.00-6.50	SPT 25*/75 50/25 D B			25/50		(2.53)					
7.50-7.53 7.50-7.53	SPT 25*/20 50/10 D			25/50 15/04/2021:DRY		7.53	Complete at 7.53m				
Remarks								Scale (approx) 1:25	Logged By SCB/SJ		
								Figure No. 7200.BH2			



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Site TRINITY C OF E HIGH SCHOOL, HIGHER CAMBRIDGE STREET, MANCHESTER	Date Drawn 21/05/2021	Date Checked	Sheet 1/1	Job Number 7200
Client TRINITY C OF E HIGH SCHOOL	Drawn By	Checked By	Scale 1:50[V]	Figure No. 7200.1

FIGURES

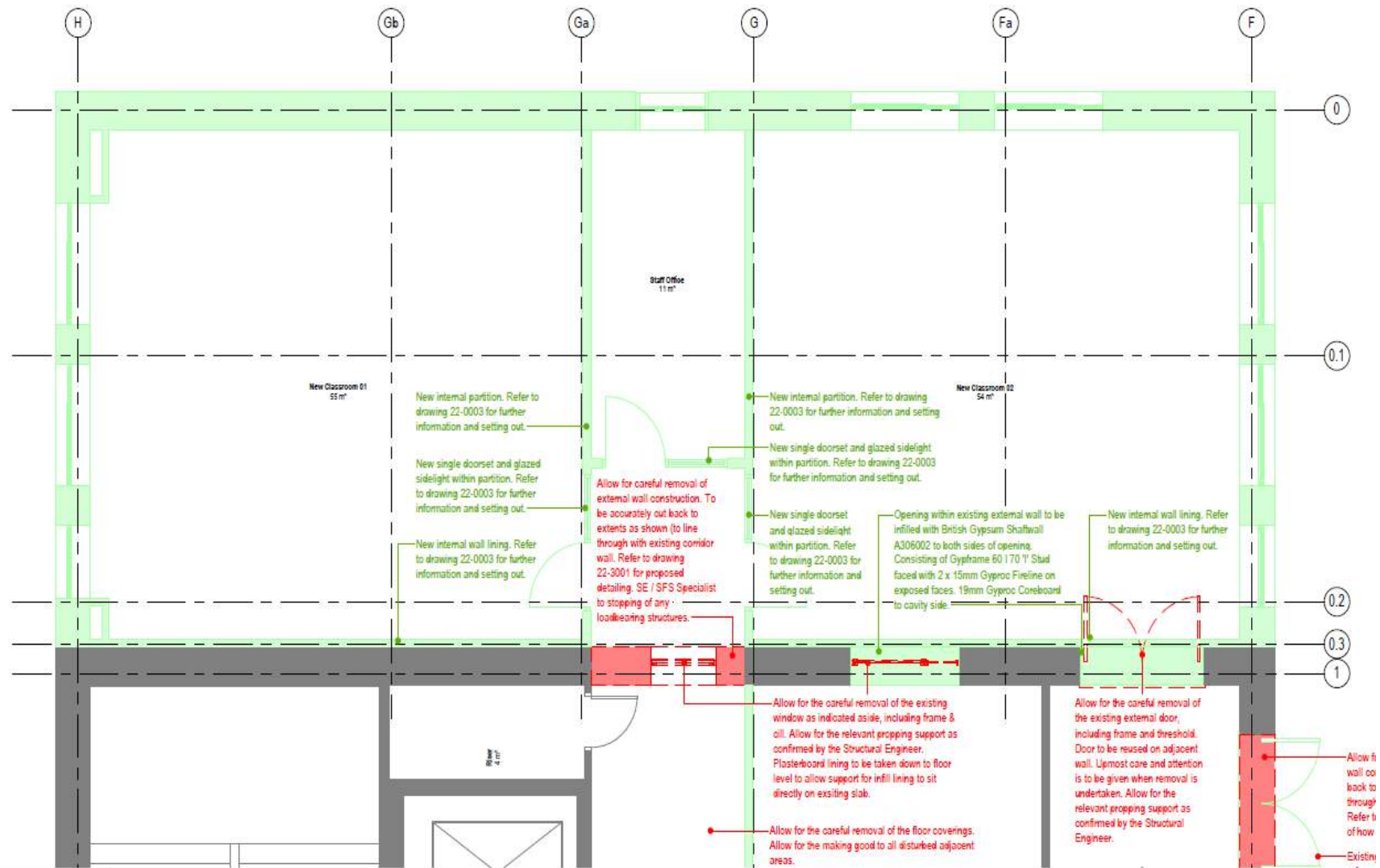


	SUB SURFACE
	SITE INVESTIGATION SPECIALISTS, GEOTECHNICAL & ENVIRONMENTAL CONSULTANTS
	3 Peel Street, Preston, Lancashire, PR2 2QS. Tel: (01772) 561135 Fax: (01772) 204907
Site	
TRINITY C OF E HIGH SCHOOL, HIGHER CAMBRIDGE STREET, MANCHESTER	
Client	
TRINITY C OF E HIGH SCHOOL	

Date Drawn 14-May-21	Date Checked -	Orientation 	Job No. 7200
Drawn By DM	Checked By -	Scale —	Figure No. 1



SS SUB SURFACE SITE INVESTIGATION SPECIALISTS, GEOTECHNICAL & ENVIRONMENTAL CONSULTANTS 3 Peel Street, Preston, Lancashire, PR2 2QS. Tel: (01772) 561135 Fax: (01772) 204907	Site Location and Proposed Development Plan			
Site TRINITY C OF E HIGH SCHOOL, HIGHER CAMBRIDGE STREET, MANCHESTER	Date Drawn 14-May-21	Date Checked -	Orientation 	Job No. 7200
Client TRINITY C OF E HIGH SCHOOL	Drawn By DM	Checked By -	Scale -	Figure No. 2

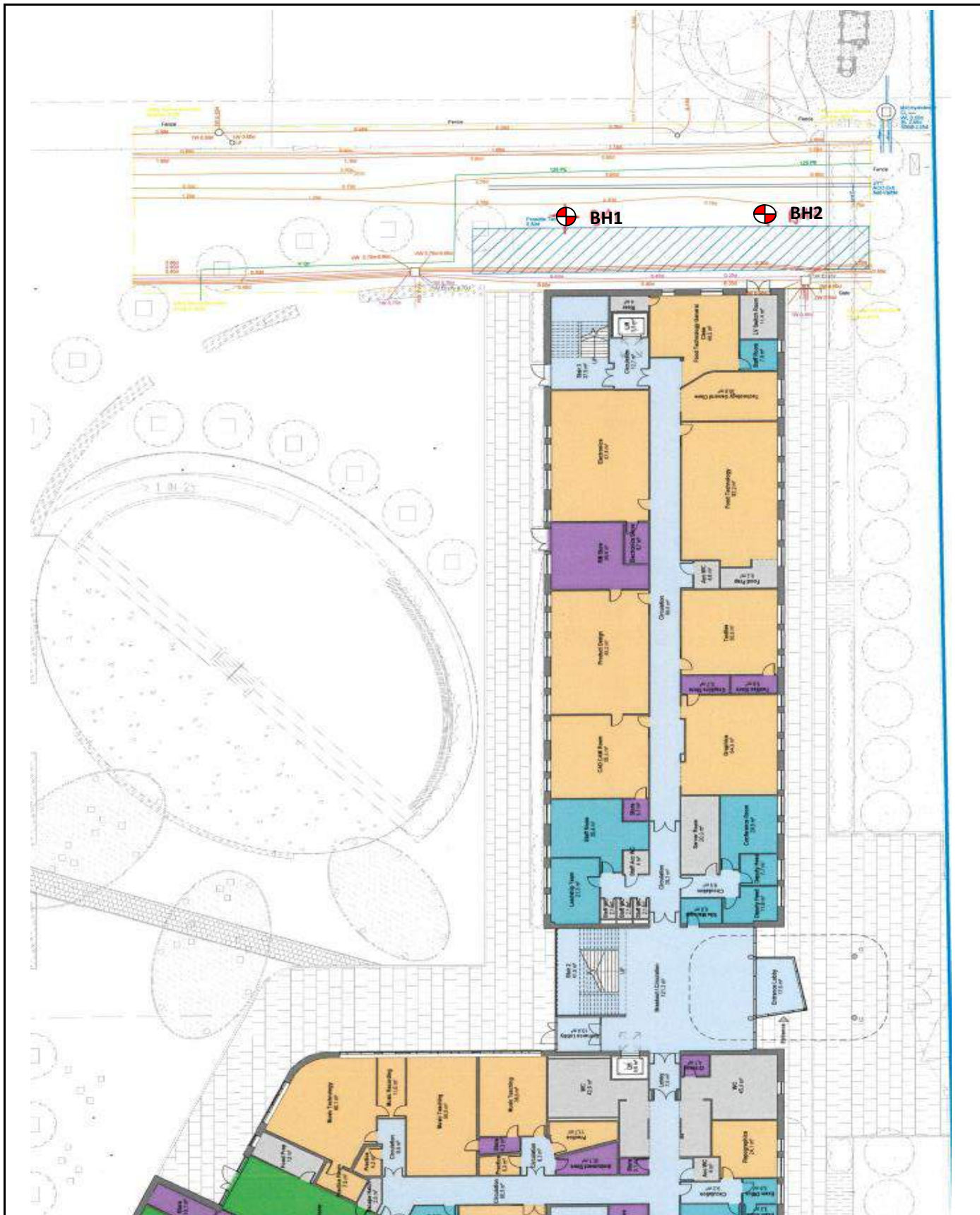


SUB SURFACE

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3 Peel Street, Preston, Lancashire, PR2 2QS. Tel: (01772) 561135. Fax: (01772) 204907

Proposed Development Plan

Site	TRINITY C OF E HIGH SCHOOL, HIGHER CAMBRIDGE STREET, MANCHESTER	Date Drawn	14-May-21	Date Checked	-	Orientation		Job No.	7200
Client	TRINITY C OF E HIGH SCHOOL	Drawn By	DM	Checked By	-	Scale	-	Figure No.	3



SS SUB SURFACE SITE INVESTIGATION SPECIALISTS, GEOTECHNICAL & ENVIRONMENTAL CONSULTANTS 3 Peel Street, Preston, Lancashire, PR2 2QS. Tel: (01772) 561135 Fax: (01772) 204907	Borehole Location Plan			
Site TRINITY C OF E HIGH SCHOOL, HIGHER CAMBRIDGE STREET, MANCHESTER	Date Drawn 14-May-21	Date Checked -	Orientation 	Job No. 7200
Client TRINITY C OF E HIGH SCHOOL	Drawn By DM	Checked By -	Scale -	Figure No. 4