



1ST LINE DEFENCE



Detailed Unexploded Ordnance (UXO) Risk Assessment

Project Name	ID Manchester
Client	NX Consulting
Site Address	Land at the University of Manchester, Manchester, M1 7JR
Report Reference	DA14968-00
Date	8 th April 2022
Originator	AB



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Executive Summary

Site Location and Description

The overall site comprises four distinct areas within the City of Manchester. For the purposes of this report, these shall hereafter be referred to as Site A, Site B, Site C and Site D.

Recent aerial photography shows that the majority of the site area is occupied by large buildings associated with the University of Manchester, as well as some commercial structures and small areas of open green space.

Site A is situated to the north of Site B, C and D. It is bound by Whitworth Street to the north, Coburg Street and Chandos Hall to the east, raised railway tracks and Altrincham Street to the south, and Sackville Street to the west. It is occupied by the Sackville Street Building, Granby Row, and Vimto Park.

Site B is situated west of Site C. It is bound by raised railway tracks and Granby Row to the north, Sackville Street to the east, Charles Street to the south, and Princess Street to the west. It is occupied by a large multi-storey car-park structure and open hard-standing space.

Site C, the largest site, is situated adjacent to Site B, to the east of Sackville Street; it is bound by Altrincham Street, raised railway tracks and Site A to the north, Site D to the east, with large commercial structures and Mancunian Way situated to the south. It is occupied by multiple structures associated with the University of Manchester, including the Renold Building and The Mill, plus open space, footpaths and roadway including Lower Albion Street.

Site D is directly east of Site C, bound by Altrincham Street to the north and London Road to the east and south; it is a small area of open green space with an intersecting footpath.

The site as a whole is approximately centred on the OS grid reference: **SJ 84592 97595**.

Proposed Works

Information provided by the client suggests that the works will involve the large scale demolition of a number of existing buildings, with the site to be redeveloped for a general commercial and residential mix with associated areas of car parking, public open space, parks, and event squares. The Sackville Building is to be redeveloped with a hotel and commercial office space.

Geology and Bomb Penetration Depth

The British Geological Survey (BGS) map shows the bedrock geology of the site to be underlain by the Chester Formation – sandstone, of the Triassic Epoch. The superficial deposits are comprised of Till, Devensian – Diamicton, of the Quaternary period.

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

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

**UXO Risk Assessment**

1st Line Defence has assessed that the risk from unexploded German and anti-aircraft unexploded ordnance is not homogenous across the site of proposed works: see **Annex N** for risk mapping of the area. The southern section of Site C has been assessed as of **Medium Risk** from UXO contamination, whilst Site A, Site B, and Site D, as well as the remaining areas Site C, have been given a **Low Risk**. There is also an assessed **Low Risk** from Allied unexploded ordnance across the site area. This assessment is based on the following factors:

German Risk:

- The overall site comprises four distinct areas within the City of Manchester; for the purposes of this report, these areas are referred to as Site A, Site B, Site C and Site D.
- During WWII, the site area was located within the County Borough of Manchester, which according to official Home Office bombing statistics sustained an overall low density of bombing. This comprised a total of 738 items of ordnance across the 27,255 acre district. Although Manchester was not targeted to the same extent as cities such as London and Birmingham, it was subject to several major raids, the worst of which is often referred to as the 'Christmas Blitz'.
- Bomb plot and damage mapping obtained from the University of Manchester shows several bomb strikes occurred within the bounds of Site A and Site C. Site A reportedly sustained one HE strike at the College of Technology on the 31st August 1940, and one fire bomb on the 1st/2nd June 1941. Site C sustained one direct HE strike to the south on Temple Street, dating from the 22nd – 24th December 1940, and a second HE strike at the Cotton Mills on Jackson Street; additional strikes were recorded beyond the bounds of Site C to the south, including one directly adjacent to the border. This mapping also recorded damage within Site A and Site C: partial damage to the College of Technology and the Cotton Mills, correlating with the aforementioned bomb strikes, in addition to demolished structures within Site C between Clowes Terrace and Thompson Terrace to the south, and adjacent to the southern boundary between Jackson Street and Lyon Street. In contrast, no incidents of bombing or damage were recorded on or adjacent to either Site B or Site D.
- War damage reports also outlined damage to properties within Site C, along Clowes Terrace, Holt Street, Jackson Street, Jackson Terrace, Temple Street, Thompson Street and School Street; this correlates with the incidents / damage outlined on the previously discussed bomb mapping. This is further supported by areas of clearance evident on both post-war OS mapping and RAF aerial photography, whereby pre-war structures are no longer present, instead occupied by areas of rough open ground. Clearance can be an indication that buildings on site sustained severe bomb damage and were subsequently demolished.
- It is likely that a high level of access was permissible on each site at the outbreak of WWII, and that specific post-raid inspections were carried out in the area, given the sites location in an urban area of Manchester, with various structures and roadways situated on site. However, access to certain areas of Site C may have been significantly reduced following the recorded bomb strikes and severe damage identified, which may have led to ground conditions obstructive to the discovery of UXO, such as rubble and debris. These areas were predominately situated within the southern section of Site C.
- Access may also have been reduced for a period within part of Site A, due to the aforementioned bomb damage and bomb strike at the College of Technology. However, this level of damage is understood to have been relatively minor and to have been swiftly resolved. This is confirmed by a local historical account which states: "the building suffered no lasting damage – shattered windows were replaced and demolished rooms were quickly restored". Any reduction of access in this area is therefore anticipated to be more minor and shorter in comparison to the aforementioned damaged areas of Site C.
- After considering the information presented above, 1st Line Defence has assessed that the risk from unexploded German air-delivered ordnance is not homogenous across the site: see **Annex N** for risk mapping of the area. The southern section of Site C has been assessed as of **Medium** risk from UXO contamination, given the recorded bomb strikes and clear evidence of significant bomb damage across large parts of this area, which likely resulted in conditions obstructive to the discovery of UXO. The remainder of the combined site footprint has been assessed as at a **Low Risk** from unexploded German air-delivered ordnance. No evidence could be found within any of the consulted sources to suggest that Site B, Site D and the remaining area of Site C were subject to either bombing or bomb damage.
- Site A is recorded to have sustained one HE bomb strike and one 'fire bomb strike' at the location of the former College of Technology (now the Sackville Building). However, these incidents are recorded to have resulted in limited damage and do not appear to have had any major impact on either the condition or usage of this area, which remained in use by the college for the duration of the war. It has therefore been possible to lower the risk that UXB's could have fallen unnoticed within this area on this occasion. The risk is not considered high enough to warrant proactive risk mitigation measures, however UXO awareness briefings are recommended as a sensible minimum precaution for intrusive ground works.

**UXO Risk Assessment****Allied Risk:**

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

Post-War Redevelopment:

- Extensive post-war redevelopment has occurred within the site area; the majority of the pre-war infrastructure and roadways have since been demolished and redeveloped, and the River Medlock which previously ran through the site has since been diverted/infilled. The majority of the site is now home to large buildings and open space associated with the University of Manchester.
- The risk of UXO remaining is considered to be mitigated at the location of and down to the depth of any post-war redevelopment on site. For example, the risk from deep buried UXO will only have been mitigated within the volumes of any post-war pile foundations or deep excavations for basement levels. The risk will however remain within virgin geology below and amongst these post-war works, down to the maximum bomb penetration depth

Recommended Risk Mitigation Measures

The following risk mitigation measures are recommended to support the proposed works at ID Manchester:

All Works

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

Medium Risk Areas**Open Intrusive Works (trial pits, service pits, open excavations, shallow foundations etc.)**

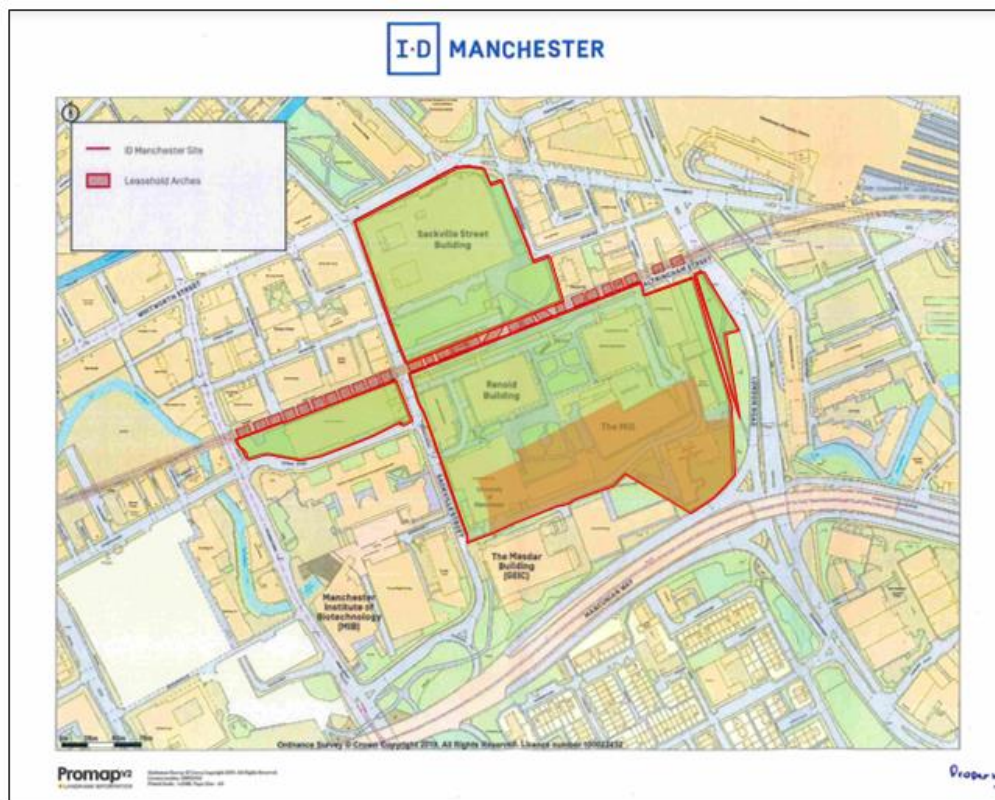
- UXO Specialist On-site Support

Boreholes and Piled Foundations

- Intrusive Magnetometer Survey of all borehole and pile locations/clusters down to maximum bomb penetration depth.



German UXO Risk Map



For indicative purposes – not to scale.

Please note that this assessed risk map may not take into account all post-war redevelopment/excavations on site.



1st Line Defence Risk Mitigation Services:

All Areas of the Site:

- Site Specific Unexploded Ordnance Awareness Briefings – a service recommended to all personnel conducting intrusive works.
- UXO Risk Management Plan

Medium Risk Areas of the site:

Open Intrusive Works (trial pits, service pits, open excavations, shallow foundations etc.)

- UXO Specialist On-site Support

Boreholes and Piled Foundations

- Intrusive Magnetometer Survey of all borehole and pile locations/clusters down to maximum bomb penetration depth.

Glossary

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



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1st Line Defence Limited

Detailed Unexploded Ordnance (UXO) Risk Assessment

Site: ID Manchester
Client: NX Consulting

1. Introduction

1.1. Background

1st Line Defence has been commissioned by NX Consulting to conduct a Detailed Unexploded Ordnance (UXO) Risk Assessment for the works proposed at ID Manchester.

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

UXO in the UK can originate from three principal sources:

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

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

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

2. Method Statement

2.1. Report Objectives

The aim of this report is to conduct a comprehensive assessment of the potential risk from UXO at ID Manchester. The report will also recommend appropriate site and work-specific risk mitigation measures to reduce the risk from explosive ordnance during the envisaged works to a level that is as low as reasonably practicable.

2.2. Risk Assessment Process

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

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

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

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

2.3. Sources of Information

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

- The National Archives and Manchester Central Library.
- Historical mapping datasets.
- Historic England National Monuments Record.
- Relevant information supplied by NX Consulting.
- Available material from 33 Engineer Regiment (EOD) Archive (part of 29 Explosive Ordnance and Disposal and Search Group).
- 1st Line Defence's extensive historical archives, library and UXO geo-datasets.
- Open sources such as published books and internet resources.

3. Background to Bombing Records

3.1. General Considerations of Historical Research

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

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

3.2. German Bombing Records

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

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

3.3. Allied Records

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

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

4. UK Regulatory Environment and Guidelines

4.1. General

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

4.2. CDM Regulations 2015

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

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

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

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

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

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

4.4. CIRIA C681

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

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

4.5. Additional Legislation

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

5. The Role of Commercial UXO Contractors and The Authorities

5.1. Commercial UXO Specialists

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

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

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

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

5.2. The Authorities

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

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

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

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

6. The Site

6.1. Site Location

The overall site comprises four distinct areas within the City of Manchester. For the purposes of this report, these shall hereafter be referred to as Site A, Site B, Site C and Site D.

Site A is situated to the north of Site B, C and D. It is bound by Whitworth Street to the north, Coburg Street and Chandos Hall to the east, raised railway tracks and Altrincham Street to the south, and Sackville Street to the west.

Site B is situated west of Site C. It is bound by raised railway tracks and Granby Row to the north, Sackville Street to the east, Charles Street to the south, and Princess Street to the west.

Site C is situated adjacent to Site B, to the east of Sackville Street; it is bound by Altrincham Street, raised railway tracks, and Site A to the north, Site D to the east, with large commercial structures and Mancunian Way situated to the south.

Site D is directly east of Site C, bound by Altrincham Street to the north and London Road to the east and south.

The site is approximately centred on the OS grid reference: **SJ 84592 97595**.

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

6.2. Site Description

Recent aerial photography shows that the majority of the site area is occupied by large buildings associated with the University of Manchester, as well as some commercial structures and small areas of open green space.

Site A is occupied by the Sackville Street Building, Granby Row, and Vimto Park, and Site B is occupied by a large multi-storey car-park structure and open hard-standing space. Site C, the largest site, is occupied by multiple structures associated with the University of Manchester, including the Renold Building and The Mill, plus open space, footpaths and roadway including Lower Albion Street. Site D is a small area of open green space with an intersecting footpath.

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

7. Scope of the Proposed Works

7.1. General

Information provided by the client suggests that the works will involve the large scale demolition of a number of existing buildings, with the site to be redeveloped for a general commercial and residential mix with associated areas of car parking, public open space, parks, and event squares. The Sackville Building is to be redeveloped with a hotel and commercial office space.

8. Ground Conditions

8.1. General Geology

The British Geological Survey (BGS) map shows the bedrock geology of the site to be underlain by the Chester Formation – sandstone, of the Triassic Epoch. The superficial deposits are comprised of Till, Devensian – Diamicton, of the Quarternary period.

8.2. Site Specific Geology

Site-specific geotechnical data was not provided by the client during the production of this report.

9. Site History

9.1. Introduction

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

9.2. Ordnance Survey Historical Maps

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

Pre-WWII		
Date	Scale	Description
1922	1:2,500	<p>This OS mapping from 1922 shows the pre-war composition of each side footprint.</p> <p>Site A is shown to be occupied by a number of structures of various sizes, including those labelled <i>College of Technology</i> and <i>School</i>. <i>Granby Row</i> runs through the centre of the site; the site also features areas of open ground, and a portion of the <i>River Medlock</i> to the south. It is bound by <i>Whitworth Street</i> to the north, <i>Coburg Street</i> to the east, railway viaduct, the <i>River Medlock</i>, and <i>Altrincham Street</i> to the south, and <i>Sackville Street</i> to the west. It is situated to the north of Sites B, C and D.</p> <p>Site B is occupied by several small structures, including a <i>Box Works</i> and <i>Saw Mills</i>; <i>Charles Street</i> roadway runs through the centre of the site. It is bound by the railway viaduct to the north, <i>Sackville Street</i> to the east, the <i>River Medlock</i> to the south, with <i>Carpenter Street</i> and <i>Princess Street</i> to the west.</p> <p>Site C is a large area occupied by multiple structures of varying sizes, several roadways, and a significant portion of the <i>River Medlock</i>. Structures within the site boundary include the <i>Atlas Box Works</i>, an <i>Iron Works</i>, a <i>Sunday School</i>, the <i>Temple Buildings</i>, <i>Cotton Mills</i>, the <i>Manchester Nut & Bolt Works</i>, and the <i>Cloth Finishing Works</i>. Roadways on site included <i>Holt Street</i>, <i>Temple Street</i>, <i>Jackson Street</i>, <i>Jackson Terrace</i>, <i>Clowes Terrace</i>, <i>Thompson Terrace</i>, <i>Lower Albion Street</i>, <i>Brierley Street</i>, <i>Britain Street</i>, and <i>Hague Street</i>. The site is bound by <i>Altrincham Street</i>, the railway and Site A to the north, and Site D to the east. Additional structures and roadways are situated to the south, including <i>Back Temple St</i>, <i>School Street</i>, <i>Pierce Street</i>, <i>Lyon Street</i>, with <i>Sackville Street</i> and Site B to the west.</p> <p>Site D is a small site, occupied by several structures, <i>Back Albion Street</i>, and <i>Brierley Street</i>. It is bound by <i>Altrincham Street</i> to the north, <i>London Road</i> to the east, small structures to the south and Site C to the west.</p>
1938	1:10,560	<p>Though of a lower quality, this mapping shows the composition of the site more immediately prior to WWII. The majority of each site remains the same as per the previous map edition; however some change is evident on Site A, whereby an area previously occupied by a <i>School</i> is now shown to be occupied by additional open ground.</p>

Post-WWII		
Date	Scale	Description
1948	1:1,250	<p>This OS mapping shows the composition of the site immediately post-war, with some changes evident.</p> <p>Site A is shown to be occupied by several structures, including the <i>College of Technology</i> structures seen on previous mapping, There are some changes to the layout of structures on site, with some new structures under construction.</p> <p>Site B remains largely the same, with minor changes to the layout of structures.</p> <p>Site C is still densely populated by several structures, roadways and the River Medlock. Features labelled on site include <i>Britannia Mills (Clothing)</i>, <i>Lanrest House</i>, <i>Atlas Box Works</i>, <i>Motor Engineering Works</i>, <i>Iron Works</i>, <i>Travelling Crane</i>, <i>Sunday School</i>, <i>Temple Buildings</i>, <i>Warehouse</i>, <i>Cotton Mills</i>, <i>Manchester Nut & Bolt Works</i>, and the <i>Cloth Finishing Works (Disused)</i>. Several changes are evident to the site, including multiple areas of clearance; missing properties are evident to the south on <i>Holt Street</i>, <i>Temple Street</i>, <i>Bury Street</i>, <i>Jackson Street</i>, <i>Jackson Terrace</i>, <i>Clowes Terrace</i>, and <i>Thompson Terrace</i>. Additional clearance is present to the north of this on <i>Temple Street</i>, and an area to the north-east adjacent to <i>Lower Albion Street</i> and <i>Britain Street</i> has been cleared and labelled as <i>Medlock Square</i>.</p> <p>Site D remains largely the same, occupied by small structures and roadway,</p>
1965	1:2,500	<p>This OS mapping shows how the site area has been redeveloped by 1965. Site B appears to remain largely the same; the other site boundaries appear to have seen significant redevelopment, and the section of the <i>River Medlock</i> on-site has been infilled. Site A still features the <i>College of Science and Technology</i>, though all other structures have been cleared; Site C has significantly altered in composition, with many of the original structures and roadways having been cleared and redeveloped into new large structures also associated with the <i>College of Science and Technology</i>; Site D has largely been cleared of structures. Significant clearance is also present to the south.</p>

9.3. Pre-WWII Photography of the Site

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

Title of Photograph	Comments
The city between the Central Railway Station and Manchester Piccadilly Station, Manchester, August 1937	This oblique aerial imagery from 1937 shows the composition of the site prior to the outbreak of WWII. The site is situated within a heavily urban area, densely populated by multiple structures of varying size and nature, with multiple roadways.

10. Introduction to German Aerial Delivered Ordnance

10.1. General

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

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

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

10.2. Generic Types of WWII German Aerial Delivered Ordnance

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

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

10.3. Failure Rate of German Aerial Delivered Ordnance

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

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

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

10.4. UXB Ground Penetration

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

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

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

10.4.1. The J-Curve Effect Principle

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

10.4.2. WWII UXB Ground Penetration Studies

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

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

10.4.3. Site Specific Bomb Penetration Considerations

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

- WWII geology – Chester Formation.
- Impact angle and velocity – 10-15° from vertical and 270 metres per second.
- Bomb mass and configuration – The 500kg SC HE bomb, without retarder units or armour piercing nose (this was the largest of the common bombs used against Britain).

It has not been possible to determine maximum bomb penetration capabilities at this stage due to the limitations of site-specific geotechnical information provided for the purpose of this report. An assessment can be made once further information becomes available or by a UXO Specialist on-site, where required.

10.5. V-Weapons

Hitler's 'V-weapon' campaign began from mid-1944. It used newly developed unmanned cruise missiles and rockets. The V-1, known as the *flying bomb* or *pilotless aircraft*, and the V-2, a long range rocket, were launched from bases in Germany and occupied Europe. A total of 9,251 V-1s and 1,115 V-2s were recorded in the United Kingdom.

Although these weapons caused considerable damage, their range was limited by their position of deployment across Europe and as a result the vast majority of V-weapon strikes were directed against targets in the south-east of England, predominantly in the London Boroughs and Home Counties. This limitation of capability meant targets in Manchester were generally too far to be considered for V-weapon strikes by the Luftwaffe.

The risk from V-weapons is therefore considered negligible and will not be further addressed in this report.

11. The Likelihood of Contamination from German Aerial Delivered UXBs

11.1. World War I

During WWI Britain was targeted and bombed by Zeppelin Airships as well as Gotha and Giant fixed-wing aircraft. The objective of these raids was to unnerve the British public, to destroy strategic targets and to ultimately attempt to coerce Britain's capitulation from the war. A WWI map of air raids and naval bombardments across the UK was consulted, see **Annex H**. This source does not record any WWI bombing incidents to have affected Manchester.

WWI bombs were generally smaller and dropped from a lower altitude than those used in WWII. This resulted in limited UXB penetration depths. Aerial bombing was often such a novelty at the time that it attracted public interest and even spectators to watch the raids in progress. For these reasons there is a limited risk that UXBs passed undiscovered in the urban environment. When combined with the relative infrequency of attacks and an overall low bombing density, the risk from WWI UXBs is considered low and will not be further addressed in this report.

11.2. World War II Bombing of Manchester

The Luftwaffe's main objective for the attacks on Britain was to inhibit the country's economic and military capability. To achieve this they targeted airfields, depots, docks, warehouses, wharves, railway lines, factories, and power stations. As the war progressed the Luftwaffe bombing campaign expanded to include the indiscriminate bombing of civilian areas in an attempt to subvert public morale.

During WWII the site was located within the County Borough of Manchester, which sustained an overall low-moderate density of bombing, as represented by bomb density data figures below. Manchester and the wider area were not targeted to the same extent as cities such as London and Birmingham, however it was subject to several major raids. The first raid on the city was in September 1940, but the worst came in December 1940, often referred to as the 'Christmas Blitz', whereby the city was raided for two consecutive nights which resulted in an estimated 684 people losing their lives, and more than 2,000 being injured.² The city was home to a significant number of important targets, such as the docks, Manchester Central Station, and Gaythorn Gas Works; see Luftwaffe target mapping and imagery in **Annex I**. The site itself is visible on this Luftwaffe target mapping, in close proximity to London Road Station, which is marked as a target.

Records of bombing incidents in the civilian areas of Manchester were typically collected by Air Raid Precautions wardens and collated by Civil Defence personnel. Some other organisations, such as port and railway authorities, maintained separate records. Records would be in the form of typed or hand written incident notes, maps and statistics. Bombing data was carefully analysed, not only due to the requirement to identify those parts of the country most needing assistance, but also in an attempt to find patterns in the Germans' bombing strategy in order to predict where future raids might take place.

Records of bombing incidents are presented in the following sections.

² <https://www.iwm.org.uk/history/the-manchester-blitz>

11.3. WWII Home Office Bombing Statistics

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

Record of German Ordnance Dropped on the County Borough of Manchester		
Area Acreage		27,321
Weapons	High Explosive Bombs (all types)	712
	Parachute Mines	18
	Oil Bombs	7
	Phosphorus Bombs	0
	Fire Pot	0
	Pilotless Aircraft (V-1)	1
	Long Range Rockets (V-2)	0
Total		738
Number of Items per 1,000 acres		27.1

Source: Home Office Statistics

This table does not include UXO found during or after WWII.

Detailed records of the quantity and locations of the 1kg incendiary and anti-personnel bombs were not routinely maintained by the authorities as they were frequently too numerous to record. Although the risk relating to IBs is lesser than that relating to larger HE bombs, they were similarly designed to inflict damage and injury. Anti-personnel bombs were used in much smaller quantities and are rarely found today but are potentially more dangerous. Although Home Office statistics did not record these types of ordnance, both should not be overlooked when assessing the general risk to personnel and equipment.

11.4. University of Manchester Bomb and Damage Map

A local map showing bomb strikes and the extent of resulting bomb damage was obtained from the University of Manchester Library. This map was compiled during/after WWII by Manchester Council's City Architect's Department. The section showing the area of the site is described in the table below and presented in **Annex J**.

University of Manchester Library Bomb Map – Annex J	
Date Range	Comments
1940-1944	<p>Site A – one HE bomb strike is recorded on the College of Technology, dating from 31/8/1940. One fire bomb is recorded at the centre of the site, labelled as occurring on 1-2/6/1941. A section of the college building appears to have been recorded as partially damaged.</p> <p>Site B – no direct incidents of bombing are recorded on or adjacent to the site.</p> <p>Site C – two HE bomb strikes occurred directly within the site boundary. One HE is recorded along the southern border of the site, on Temple Street; this is dated as 22-24/12/40. The second is recorded over the Cotton Mills on Jackson Street, dated 1-2/6/41; a section of the Cotton Mills are recorded as partially damaged.</p> <p>Additional strikes are recorded to the south of the boundary of Site C – the closest was recorded directly adjacent to the site, over a structure which has been labelled as a demolished building off Jackson Street. Two additional strikes were recorded approximately 50m to the south, over Temple Street. All three of these strikes are dated as 22-4/12/40.</p> <p>Site D – no direct incidents are recorded on or adjacent to the site.</p>

11.5. Interactive 'Christmas Blitz' Bomb Map

A local bomb map, compiled by the Manchester Evening News and utilising data from the Commonwealth and War Graves Commission, was consulted during the production of this report. This map, named the Manchester Christmas Blitz Map, shows the locations of civilian deaths in Greater Manchester between 22nd and 24th December 1940. During this two day period, a reported 800 people were killed as a result of air raids.³

As this map only records bombs which resulted in fatalities, it is not considered a comprehensive account of Christmas bombing raids. The closest fatal bomb strike to the site occurred approximately 120m to the south of Site C. A section of the map showing the site and its surroundings is presented in **Annex K**.

11.6. Region 10 Bomb Census Reports

Bomb census reports compiled by the Research and Experiments Branch of the Ministry of Home Security during WWII were consulted at The National Archives. These reports recorded information such as the date, time, type and damage caused by bomb incidents for a selected time period in Region 10 (the 'North West') and are therefore not often comprehensive.

No reference to the site has been found in this record set.

11.7. Manchester Air Raid Damage Files

Written ARP Incident Records were obtained from The National Archives. This record was compiled by local Air Raid Precaution (ARP) personnel and volunteers during the war and records the location, date and time of bombing raids within Manchester, as well as the types of bomb used and the damage caused. It is also not considered to be comprehensive and only appears to cover selected incidents.

This record set was checked, and no references to the site were found within it.

³ <https://www.manchestereveningnews.co.uk/news/greater-manchester-news/manchester-blitz-bomb-sites-map-10465447>

11.8. War Damage to Housing / Property Cards

Written records were obtained from the Manchester Central Library, covering war damage to housing and property across specific streets in Manchester. The coverage of this record set is not considered to be comprehensive. Records were found in relation to damage sustained on streets situated within the site area; specifically, records covering damage within Site B and Site C were found. A transcript of the relevant written records is presented in the table below, and example imagery of these entries are presented in **Annex L**.

War Damage to Housing – Annex L1 – L2		
Date	Location	Comments
Incident date: unknown. Date of inspection: 10/4/42	Jackson Street	Nos. 17, 18, 19, 21, 23, 25, 27. Damage classification – B. <i>Jackson Street is situated within the bounds of Site C.</i>
	Jackson Terrace	Nos. 1, 3, 5, 7. Damage classification – B. <i>Jackson Terrace is situated on the southern border of Site C.</i>
	Temple Street	Nos. 23, 25, 27, 29, 75, 77. Damage classification – B. <i>Nos 23 and 25 were situated on the southern border of Site C.</i>
Incident date: 1/6/41 Date of inspection: 2/6/41	Clowes Terrace	Nos. 7, 9, 11, 13, 15. Damage classification – CB. <i>Situated adjacent to the southern boundary of Site C.</i>
	Holt Street	Nos. 1, 3 & 5, 7, 9, 11, 13, 15, 17. Nos. 2, 4, 6, 8. Damage classification – D & E. <i>Situated within the bounds of Site C.</i>
	Jackson Street	No. 5. Damage classification – CA. Thompson Terrace – Nos. 7, 9, 11, 13, 15, 17, 19. Damage – CB / B. Clowes Terrace – Nos. 21, 23. Damage – B. Jackson Terrace – Nos. 25, 27. Damage – B. Temple Street – Nos. 35, 37, 39, 42, 43. Damage – D & E. <i>Situated within the bounds of Site C.</i>
	Jackson Terrace	Nos. 1, 3, 5, 7, 9, 11, 13, 15. Damage Classification – CB. <i>Jackson Terrace is situated on the southern border of Site C.</i>
	Temple Street	Nos. 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 52, 54, 56. Damage classification – D & E. Nos. 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39. Damage classification – CB / D & E <i>Nos. 14 – 34 and 19 – 23 were situated within the bounds of Site C.</i>
	Thompson Terrace	Nos. 5 and 7. Damage classification – CB. <i>Situated within the bounds of Site C.</i>
	School Street	No. 2, 4, 6, 8, 10, 12, 14, 16, 18. Damage classification – D & E. No. 1, 3, 5, 7, 9. Damage classification – D & E. <i>Nos. 1/2 School Street were situated on the southern border of Site C.</i>

War Damage to Property – Annex L3		
Date	Location	Comments
22.12.1940	A&P Stevens, 12 Charles Street, off Sackville Street, C-on-M.	<u>Description of Property:</u> Workshop <u>Type of Bomb:</u> HE <u>Indication of Damage:</u> No damage to walls, floors or contents. No danger. Damage to roof caused by blast. <u>Type of Damage:</u> C (a) <i>This incident occurred within the bounds of Site B.</i>
22/23.12.1940	Oxford Road, Grosvenor St, Downing St, Whitworth St Butterworth Clifford TC. Timber Merchants. 1a Charles Street, C. on M.	<u>Description of Property:</u> Timber Yard <u>Type of Bomb:</u> HE <u>Indication of Damage:</u> Generally, no damage. Slight damage to roof and partition wall. <u>Type of Damage:</u> D <i>This incident occurred within the bounds of Site B.</i>
1/2.6.41	1 Charles Street, Manchester	<u>Description of Property:</u> Warehouse & Offices. <u>Type of Bomb:</u> HE <u>Indication of Damage:</u> No damage to roof, walls, floor. Blast damage to windows. <u>Type of Damage:</u> E <i>This incident occurred within the bounds of Site B.</i>
1/2.6.41	Butterworth Clifford & Co., 1 Charles Street, Manchester	<u>Description of Property:</u> Saw mills & offices. <u>Type of Bomb:</u> HE <u>Indication of Damage:</u> No damage to roof, walls, floor. Blast damage to windows. <u>Type of Damage:</u> E <i>This incident occurred within the bounds of Site B.</i>

11.9. 'Luftwaffe Over Manchester: The Blitz Years 1940 – 1944'

Luftwaffe Over Manchester: The Blitz Years 1940 – 1944, by Peter Smith, was consulted during the production of this report; this source provides greater detail of air raids and bombing incidents which occurred in Manchester during the Blitz.

This source identifies an incident of bombing which reportedly occurred directly within the boundary of Site A on the 31st August 1940, see below:

One bomb fell through the glass roof of the College of Technology in Whitworth Street, blowing out many windows amongst other damage.

This corroborates with the incident of bombing outlined within Site A on the Manchester Bomb and Damage Map discussed in Section 11.4.

11.10. 'Blitz Britain; Manchester and Salford'

Blitz Britain; Manchester and Salford, by Graham Phythian, was consulted during the production of this report. This source included a copy of the Manchester Emergency Committees Log of Bombing Incidents 22-24 December 1940, providing details of incidents which occurred during the Christmas Blitz'. Within this source, no reference to the site could be found.

11.11. Online Sources: University of Manchester

Various online sources were consulted during the production of this report, in order to ascertain the wartime history of specific buildings and areas of the site footprint which may have sustained incidents of bombing or damage. One such source was the University of Manchester website, in which a brief history of the Sackville Street building was outlined; this building is situated within Site A and was previously known as the College of Technology. The below extract addresses the bomb which fell on the College in August 1940:⁴

During the Second World War, in the summer of 1940, the building suffered a direct bomb hit – a bomb crashed straight through the South West Corner of the Chemistry Laboratory and exploded in the Senior Common Room. Thanks to its sturdy construction, the Sackville Street Building suffered no lasting damage – shattered windows were replaced and demolished rooms were quickly restored.

Students and staff played an integral role during wartime; the College was used by various ministries and armed forces for technological investigation. During this time various new advances were developed and manufactured within the building in order to aid the war effort, including a deep sea hydrophone to counter the submarine threat to shipping, instruments to measure the permeability of airship fabrics and a high-frequency alternator to power aircraft radios.

In 1927 plans had been drawn up to extend the Sackville Street Building. The construction had started in 1938 but was significantly slowed by the Great Depression and the Second World War; the expansion was finally finished in 1957.

⁴ <https://www.manchester.ac.uk/discover/history-heritage/history/buildings/sackville-street/>

11.12. WWII-Era Aerial Photography

WWII-era aerial photography for the site area was obtained from the National Monuments Record Office (Historic England). This photography provides a record of the potential composition of the site during the war, as well as its condition immediately following the war (see **Annex M**).

WWII-Era Aerial Photography	
Date	Description
7 th May 1946 Annex M1	This RAF aerial photography shows the south-eastern corner of Site C in May 1946. The site is shown to feature areas of clearance, whereby pre-war housing appears to have been removed, as well as areas of rough open ground.
16 th May 1948 Annex M2 – M4	<p>RAF aerial imagery of the site taken in May 1948 is presented in Annex M2 – M4, showing the condition of each site area post-WWII:</p> <ul style="list-style-type: none"> • Site A is shown to be occupied by several large structures; the College of Technology is present to the north, with some construction work / rough ground evident in the east. Structures and open ground are present to the south of Granby Street. Given the ground cover, any signs of damage are difficult to determine. • Site B is shown to be occupied by Charles Street, with numerous structures on either side of the roadway. No obvious signs of damage are evident across the majority of the site, although some small potential areas of clearance and roofing repairs are visible. • Site C is occupied by the River Medlock, several roadways, various buildings of different sizes / purposes, and several open spaces. Several areas of clearance are evident, particularly within the southern sector adjacent to Jackson Street, whereby properties appear to have been removed. • Site D is shown to be occupied by structures and a small roadway, which appear to remain undamaged. <p>A visual overlay highlighting bomb damage and features of note is presented in Annex M4.</p>

11.13. Abandoned Bombs

A post air-raid survey of buildings, facilities, and installations would have included a search for evidence of bomb entry holes. If evidence of an entry hole was encountered, Bomb Disposal Officer Teams would normally have been requested to attempt to locate, render safe, and dispose of the bomb. Occasionally, evidence of UXBs was discovered but due to a relatively benign position, access problems, or a shortage of resources the UXB could not be exposed and rendered safe. Such an incident may have been recorded and noted as an ‘abandoned bomb’.

Given the inaccuracy of WWII records, and the fact that these bombs were ‘abandoned’, their locations cannot be considered definitive or the lists exhaustive. The MoD states that ‘action to make the devices safe would be taken only if it was thought they were unstable’. It should be noted that other than the ‘officially’ abandoned bombs, there will inevitably be UXBs that were never recorded.

1st Line Defence holds no records of officially registered abandoned bombs at or near the site of the proposed works.

11.14. Bomb Disposal Tasks

The information service from the Explosive Ordnance Disposal (EOD) Archive Information Office at 33 Engineer Regiment (now part of 29 EOD & Search Group) is currently facing considerable delay. It has therefore not been possible to include any updated official information regarding bomb disposal/clearance tasks with regards to this site. A database of known disposal/clearance tasks has been referred to which does not make reference to such instances occurring within the site of proposed works. If any relevant information is received at a later date, NX Consulting will be advised.

11.15. Evaluation of German Aerial Delivered UXO Records

Factors	Conclusion
Density of Bombing <i>It is important to consider the bombing density when assessing the possibility that UXBs remain in an area. High bombing density could allow for error in record keeping due to extreme damage caused to the area.</i>	<p>During WWII the site was located within the County Borough of Manchester, which according to official Home Office bombing statistics sustained an overall low density of bombing, this comprised a total of 738 items of ordnance across the 27,255 acre district. Although Manchester was not targeted to the same extent as cities such as London and Birmingham, it was subject to several major raids, the worst of which is often referred to as the 'Christmas Blitz'.</p> <p>Bomb plot and damage mapping obtained from the University of Manchester shows several incidents of bombing occurred within the site area. Site A reportedly sustained one HE bomb strike at the College of Technology (now the Sackville Street building), dating 31/8/1940, and one fire bomb was recorded on the 1-2/6/1941. In addition, Site C reportedly sustained two direct HE bomb strikes. One HE is recorded along the southern border of the site, on Temple Street; this is dated as 22-4/12/40. The second is recorded over the Cotton Mills on Jackson Street, dated 1-2/6/41; a section of the Cotton Mills are recorded as partially damaged. In addition to these, further strikes are recorded to the south of Site C; including one recorded directly adjacent to the border. Meanwhile, no direct incidents of bombing were recorded on or adjacent to Site B or Site D.</p> <p>Written records covering the area were limited; no reference could be found to aforementioned bomb incidents on-site within available bomb census reports and air raid damage files. However, war damage reports covering specific streets in Manchester recorded damage to structures within the site area as a result of HE bombing.</p> <p>Reference to the site was also made within published sources, with the <i>Luftwaffe Over Manchester: The Blitz Years 1940 – 1944</i>, by Peter Smith, referencing a bomb falling through the glass roof of the College of Technology in Whitworth Street, 'blowing out many windows amongst other damage', on the 31st August 1940; this correlates with the aforementioned bomb mapping as well as online sources.</p>
Damage <i>If buildings or structures on a site sustained bomb or fire damage, any resulting rubble and debris could have obscured the entry holes of unexploded bombs dropped during the same or later raids. Similarly, a high explosive bomb strike in an area of open agricultural land will have caused soil disturbance, increasing the risk that a UXB entry hole would be overlooked.</i>	<p>Bomb plot and damage mapping obtained from the University of Manchester recorded partial damage to the College of Technology, within Site A, as well as to the Cotton Mills, within Site C. This map also recorded demolished structures within Site C, between Clowes Terrace and Thompson Terrace, along the southern boundary. Further demolished properties were present just south of the border, adjacent to Jackson Street & Lyon Street.</p> <p>In addition to this, a comparison of pre- and post-WWII OS mapping reveals areas of clearance within Site C, whereby pre-war structures are no longer present. Missing properties are evident to the south on Holt Street, Temple Street, Bury Street, Jackson Street, Jackson Terrace, Clowes Terrace, and Thompson Terrace. Additional clearance is present</p>



	<p>to the north of this on Temple Street, and an area to the north-east adjacent to Lower Albion Street and Britain Street has been cleared and labelled as Medlock Square. These areas of clearance are also evident within post-WWII RAF aerial photography, dating from 1946 and 1948, alongside areas of open rough ground in places. Clearance can be an indication that buildings on site sustained bomb damage and were subsequently demolished, although it can also be the result of other factors, such as planned redevelopment.</p> <p>War damage reports outlined damage to properties within Site C; along Clowes Terrace, Holt Street, Jackson Street, Jackson Terrace, Temple Street, Thompson Street and School Street. This correlates with the incidents / damage outlined on the previously discussed mapping and aerial photography.</p>
Ground Cover <i>The nature of the ground cover present during WWII would have a substantial influence on any visual indication that may indicate UXO being present.</i>	<p>It is anticipated that the ground cover on each site would have been largely favourable to the detection of UXO at the outbreak of WWII, given that each site was densely occupied by various structures, both industrial and residential, and multiple roadways.</p> <p>However, recorded bombing incidents and subsequent damage caused may have led to ground conditions obstructive to the discovery of UXO in some areas, due to the resulting rubble and debris likely left on site. In addition, it is not possible to entirely discount that items of UXO could have fallen unobserved in the various areas of open ground present on-site. The entry hole of a 50kg UXB can be as little as 20cm in diameter – much smaller for items such as 1kg incendiary bombs – and can be easily overlooked in such conditions.</p>
Access Frequency <i>UXO in locations where access was irregular would have a greater chance of passing unnoticed than at those that were regularly occupied. The importance of a site to the war effort is also an important consideration as such sites are likely to have been both frequently visited and subject to post-raid checks for evidence of UXO.</i>	<p>It is likely that a high level of access was permissible on each site at the outbreak of WWII, and that specific post-raid inspections were carried out in this area, given that each site was densely occupied by various structures and roadways, located in an urban area of Manchester. Frequent access improves the likelihood that signs of UXO would have been noticed and reported.</p> <p>However, following the recorded bombing incidents and damage to the site area, it is likely that access may have significantly reduced in these areas, increasing the likelihood that evidence of UXO may have gone unnoticed and unreported.</p>
Bomb Failure Rate	<p>There is no evidence to suggest that the bomb failure rate in the locality of the site would have been dissimilar to the 10% normally used.</p>
Abandoned Bombs	<p>1st Line Defence holds no records of abandoned bombs at or within the site vicinity.</p>
Bombing Decoy sites	<p>1st Line Defence could find no evidence of bombing decoy sites within the site vicinity.</p>
Bomb Disposal Tasks	<p>1st Line Defence could find no evidence of bomb disposal tasks within the site boundary and immediate area.</p>

12. Introduction to Allied Ordnance

12.1. General

Many areas across the UK may be at risk from Allied UXO because of both wartime and peacetime military use. Typical military activities and uses that may have led to a legacy of military UXO at a site include former minefields, home guard positions, anti-aircraft emplacements, training and firing ranges, military camps, as well as weapons manufacture and storage areas.

Although land formerly used by the military was usually subject to clearance before returned to civilian use, items of UXO are sometimes discovered and can present a potential risk to construction projects.

It should be highlighted that there is no evidence that the site formerly had any military occupation or usage that could have led to contamination with such items of Allied ordnance. Despite this, urban areas, such as the location of the site, can be at risk from buried unexploded anti-aircraft projectiles fired during WWII – as addressed below.

12.2. Defending the UK From Aerial Attack

During WWII the War Office employed a number of defence tactics against the Luftwaffe from bombing major towns, cities, manufacturing areas, ports and airfields. These can be divided into passive and active defences (examples are provided in the table below).

Active Defences	Passive Defences
<ul style="list-style-type: none">• Anti-aircraft gun emplacements to engage enemy aircraft.• Fighter aircraft to act as interceptors.• Rockets and missiles were used later during WWII.	<ul style="list-style-type: none">• Blackouts and camouflaging to hinder the identification of Luftwaffe targets.• Decoy sites were located away from targets and used dummy buildings and lighting to replicate urban, military, or industrial areas.• Barrage balloons forced enemy aircraft to greater altitudes.• Searchlights were often used to track and divert adversary bomber crews during night raids.

Active defences such as anti-aircraft artillery present a greater risk of UXO contamination than passive defences. Unexploded ordnance resulting from dogfights and fighter interceptors is rarely encountered and difficult to accurately qualify.

12.2.1. Anti-Aircraft Artillery (AAA)

During WWII three main types of gun sites existed: heavy anti-aircraft (HAA), light anti-aircraft (LAA) and 'Z' batteries (ZAA). If the projectiles and rockets fired from these guns failed to explode or strike an aircraft they would descend back to land. The table below provides further information on the operation and ordnance associated with these type of weapons.

Anti-Aircraft Artillery				
Item	Description			
HAA	These large calibre guns such as the 3.7" QF (Quick Firing) were used to engage high flying enemy bombers. They often fired large HE projectiles, which were usually initiated by integral fuzes, triggered by impact, area, time delay or a combination of aforementioned mechanisms.			
LAA	These mobile guns were intended to engage fast, low flying aircraft. They were typically rotated between locations on the perimeters of towns and strategically important industrial works. As they could be moved to new positions with relative ease when required, records of their locations are limited. The most numerous of these were the 40mm Bofors gun which could fire up to 120 x 40mm HE projectiles per minute to over 1,800m.			
Variations in HAA and LSA Ammunition	Gun type	Calibre	Shell Weight	Shell Dimensions
	3.0 Inch	76mm	7.3kg	76mm x 356mm
	3.7 Inch	94mm	12.7kg	94mm x 438mm
	4.5 Inch	114mm	24.7kg	114mm x 578mm
	40mm	40mm	0.9kg	40mm x 311mm
Z-AA	The three inch unrotated rocket/projectile known as the UP-3 had initially been developed for the Royal Navy. The UP-3 was also used in ground-based single and 128-round launchers known as "Z" batteries. The rocket, containing a high explosive warhead was often propelled by cordite.			

The conditions in which anti-aircraft projectiles may have fallen unnoticed within a site area are analogous to those regarding aerial delivered ordnance. Unexploded anti-aircraft projectiles could essentially have fallen indiscriminately anywhere within range of the guns. The chance of such items being observed, reported and removed during the war depends on factors such as land use, ground cover, damage and frequency of access – the same factors that govern whether evidence of a UXB is likely to have been noted. More information about these factors with regards to this particular site can be found in the German Aerial Delivered Ordnance section of this report.

Illustrations of Anti-Aircraft artillery, projectiles and rockets are presented at **Appendix iv**.

13. The Likelihood of Contamination from Allied Ordnance

13.1. Introduction

There are several factors that may serve to either affirm, increase, or decrease the level of risk within a site with a history of military usage. Such factors are typically dependent upon the proximity of the proposed area of works to training activities, munition productions and storage, as well as its function across the years.

This section will examine the history of the proposed site and assess to what degree, if any, the site could have become contaminated as a result of the military use of the surrounding area.

13.2. Evaluation of Contamination Risk from Allied UXO

1st Line Defence has considered the following potential sources of Allied ordnance contamination:

Sources of Allied UXO Contamination	Conclusion
Military Camps <i>Military camps present an elevated risk from ordnance simply due to the large military presence and likelihood of associated live ordnance training.</i>	1 st Line Defence could find no evidence of a military camp within the site.
Anti-Aircraft Defences <i>Anti-Aircraft defences were employed across the country. Proximity to anti-aircraft defences increases the chance of encountering AA projectiles.</i>	1 st Line Defence could find no evidence of Anti-Aircraft defences such as a HAA or LAA gun emplacement occupying or bordering the site. The closest HAA was located approximately 2.85km north-west of the site, in the vicinity of Lower Broughton. Despite this distance the maximum effective range of an AA projectile can be up to 15km. The conditions in which HAA or LAA projectiles may have fallen unnoticed within a site footprint are analogous to those regarding German aerial delivered ordnance.
Home Guard Activity <i>The Home Guard regularly undertook training and ordnance practice in open areas, as well as burying ordnance as part of anti-invasion defences.</i>	Evidence of Home Guard activity is often difficult to locate, owing to the ad-hoc nature of Home Guard activity within each local area. Such training was often conducted on a small scale at the discretion of individual commanders and as such was seldom recorded officially. As such, no positive evidence could be found to confirm the presence of HG units within proximity to the site.
Defensive Positions <i>Defensive positions suggest the presence of military activity, which is often indicative of ordnance storage, usage or disposal.</i>	There is no evidence of any pillbox, emplacement or other defensive features formerly located on or bordering the site footprint.
Training or firing ranges <i>Areas of ordnance training saw historical ordnance usage in large numbers, often with inadequate disposal of expended and live items. The presence of these ranges significantly impact on the risk of encountering items of ordnance in their vicinity.</i>	No evidence of training or firing ranges could be found within the site or surrounding area.



Defensive Minefields <i>Minefields were placed in strategic areas to defend the country in the event of a German invasion. Minefields were not always cleared with an appropriate level of vigilance.</i>	There is no evidence of defensive minefields affecting the site.
Ordnance Manufacture <i>Ordnance manufacture indicates an increased chance that items of ordnance were stored, or disposed of, within a location.</i>	No information of ordnance being stored, produced, or disposed of within the proposed site could be found.
Military Related Airfields <i>Military airfields present an elevated risk from ordnance simply due to the large military presence and likelihood of associated live ordnance training or bombing practice.</i>	The site was not situated within the perimeters or vicinity of a military airfield.

14. The Likelihood of UXO Contamination Summary

The following table assesses the likelihood that the site was contaminated by items of German aerial delivered and Allied ordnance. Factors such as the risk of UXO initiation, remaining, and encountering will be discussed later in the report.

UXO Contamination Summary	
Quality of the Historical Record	The research has evaluated pre- and post-WWII Ordnance Survey maps, pre-WWII oblique aerial photography, Luftwaffe target mapping, University of Manchester bomb and damage map, an interactive 'Christmas Blitz' map, bomb census reports and air raid damage files, published sources including Peter Smiths 'Luftwaffe Over Manchester: The Blitz Years 1940 – 1944' and Graham Phythian's 'Blitz Britain; Manchester and Salford', damage cards for housing and properties, and post-WWII aerial photography. The record set is of generally mixed quality; while there are a number of record sets available for consultation, they are not considered to be comprehensive, and do not always corroborate each other.
German Aerial Delivered Ordnance	<ul style="list-style-type: none"> The overall site comprises four distinct areas within the City of Manchester; for the purposes of this report, these areas are referred to as Site A, Site B, Site C and Site D. During WWII, the site area was located within the County Borough of Manchester, which according to official Home Office bombing statistics sustained an overall low density of bombing. This comprised a total of 738 items of ordnance across the 27,255 acre district. Although Manchester was not targeted to the same extent as cities such as London and Birmingham, it was subject to several major raids, the worst of which is often referred to as the 'Christmas Blitz'. Bomb plot and damage mapping obtained from the University of Manchester shows several bomb strikes occurred within the bounds of Site A and Site C. Site A reportedly sustained one HE strike at the College of Technology on the 31st August 1940, and one fire bomb on the 1st/2nd June 1941. Site C sustained one direct HE strike to the south on Temple Street, dating from the 22nd – 24th December 1940, and a second HE strike at the Cotton Mills on Jackson Street; additional strikes were recorded beyond the bounds of Site C to the south, including one directly adjacent to the border. This mapping also recorded damage within Site A and Site C: partial damage to the College of Technology and the Cotton Mills, correlating with the aforementioned bomb strikes, in addition to demolished structures within Site C between Clowes Terrace and Thompson Terrace to the south, and adjacent to the southern boundary between Jackson Street and Lyon Street. In contrast, no incidents of bombing or damage were recorded on or adjacent to either Site B or Site D. War damage reports also outlined damage to properties within Site C, along Clowes Terrace, Holt Street, Jackson Street, Jackson Terrace, Temple Street, Thompson Street and School Street; this correlates with the incidents / damage outlined on the previously discussed bomb mapping. This is further supported by areas of clearance evident on both post-war OS mapping and RAF aerial photography, whereby pre-war structures are no longer present, instead occupied by areas of rough open ground. Clearance can be an indication that buildings on site sustained severe bomb damage and were subsequently demolished. It is likely that a high level of access was permissible on each site at the outbreak of WWII, and that specific post-raid inspections were carried out in the area, given the sites location in an urban area of Manchester, with various structures and roadways situated on site. However, access to certain areas of Site C may have been significantly reduced following the recorded bomb strikes and severe damage identified, which may have led to ground conditions obstructive to the discovery of UXO, such as rubble and debris. These areas were predominately situated within the southern section of Site C.



	<ul style="list-style-type: none">• Access may also have been reduced for a period within part of Site A, due to the aforementioned bomb damage and bomb strike at the College of Technology. However, this level of damage is understood to have been relatively minor and to have been swiftly resolved. This is confirmed by a local historical account which states: “the building suffered no lasting damage – shattered windows were replaced and demolished rooms were quickly restored”. Any reduction of access in this area is therefore anticipated to be more minor and shorter in comparison to the aforementioned damaged areas of Site C.• After considering the information presented above, 1st Line Defence has assessed that the risk from unexploded German air-delivered ordnance is not homogenous across the site: see Annex N for risk mapping of the area. The southern section of Site C has been assessed as of Medium risk from UXO contamination, given the recorded bomb strikes and clear evidence of significant bomb damage across large parts of this area, which likely resulted in conditions obstructive to the discovery of UXO. The remainder of the combined site footprint has been assessed as at a Low Risk from unexploded German air-delivered ordnance. No evidence could be found within any of the consulted sources to suggest that Site B, Site D and the remaining area of Site C were subject to either bombing or bomb damage.• Site A is recorded to have sustained one HE bomb strike and one ‘fire bomb strike’ at the location of the former College of Technology (now the Sackville Building). However, these incidents are recorded to have resulted in limited damage and do not appear to have had any major impact on either the condition or usage of this area, which remained in use by the college for the duration of the war. It has therefore been possible to lower the risk that UXB’s could have fallen unnoticed within this area on this occasion. The risk is not considered high enough to warrant proactive risk mitigation measures, however UXO awareness briefings are recommended as a sensible minimum precaution for intrusive ground works.
Allied Ordnance	<ul style="list-style-type: none">• There is no evidence that the site formerly had any military occupation or usage that could have led to contamination with items of Allied ordnance, such as LSA and SAA. The conditions in which HAA or LAA projectiles may have fallen unnoticed within the site boundary are however analogous to those regarding aerial delivered ordnance.

15. The Likelihood that UXO Remains

15.1. Introduction

It is important to consider the extent to which any explosive ordnance clearance (EOC) activities or extensive ground works have occurred on site. This may indicate previous ordnance contamination or reduce the risk that ordnance remains undiscovered.

15.2. UXO Clearance

1st Line Defence has found no evidence in the public domain or within internal records that any official ordnance clearance operations have taken place on site. Note however that we have not received confirmation of this fact from the 33 EOD Regiment Archive (now part of 29 EOD & Search Group). It should also be noted that in addition to 29 EOD & Search Group archival information, 1st Line Defence also do not currently have access to data that may be relevant including 5131(BD)SQN Archive, SD Training Technical Advisory Section (TAS) and MACA Records (bomb disposal callouts).

If such information is available at a later date, it is recommended that it be reviewed as it will assist with understanding both levels and types of contamination likely to be present, and may indicate risk reduction in certain areas.

15.3. Post-War Redevelopment

Extensive post-war redevelopment has occurred within the site area; the majority of the pre-war infrastructure and roadways have since been demolished and redeveloped, and the River Medlock which previously ran through the site has since been diverted/infilled. The majority of the site is now home to large buildings and open space associated with the University of Manchester.

The risk of UXO remaining is considered to be mitigated at the location of and down to the depth of any post-war redevelopment on site. For example, the risk from deep buried UXO will only have been mitigated within the volumes of any post-war pile foundations or deep excavations for basement levels. The risk will however remain within virgin geology below and amongst these post-war works, down to the maximum bomb penetration depth.

16. The Likelihood of UXO Encounter

16.1. Introduction

For UXO to pose a risk at a site, there should be a means by which any potential UXO might be encountered on that site.

The likelihood of encountering UXO on the site of proposed works would depend on various factors, such as the type of UXO that might be present and the intrusive works planned on site. In most cases, UXO is more likely to be present below surface (buried) than on surface.

In general, the greater the extent and depth of intrusive works, the greater the risk of encountering. The most likely scenarios under which items of UXO could be encountered during construction works is during piling, drilling operations or bulk excavations for basement levels. The overall risk will depend on the extent of the works, such as the numbers of boreholes/piles (if required) and the volume of the excavations.

Generally speaking, the risk of encountering any type of UXO will be minimal for any works planned within the footprint and down to the depth of post-war foundations and excavations.

16.2. Encountering Aerial Delivered Ordnance

Since an aerial delivered bomb may come to rest at any depth between just below ground level and its maximum penetration depth, there is a chance that such an item (if present) could be encountered during shallow excavations (for services or site investigations) into the original WWII ground level as well as at depth.

17. The Likelihood of UXO Initiation

17.1. Introduction

UXO does not spontaneously explode. Older UXO devices will require an external event/energy to create the conditions for detonation to occur. The likelihood that a device will function can depend on a number of factors including the type of weaponry, its age and the amount of energy it is struck with.

17.2. Initiating Aerial Delivered Ordnance

Unexploded bombs do not spontaneously explode. All high explosive filling requires significant energy to create the conditions for detonation to occur.

In recent decades, there have been a number of incidents in Europe where Allied UXBs have detonated, and incidents where fatalities have resulted. There have been several hypotheses as to the reason why the issue is more prevalent in mainland Europe – reasons could include the significantly greater number of bombs dropped by the Allied forces on occupied Europe, the preferred use by the Allies of mechanical rather than electrical fuzes, and perhaps just good fortune. The risk from UXO in the UK is also being treated very seriously in many sectors of the construction industry, and proactive risk mitigation efforts will also have affected the lack of detonations in the UK.

There are certain construction activities which make initiation more likely, and several potential initiation mechanisms must be considered:

UXB Initiation	
Direct Impact	Unless the fuze or fuze pocket is struck, there needs to be a significant impact e.g. from piling or large and violent mechanical excavation, onto the main body of the weapon to initiate a buried iron bomb. Such violent action can cause the bomb to detonate.
Re- starting the Clock	A small proportion of German WWII bombs employed clockwork fuzes. It is probable that significant corrosion would have taken place within the fuze mechanism over the last 70+ years that would prevent clockwork mechanisms from functioning. Nevertheless, it was reported that the clockwork fuze in a UXB dealt with by 33 EOD Regiment in Surrey in 2002 did re-start.
Friction Impact	The most likely scenario resulting in the detonation of a UXB is friction impact initiating the shock-sensitive fuze explosive. The combined effects of seasonal changes in temperature and general degradation over time can cause explosive compounds to crystallise and extrude out from the main body of the bomb. It may only require a limited amount of energy to initiate the extruded explosive which could detonate the main charge.

18. Consequences of Initiation/Encounter

18.1. Introduction

The repercussions of the inadvertent detonation of UXO during intrusive ground works, or if an item or ordnance is interfered with or disturbed, are potentially profound, both in terms of human and financial cost. A serious risk to life and limb, damage to plant and total site shutdown during follow-up investigations are potential outcomes. However, if appropriate risk mitigation measures are put in place, the chances of initiating an item of UXO during ground works is comparatively low.

The consequences of encountering UXO can be particularly notable in the case of high-profile sites (such as airports and train stations) where it is necessary to evacuate the public from the surrounding area. A site may be closed for anything from a few hours to a week with potentially significant cost in lost time. It should be noted that even the discovery of suspected or possible item of UXO during intrusive works (if handled solely through the authorities), may also involve significant loss of production.

18.2. Consequences of Detonation

When considering the potential consequences of a detonation, it is necessary to identify the significant receptors that may be affected. The receptors that may potentially be at risk from a UXO detonation on a construction site will vary depending on the site specific conditions but can be summarised as follows:

- People – site workers, local residents and general public.
- Plant and equipment – construction plant on site.
- Services – subsurface gas, electricity, telecommunications.
- Structures – not only visible damage to above ground buildings, but potentially damage to foundations and the weakening of support structures.
- Environment – introduction of potentially contaminating materials.

19. 1st Line Defence Risk Assessment

19.1. Risk Assessment Stages

Taking into account the quality of the historical evidence, the assessment of the overall risk from unexploded ordnance is based on the following five considerations:

1. That the site was contaminated with unexploded ordnance.
2. That unexploded ordnance remains on site.
3. That such items will be encountered during the proposed works.
4. That ordnance may be initiated by the works operations.
5. The consequences of encountering or initiating ordnance.

19.2. Assessed Risk Level

1st Line Defence has assessed that the risk from unexploded German and anti-aircraft unexploded ordnance is not homogenous across the site of proposed works: see **Annex N** for risk mapping of the area. The southern section of Site C has been assessed as of **Medium Risk** from UXO contamination, whilst Site A, Site B, and Site D, as well as the remaining areas Site C, have been given a **Low Risk**. There is also an assessed **Low Risk** from Allied unexploded ordnance across the site area.

Medium Risk Areas – Southern Section of Site C:

Ordnance Type	Risk Level			
	Negligible	Low	Medium	High
German Unexploded HE Bombs			✓	
German Incendiary Bombs			✓	
Anti-Aircraft Artillery Projectiles			✓	
Allied Land Service and Small Arms Ammunition		✓		

Low Risk – Site A, Site B, Northern Section of Site C and Site D:

Ordnance Type	Risk Level			
	Negligible	Low	Medium	High
German Unexploded HE Bombs		✓		
German 1kg Incendiary Bombs		✓		
Anti-Aircraft Artillery Projectiles		✓		
Allied Land Service and Small Arms Ammunition		✓		



Please note – although the risk from unexploded ordnance on this site has been assessed as ‘Low’ across the majority of the site, this does not mean there is ‘no’ risk of encountering UXO within these areas. This report has been undertaken with due diligence, and all reasonable care has been taken to access and analyse relevant historical information. By necessity, when dealing historical evidence, and when making assessments of UXO risk, various assumptions have to be made which we have discussed and justified throughout this report. Our reports take a common-sense and practical approach to the assessment of risk, and we strive to be reasonable and pragmatic in our conclusions.

It should however be stressed that if any suspect items are encountered during the proposed works, 1st Line Defence should be contacted for advice/assistance, and to re-assess the risk where necessary. The mitigation measures outlined in the next section are recommended as a minimum precaution to alert ground personnel to the history of the site, what to look out for, and what measures to take in the event that a suspect item is encountered. It should also be noted that the conclusions of this report are based on the scope of works outlined in the ‘Proposed Works’ section of this report. Should the scope of works change or additional works be proposed, 1st Line Defence should be contacted to re-evaluate the risk.

20. Proposed Risk Mitigation Methodology

20.1. General

The following risk mitigation measures are recommended to support the proposed works at ID Manchester:

Type of Work	Recommended Mitigation Measure
All Works	<ul style="list-style-type: none"> • UXO Risk Management Plan It is recommended that a site-specific plan for the management of UXO risk be written for this site. This plan should be kept on site and be referred to in the event that a suspect item of UXO is encountered at any stage of the project. It should detail the steps to be taken in the event of such a discovery, considering elements such as communication, raising the alarm, nominated responsible persons etc. Contact 1st Line Defence for help/more information. • Site Specific UXO Awareness Briefings to all personnel conducting intrusive works. As a minimum precaution, all personnel working on the site should be briefed on the basic identification of UXO and what to do in the event of encountering a suspect item. This should in the first instance be undertaken by a UXO Specialist. Posters and information on the risk of UXO can be held in the site office for reference.
Shallow Intrusive Works/Open Excavations (Medium Risk Areas)	<ul style="list-style-type: none"> • Unexploded Ordnance (UXO) Specialist Presence on Site to support shallow intrusive works When on site the role of the UXO Specialist would include: <ul style="list-style-type: none"> • Monitoring works using visual recognition and instrumentation, including immediate response to reports of suspicious objects or suspected items of ordnance that have been recovered by the ground workers on site. • Providing UXO awareness briefings to any uninformed staff and advise staff of the need to modify working practices to take account of the ordnance risk. • To aid incident management which would involve liaison with the local authorities and police should ordnance be identified and present an explosive hazard.
Borehole/Piles (Medium Risk Areas)	<ul style="list-style-type: none"> • Intrusive Magnetometer Survey of all borehole and pile locations down to a maximum bomb penetration depth: 1st Line Defence can deploy a range of intrusive magnetometer techniques to clear pile locations. The appropriate technique is influenced by a number of factors, but most importantly the site's ground conditions. The appropriate survey methodology would be confirmed once the enabling works have been completed.

In making this assessment and recommending these risk mitigation measures, if known, the works outlined in the 'Scope of the Proposed Works' section were considered. Should the planned works be modified or additional intrusive engineering works be considered, 1st Line Defence should be consulted to see if a re-assessment of the risk or mitigation recommendations is necessary.

1st Line Defence Limited

8th April 2022

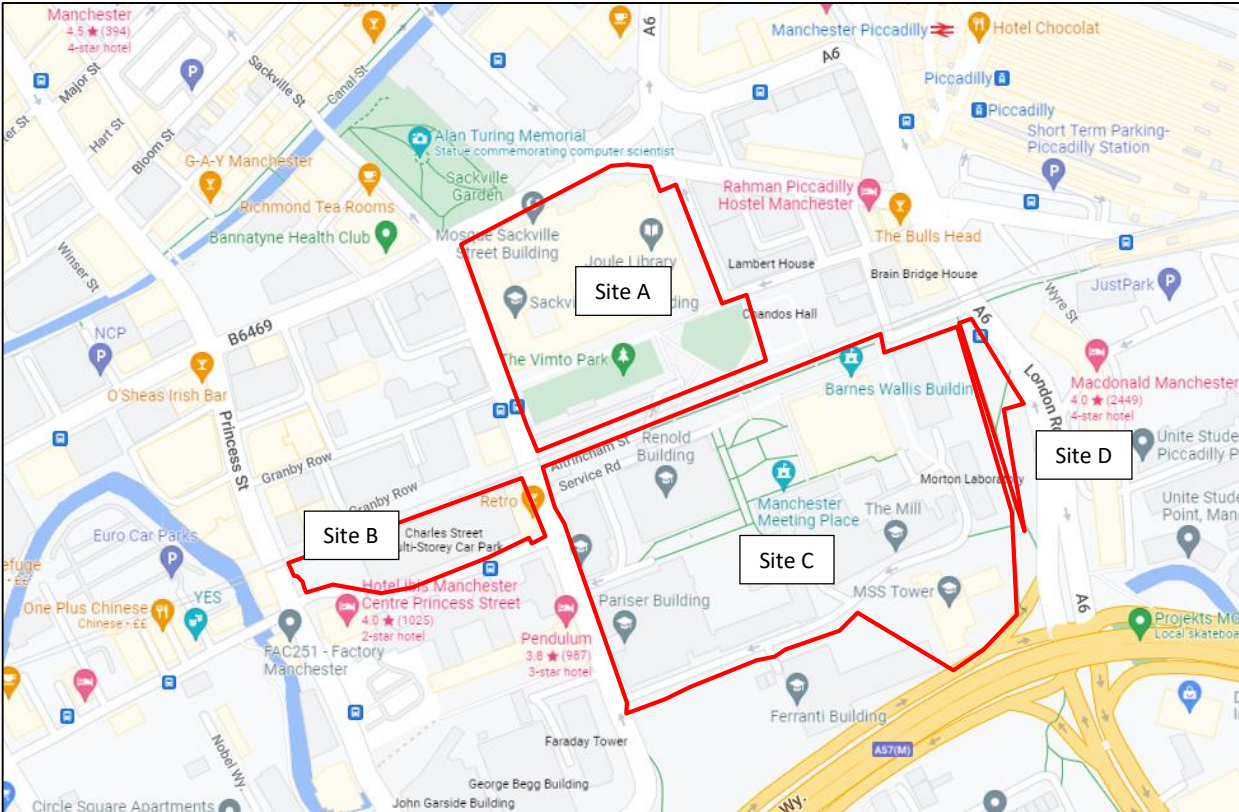
This Report has been produced in compliance with the Construction Industry Research and Information Association (CIRIA) C681 guidelines for the writing of Detailed UXO Risk Assessments.

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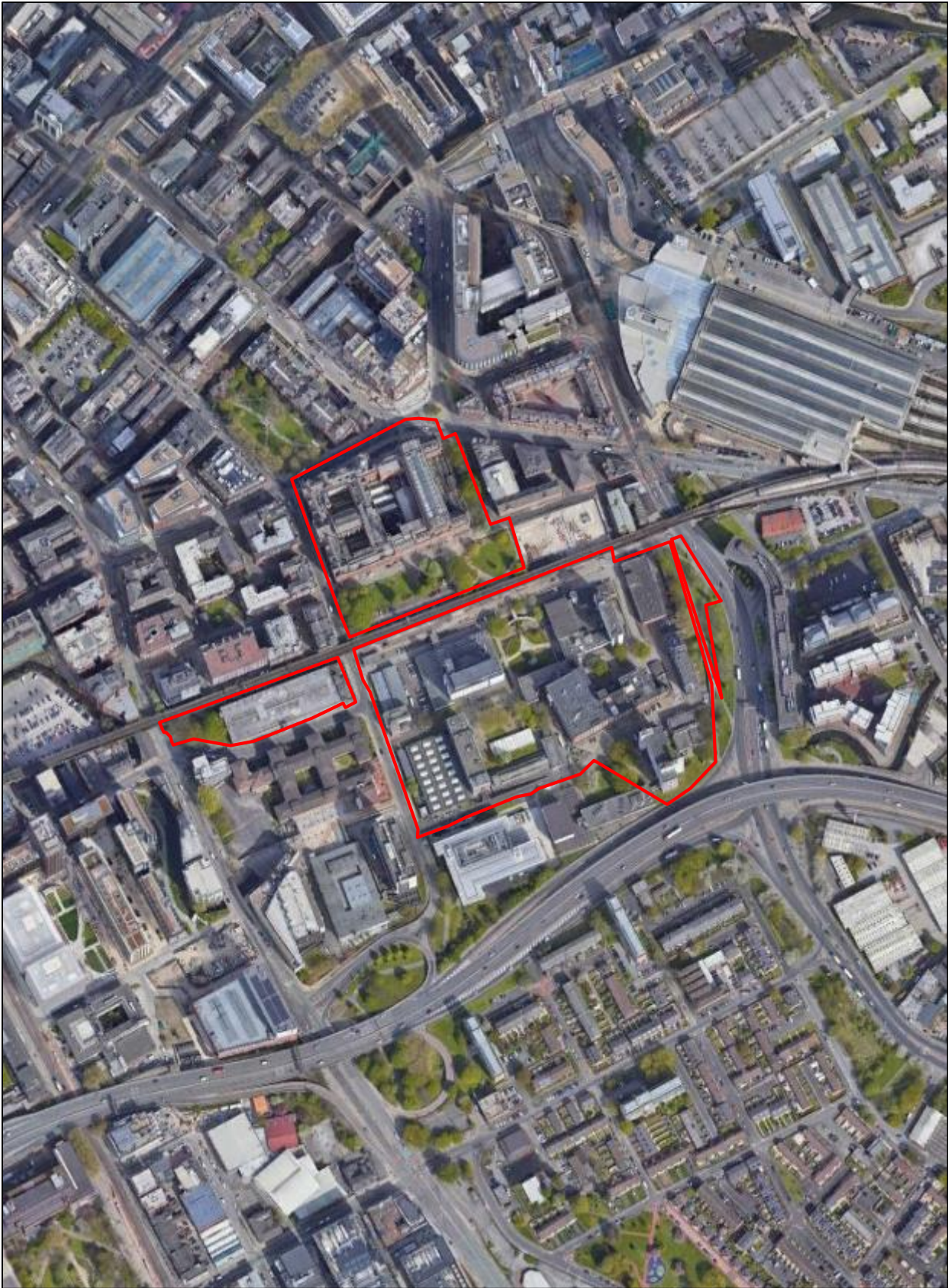
Project: **ID Manchester**

Ref: **DA14968-00**

Source: Google Maps

 **Approximate site boundary**





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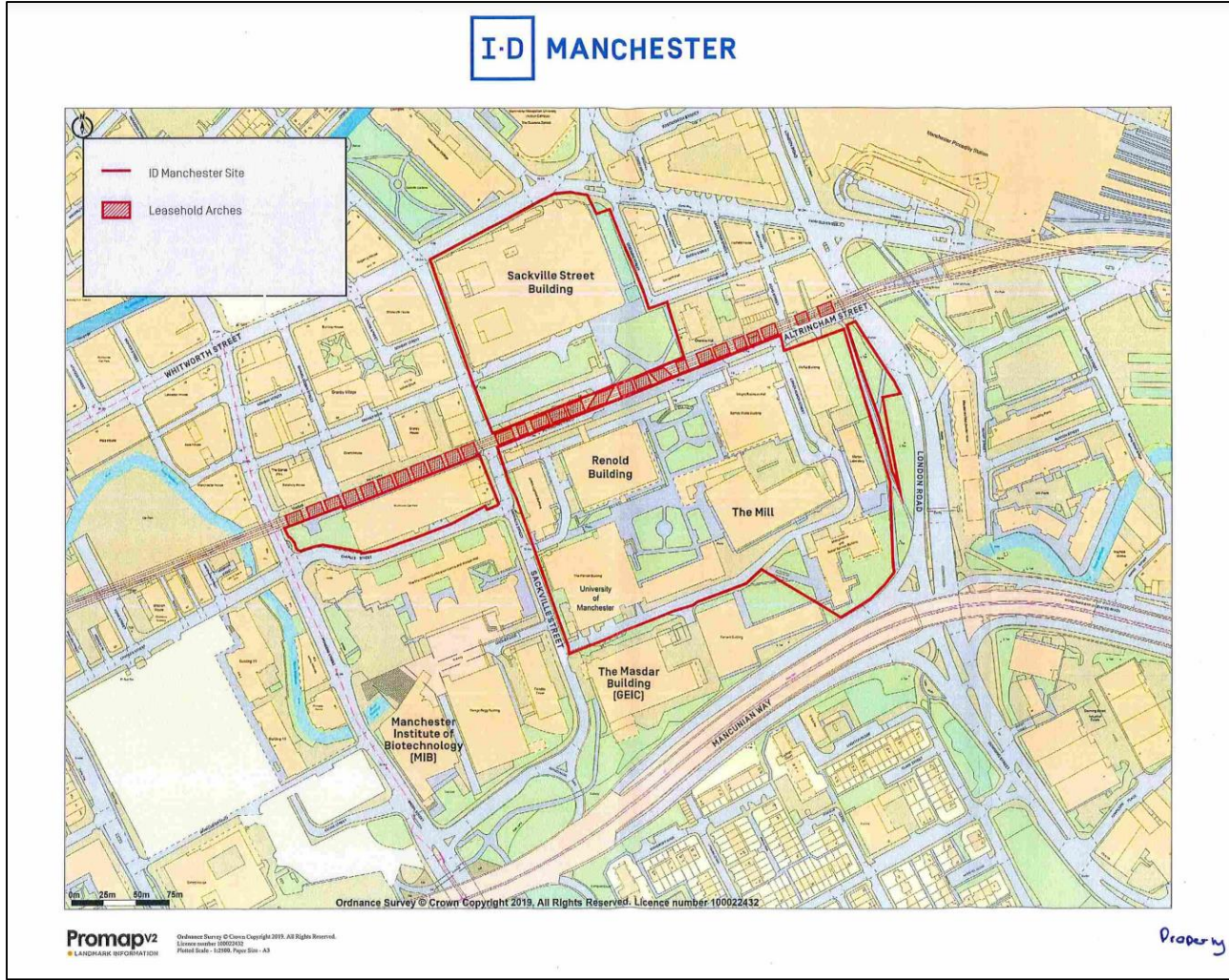
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Source: Google Earth™ Mapping Services

 **Approximate site boundary**





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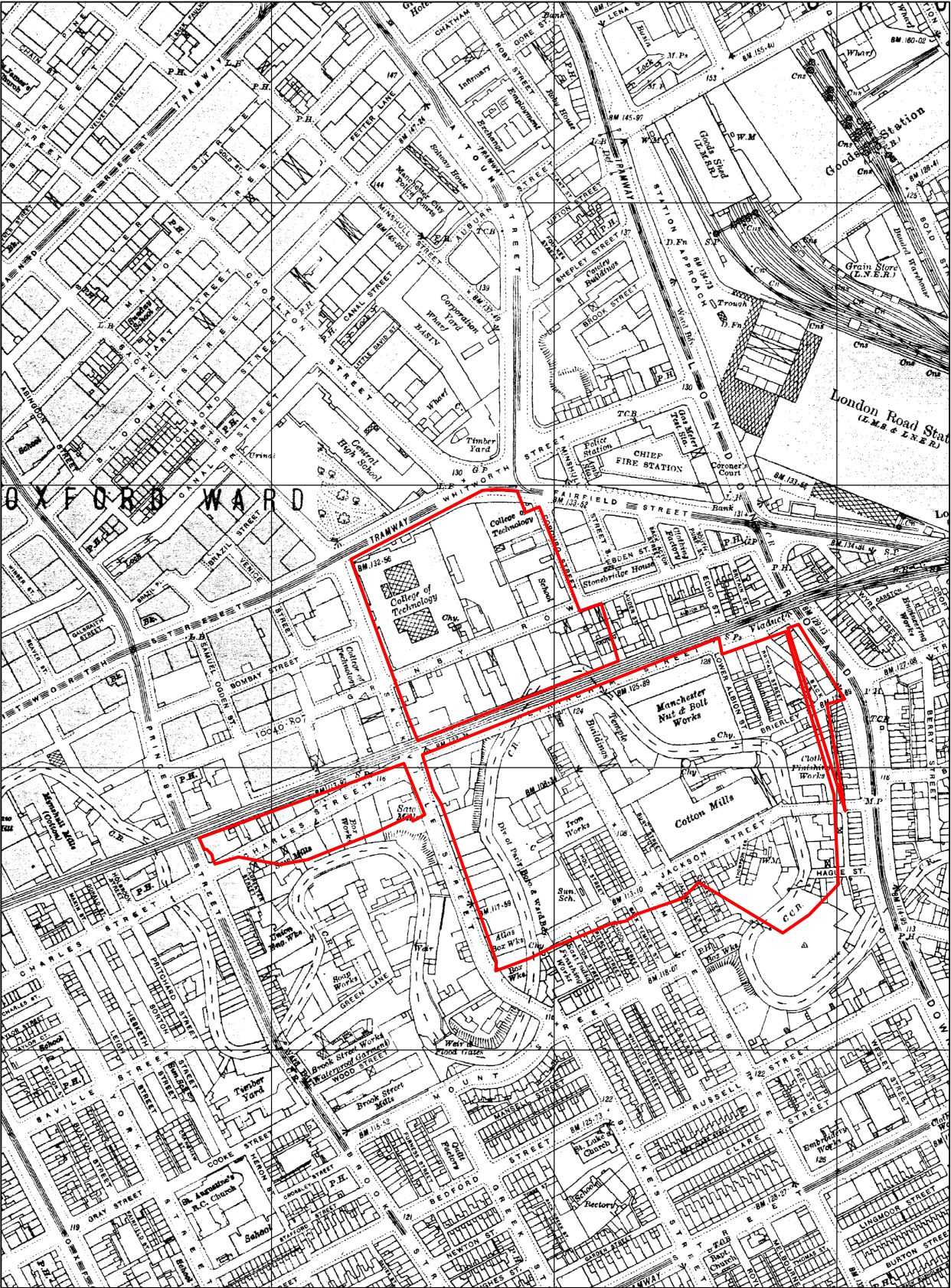
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 **Approximate site boundary**





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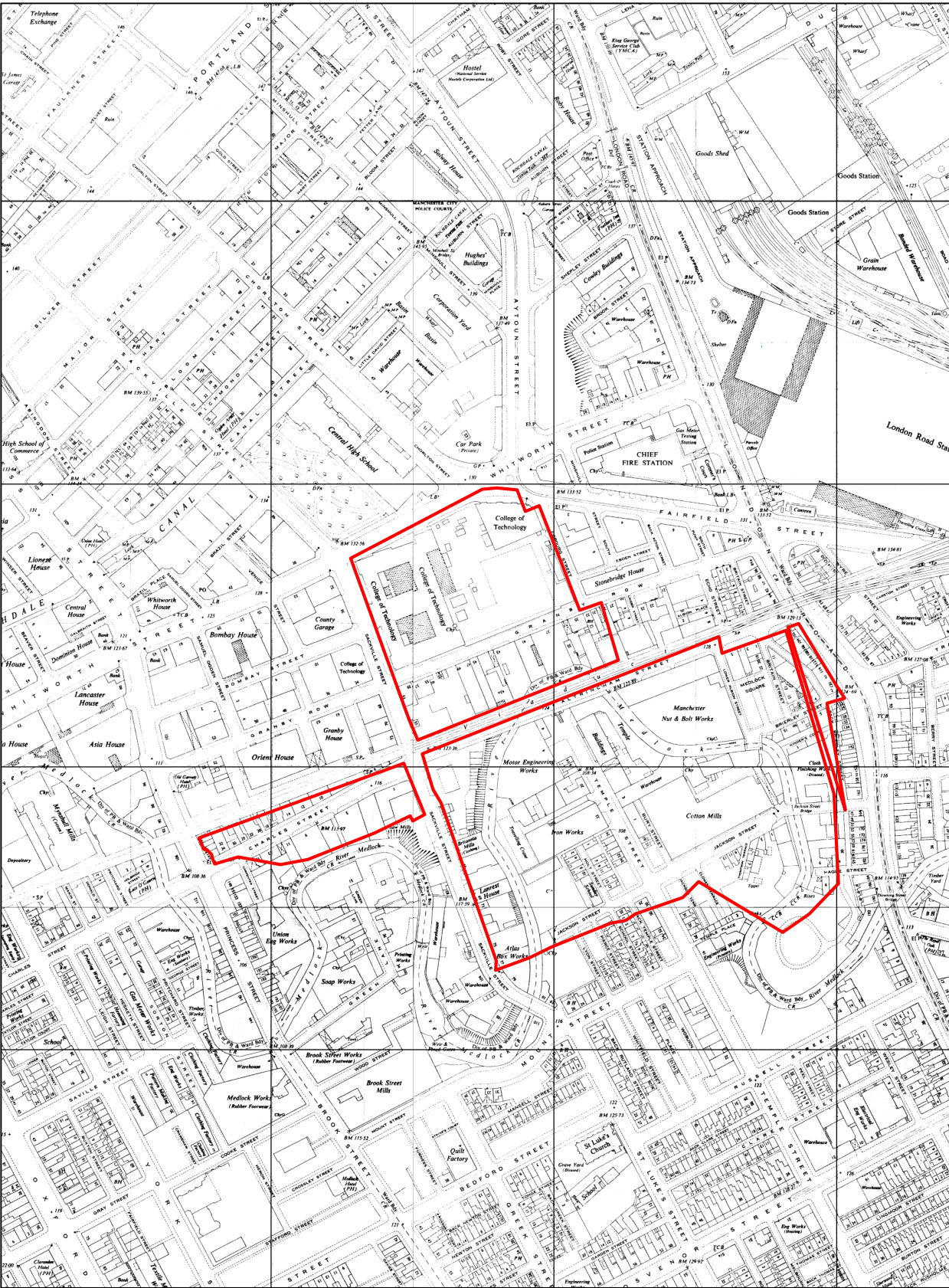
Source: **Landmark Maps**

 **Approximate site boundary**





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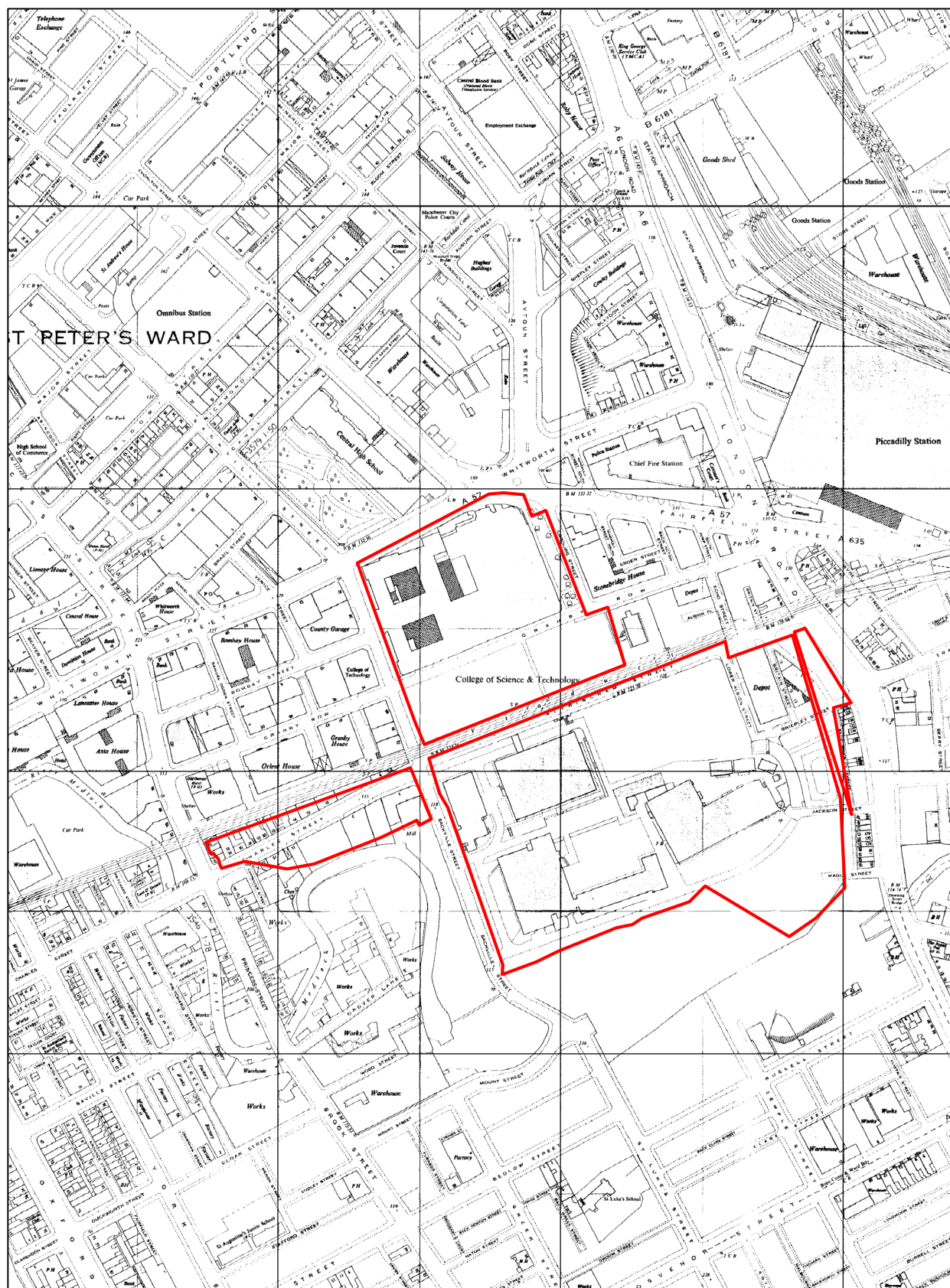
Project: **ID Manchester**

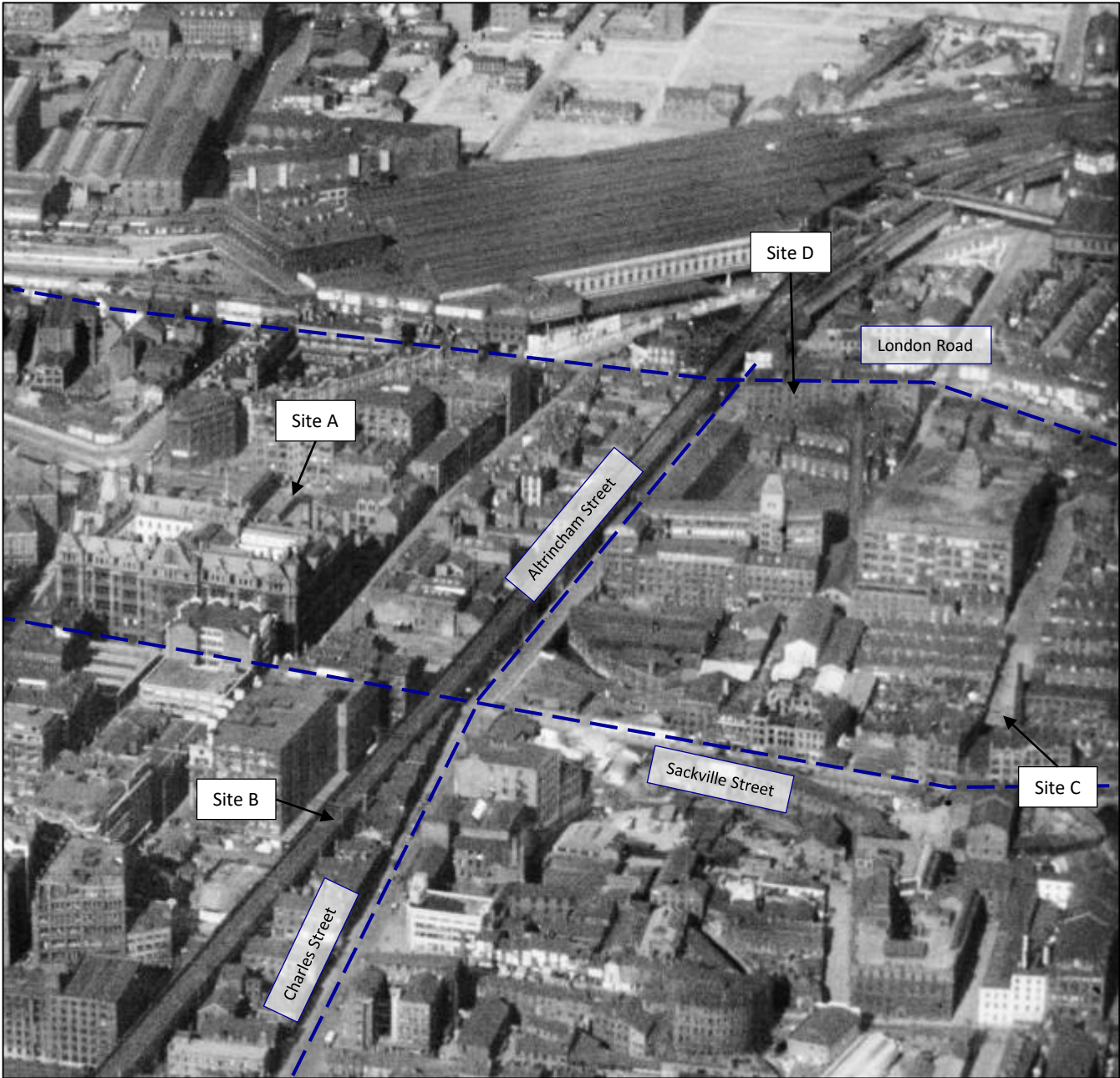
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 **Approximate site boundary**







The city between the Central Railway Station and Manchester Piccadilly Station, Manchester, August 1937



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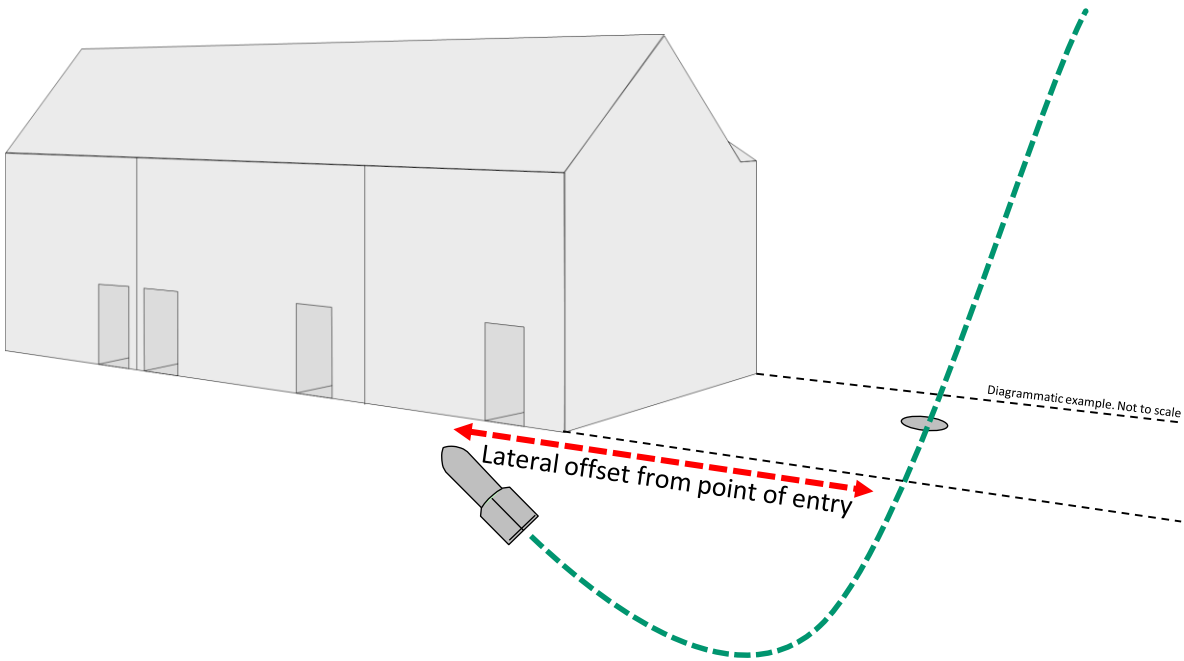
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Source: **Landmark Maps**









Top: J-curve Effect - Due to angle of entry, unexploded bombs would often end their trajectory at a lateral offset from point of entry, often ending up beneath adjacent extant structures/sites. The photograph above shows 250kg bomb found in Bermondsey pointing upwards, demonstrating ‘J-curve’



One of the most common scenarios for UXO going unnoticed was when a UXB fell into a ‘bomb site’ (such as the area shown **Top Left**), the entry hole of the bomb obscured by any debris and rubble present. Note that the entry hole of a 50kg UXB could be as little as 20cm in diameter (**Left**).



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Bermondsey bomb: World War Two device safely removed



An unexploded World War Two bomb found in south London has been driven away safely under police and Army escort.

The 500lb (250kg) device was found on a building site in Grange Walk, Bermondsey on Monday.

March 2015



Bethnal Green WW2 bomb: Experts remove unexploded device



An unexploded World War Two bomb that prompted the evacuation of 700 people in east London has been made safe and removed by the military.

Families spent the night in a school hall after the 500lb bomb was found in the basement of a building site on Temple Street, in Bethnal Green, on Monday afternoon.

A 200m (650ft) exclusion zone was set up around the device.

August 2016



Bath WW2 bomb scare: Device defused, police say



A 500lb World War Two bomb found on the site of a former school in Bath has been defused and made safe.

The discovery of the bomb on Thursday led to the evacuation of hundreds of homes and many road closures in the Lansdown area of the city.

A cordon around the site was lifted on Friday evening, more than 24 hours after residents were asked to leave their homes.

May 2016



London City Airport reopens after WW2 bomb moved



London City Airport has reopened after an unexploded 500kg World War Two bomb was safely moved from the area.

The device was discovered at the King George V Dock on Sunday during planned work at the east London airport.

All flights were cancelled on Monday after an exclusion zone was put in place, with the closure affecting up to 16,000 passengers and nearby residents being evacuated from their homes.

May 2015



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Source: BBC News

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BASF has confirmed that an explosive device, most likely a World War II-era bomb, caused the blast that left one person injured Tuesday at a plant construction site in Germany.

The explosion was reported at BASF's Ludwigshafen toluene diisocyanate (TDI) plant, which recently broke ground for a 300,000 metric tons per year TDI production plant and other construction to expand its facilities.



BASF Provides Some Details

Responding to a request from *PaintSquare News* for more information on Wednesday (Feb. 27), BASF's manager of media relations and corporate communications Europe, Ursula von Stetten, wrote in an email, "So here [are] the facts: The detonation took place at 10:00 a.m. One person was injured; the injury is not serious. He will be kept in the hospital for some days.

"Cause of the detonation was an explosive device, presumably a bomb deriving from the Second World War. The device detonated when grounding work was done. No details on [a] delay [are] available. At the moment, the exact circumstances of the incident are [being] evaluated."

1st March 2013

SPIEGEL ONLINE

Blast Kills One
World War II Bomb Explodes on German Motorway

A highway construction worker in Germany accidentally struck an unexploded World War II bomb, causing an explosion which killed him and wrecked several passing cars.



A World War II bomb has exploded during construction work on a German highway, killing one worker and injuring several motorists who were driving past, police said.

The worker had been cutting through the road surface near the south-western town of Aschaffenburg when his machine struck the bomb and triggered it. Police said they weren't sure yet what type of bomb it was. "The explosion seems to have been too small for it to have been an aircraft bomb," a police spokesman said.

23rd October 2006

WWII bomb injures 17 at Hattingen construction site



Seventeen people were injured on Friday when a construction crew unwittingly detonated a buried World War II-era bomb in Hattingen.

An excavator apparently drove over a 250-kilogramme (550 pound) American bomb, damaging surrounding buildings. Most of the injured suffered auditory trauma from the blast, and the excavator operator suffered injuries to his hands, police in the German state of North Rhine-Westphalia said.

"The hole was astoundingly small for such a large bomb full of so many explosives," Armin Gebhard, head of the Arnsberg department for military ordnance removal, told The Local. "But of course it damaged all the surrounding buildings too. We are really happy it wasn't worse."

19th September 2013



World War II bomb kills three in Germany



A special commission is investigating the causes of the explosion, while prosecutors are considering whether the team leader should face charges of manslaughter through culpable negligence, the BBC's Oana Lungescu reports from Berlin.

The blast happened an hour before the defusing operation was due to start.

Officials said the three men who died were experienced sappers, or combat engineers, who over 20 years had defused up to 700 bombs.

More than 7,000 people were immediately evacuated when the 500kg bomb was found. Several schools, a kindergarten and local companies remain closed.

2nd June 2010



June 2006



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Unexploded Second World War bomb discovered under Somerset footpath

By Western Daily Press | Posted: January 21, 2014



The unexploded bomb was found in Somerset.

Comments (8)

An unexploded bomb dropped in Britain during the Second World War has finally been discovered – underneath a popular footpath in Somerset.



21 August 2014 Last updated at 15:01

Unexploded WW2 bomb found at Kenfig Pool, Bridgend



Dean Smith believes the shell was made in Germany

Bomb experts have been called to a south Wales nature reserve after an unexploded World War Two shell was discovered by a walker in Bridgend.

Dean Smith, 38, of Pyle, was walking near Kenfig Pool on Saturday when he saw a tin sticking out of the sand.

He reached down to pick it up, but ending up falling and landed with the 25-long (0.6m) bomb on top of him.

The site has been cordoned off by police and the Royal Logistics Corps will carry out a controlled explosion.

Related Stories

'Panic' as dog nearly thrown grenade

WW2 bomb found at wind farm exploded

WWII bomb found in kitchen cupboard

Mortar thought to be from WWII found on Oshawa's Camp-X grounds

August 24, 2016 | 5:42 am



What is believed to be a World War II mortar has been discovered in south Oshawa. A man out in Intrepid Park, the site of the Camp-X Second World War training grounds, discovered the round with his metal detector on Tuesday evening. Durham police are held the scene overnight awaiting military officials from Trenton to come and properly detonate the mortar.

Holiday beach cordoned off after landslide sends more than a THOUSAND Second World War bombs and rockets tumbling onto the sands

- Bad weather led to ground movement which exposed the huge arsenal at Mableton, East Riding
- A dog walker stumbled across the deadly find on Saturday and 15 controlled explosions were carried out
- Rockets, mortar bombs and 25-pounder bombs were recovered after they were fired into the cliffs by RAF aircraft during the war
- Most of the devices were dummy rounds used for bombing practice but contain enough explosives to cause terrible injuries



Bomb Beach Alley: Rockets were found after a landslide on Mableton beach in 2012

Unexploded bomb found in farmer's field

17 May 2010



A live Second World War mortar shell was blown up by Army experts after a farmer found it in his field. The discovery was made in the field alongside the A20 between Folkestone and Dover.

The mortar shell, which was around a foot long and 3in in diameter, was around 50ft from the main road.

The farmer alerted police and PC Trevor Moody and PCSO Michelle Brady went to the field.

PC Moody contacted the Army who sent in a bomb disposal unit.

An Army officer confirmed the live shell was from the Second World War and was packed with high explosives.

They moved it a safe distance away from the A20 and carried out a controlled explosion.

PC Moody said: "Given that we live in an area that saw much action during the Second World War, it is not uncommon for us to be alerted about unexploded bombs."

The incident was on Thursday.

Click here for more news from Kent.

Royal Navy bomb disposal experts remove a World War Two shell discovered in a nature reserve

- A World War Two bomb was discovered in a Plymouth nature reserve
- Amateur metal detector found the shell and partially dug it up
- Royal Navy experts carried the explosive away before disposing of it

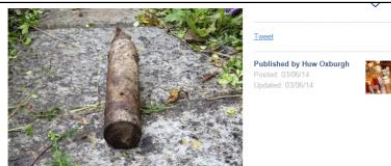
By VALERIE EDWARDS FOR MAILONLINE
PUBLISHED: 01:29, 13 January 2016 | UPDATED: 09:51, 13 January 2016

338 shares View comments

A World War Two bomb was reportedly found at Efford Nature Reserve in Plymouth after a member of the public was metal detecting and partially dug it up.

The Royal Navy Bomb Disposal team was called in to remove the bomb and police have closed off Military Lane, with the possibility of Military Road also being closed.

Police were called at around 1.30pm yesterday after what appeared to be a shell was discovered and partially dug up near Military Lane, Efford.



Unexploded bomb found in Axminster

Update: The bomb disposal unit has made the device safe and the road has re-opened

Six homes have been evacuated today after the discovery of an unexploded device in Axminster.

A Royal Navy bomb disposal team have been called to the scene after a 'historic German device' was discovered in a garden.

Police have set up a 20m cordon around the garden in Alexandra Road and evacuated homes in the surrounding area as a precaution.

Army bomb disposal team called to Blacksole Bridge in Herne Bay

by Aidan Barlow alanbarlow@thetmggroup.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 phosphorous bombs were found.



The scene at Blacksole Bridge after wartime explosives were found in the railway cutting

Storms and floods unearth unexploded wartime bombs

By Claire Marshall
BBC environment correspondent

There has been a dramatic increase in the number of wartime bombs unearthed because of the winter storms and flooding.

Bomb disposal teams in the South West have dealt with double the number of unexploded ordnance than in the same period last year.

Since mid December, the Royal Navy's Southern Dive Unit has recovered or disposed of 244 items of ordnance.

During the same period last year, they dealt with just 108 items.

Almost 70 years after the end of WWII, one legacy of that conflict continues to turn up on beaches and harbours around Britain.

Unexploded shells, bombs and mines continue to be discovered every year, and the Royal Navy's Southern Dive Unit is tasked with making these devices safe.

Its area of responsibility stretches for some 2,250km (1,400 miles). It begins from the highwater mark in Hull and proceeds seaward to the territorial limit, and then runs clockwise around the British Isles - including the Isle of Wight, Channel Islands, and Isles of Scilly - to finish in Liverpool.



The storms have uncovered a lethal past

Related Stories

Ancient trees revealed by storms

Land Service Ammunition (LSA) resulting from historic military activity is commonly encountered across the UK by the public and construction industry alike. Such finds are much more common in rural areas than in urban environments, and can often be anticipated in areas such as former RAF stations or ranges. However, many such items are encountered entirely by surprise where the landowner or developer has no knowledge of any previous military use of the land.



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Source: Various news sources

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INDEPENDENT

News > UK > Home News

Manchester city centre evacuated over 'unexploded tank cartridge'

Military bomb disposal team called in to remove device

Chris Baynes | Wednesday 24 October 2018 15:49 |

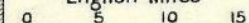


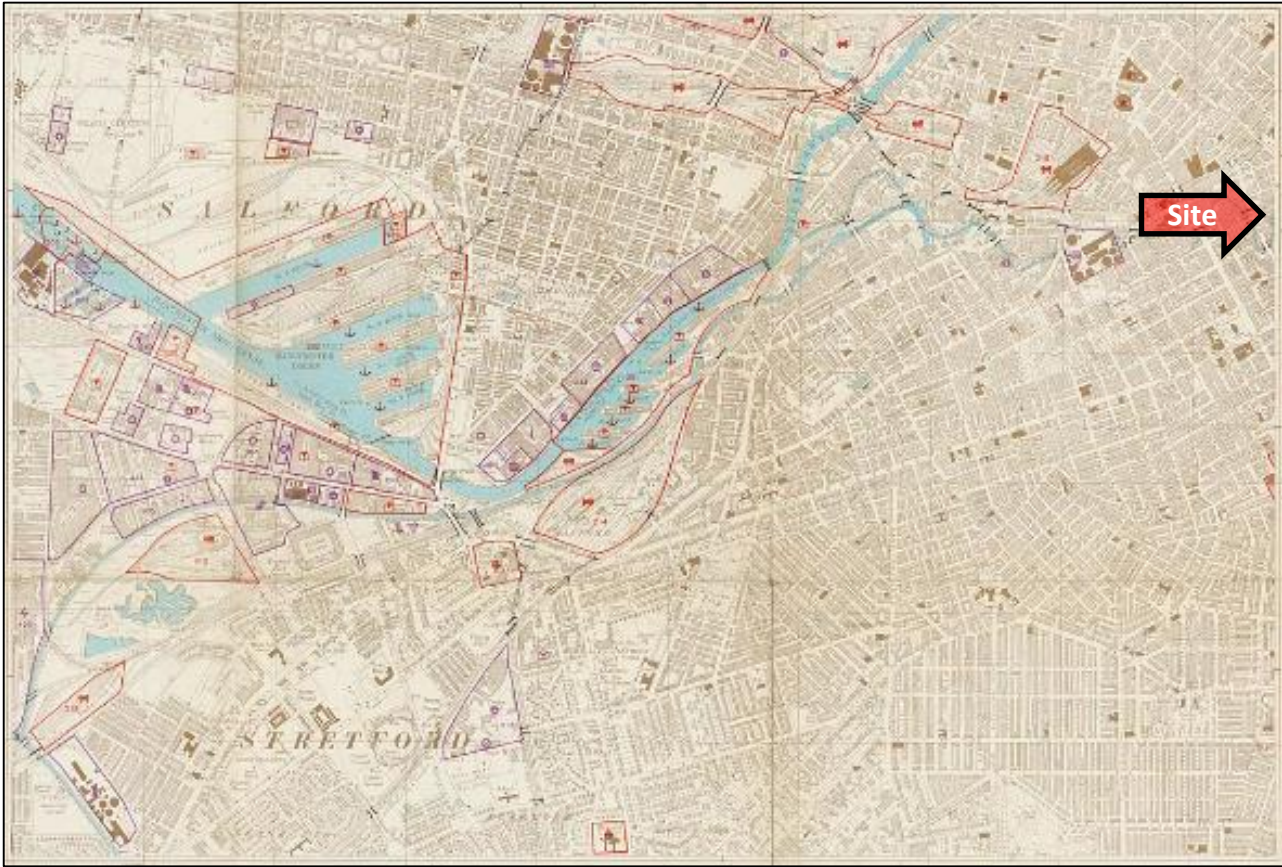
Police were forced to evacuate a number of buildings in **Manchester** city centre after an unexploded tank cartridge was found.

A military bomb disposal team was called in after the shell was uncovered on a building site in New Quay Street.

Greater Manchester Police (GMP) closed surrounding roads and told people to leave nearby flats and offices, including the former studios of Granada Television.







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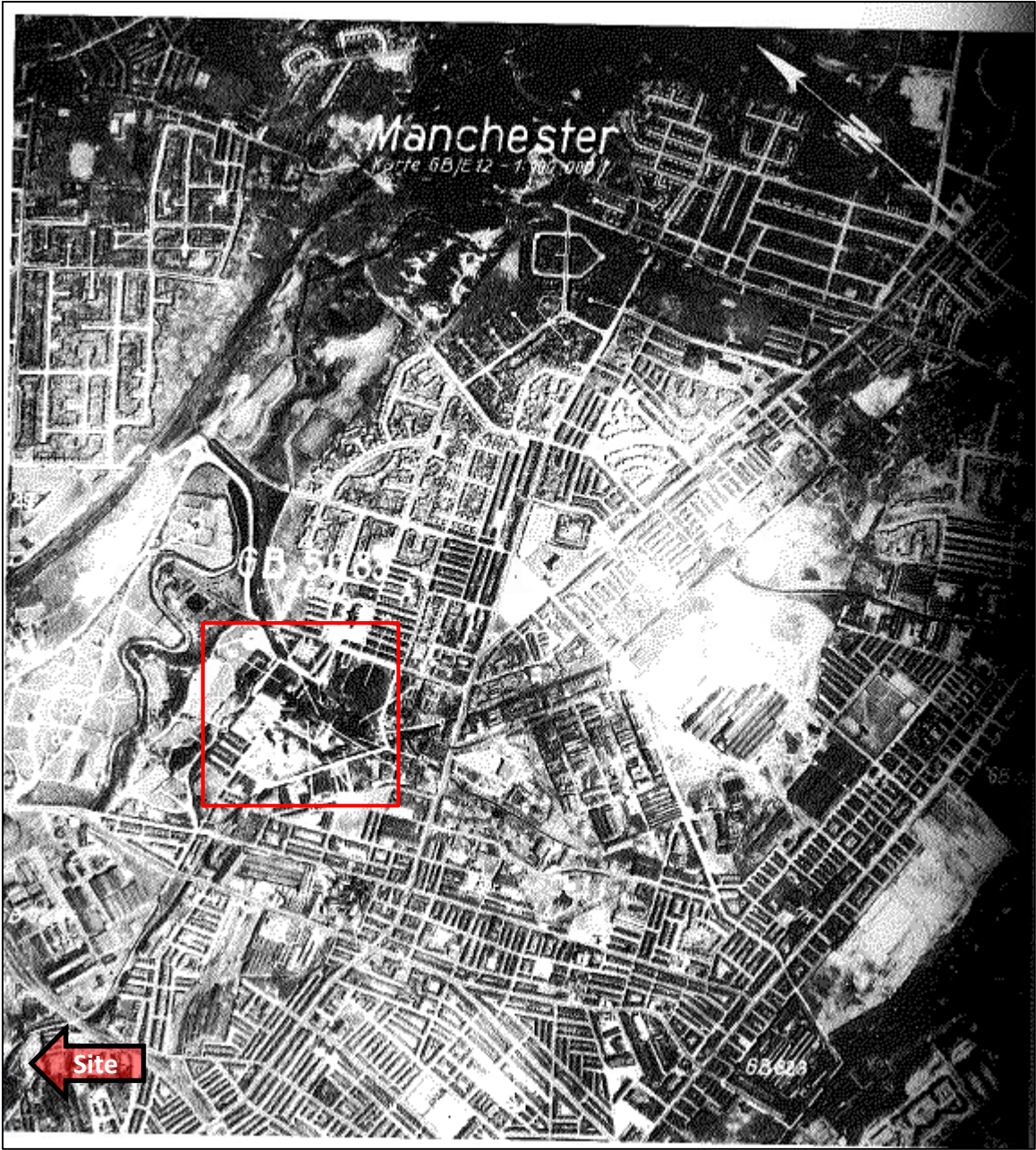
Ref: **DA14968-00**

Source: Nigel J. Clarke, "Adolf Hitler's Home Counties Holiday Snaps"

 **Approximate site boundary**



Luftwaffe Photograph, 1st October 1940



Manchester - Clayton
Red boxed area – gas works
GB 823 & GB 5083 – Designated Luftwaffe targets



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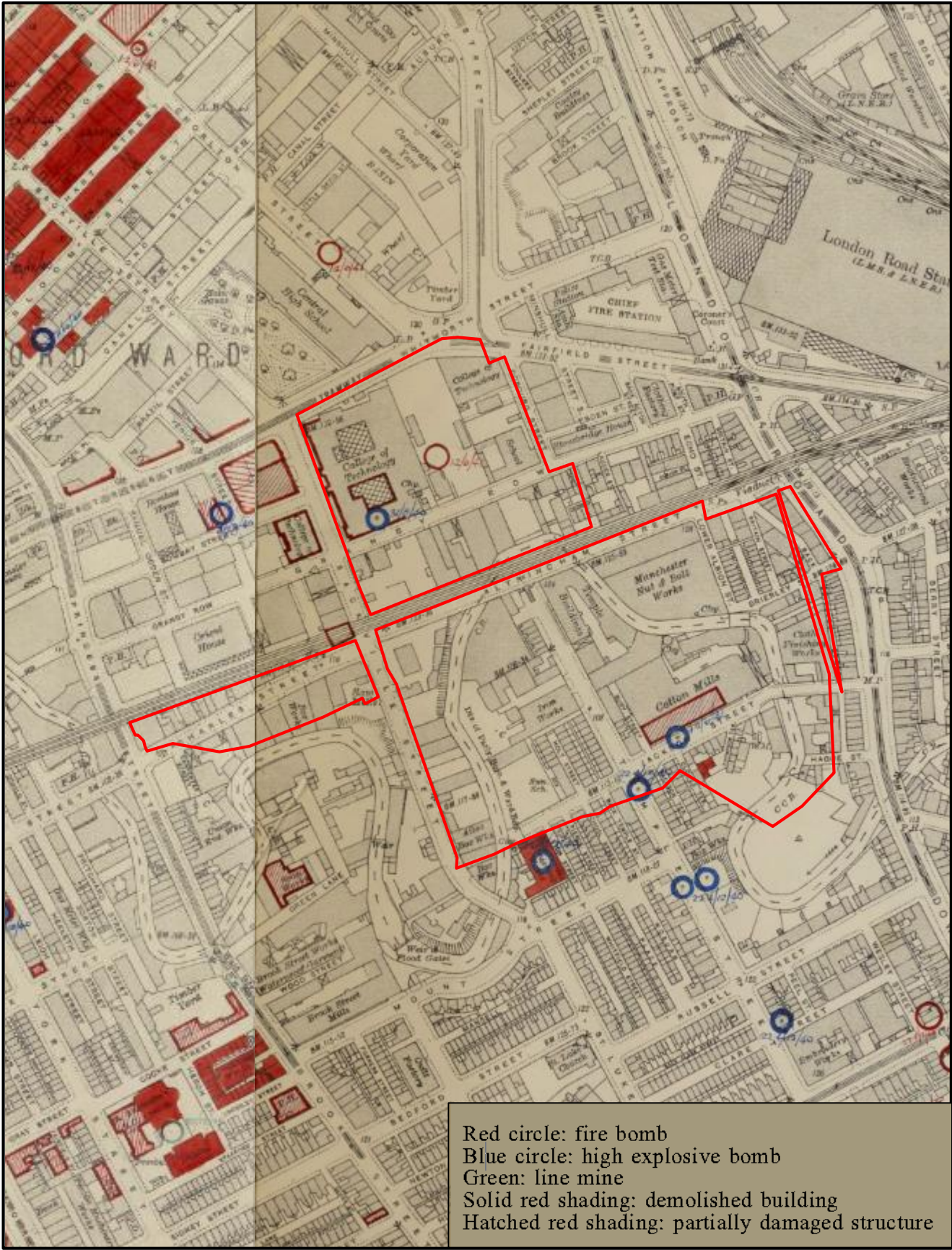
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Red circle: fire bomb
Blue circle: high explosive bomb
Green: line mine
Solid red shading: demolished building
Hatched red shading: partially damaged structure



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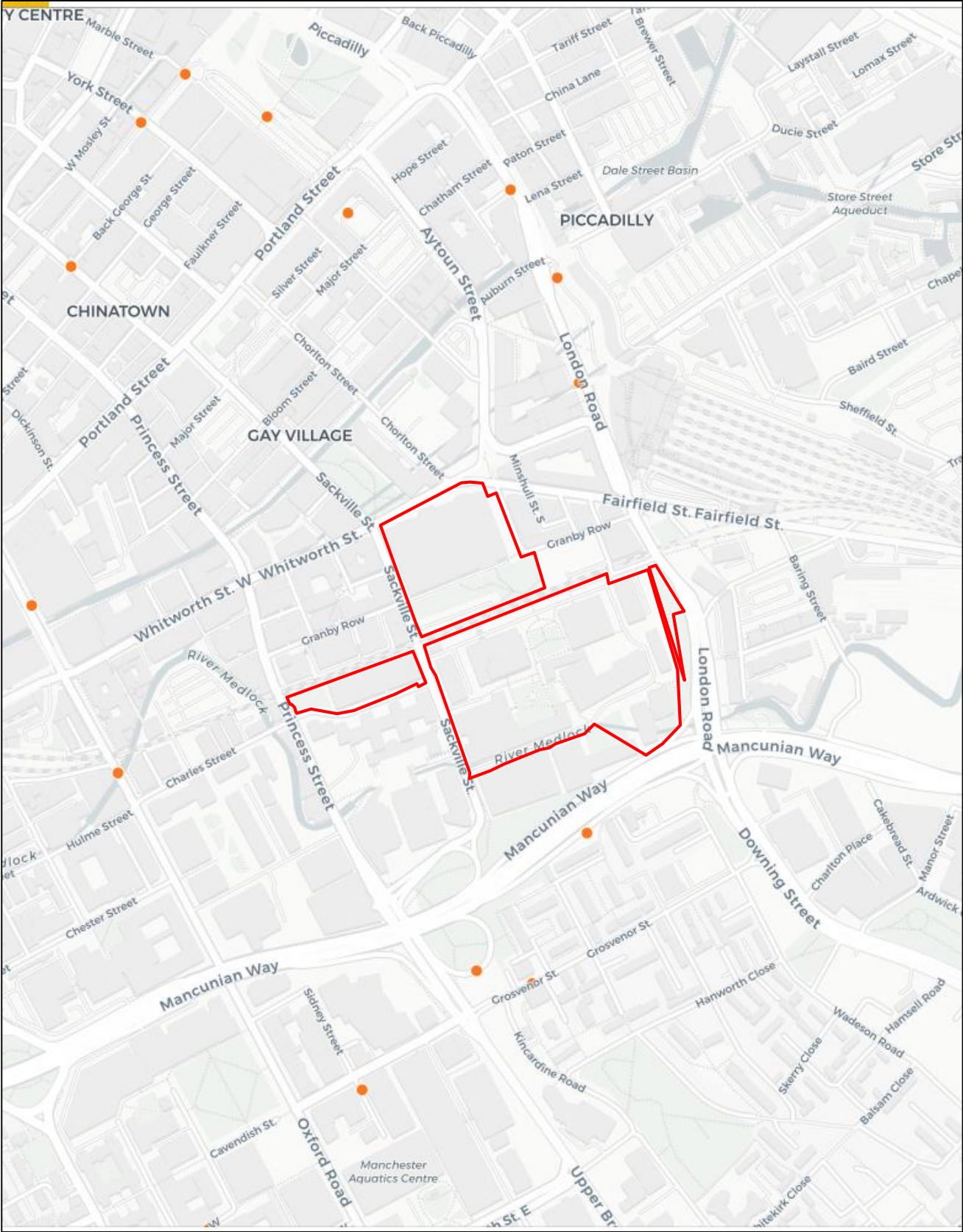
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Source: The National Archives, Kew

 **Approximate site boundary**





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Project: **ID Manchester**

Ref: **DA14968-00**

Source: Manchester Evening News

 **Approximate site boundary**



District <i>C</i>		<i>JACKSON STREET.</i>		Incident Date <i>11/6/41</i>									
Sector <i>3</i>		<i>COMM</i>		Date Inspected <i>21/6/41</i>									
Card No.		Continued on Card No.		Inspector <i>LABROURN.</i>									
No.	H. H. & S. F.	Classifica- tion	TENANT	EXTENT OF DAMAGE								Re- Classification	
				Roofs	Chimneys	Walls	Floors	Ceilings	Doors	Windows	Frames	Class	Date
<i>5</i>	<i>H</i>	<i>CA</i>	<i>x</i>	<i>H</i>				<i>H</i>		<i>G</i>			
<i>HERE IS THOMPSON TERRACE.</i>													
<i>7</i>	<i>H</i>	<i>CB</i>	<i>x</i>	<i>H</i>				<i>H</i>		<i>G D</i>			
<i>9</i>	<i>H</i>	<i>CB</i>	<i>x</i>	<i>H</i>				<i>H</i>		<i>G D</i>			
<i>11</i>	<i>H</i>	<i>CB</i>	<i>x</i>	<i>H</i>	<i>F</i>			<i>H</i>	<i>D</i>	<i>G D</i>			
<i>13</i>	<i>H</i>	<i>CB</i>	<i>x</i>	<i>H</i>	<i>F</i>			<i>H</i>	<i>D</i>	<i>G D</i>			
<i>15</i>	<i>H</i>	<i>B</i>	<i>x</i>	<i>D</i>									
<i>17</i>	<i>H</i>	<i>B</i>	<i>x</i>	<i>D</i>									
<i>19</i>	<i>H</i>	<i>CB</i>	<i>x</i>	<i>H</i>				<i>H</i>	<i>H</i>	<i>D G D</i>			
<i>HERE IS CLOWES TERRACE.</i>													
<i>21</i>	<i>H</i>	<i>B</i>	<i>x</i>	<i>D</i>		<i>D P</i>							
<i>23</i>	<i>H</i>	<i>B</i>	<i>x</i>	<i>D</i>		<i>D</i>							
<i>HERE IS JACKSON TERRACE</i>													
<i>25</i>	<i>H</i>	<i>B</i>	<i>x</i>	<i>D</i>		<i>D</i>							
<i>27</i>	<i>H</i>	<i>B</i>	<i>x</i>	<i>H</i>	<i>F</i>	<i>F</i>	<i>H</i>	<i>D</i>		<i>G D</i>			
<i>HERE IS TENNIS STREET</i>													
<i>35</i>	<i>H</i>	<i>D-E</i>	<i>x</i>	<i>H</i>				<i>S</i>		<i>G</i>			
<i>37</i>	<i>H</i>	<i>D-E</i>	<i>x</i>	<i>H</i>				<i>S</i>		<i>G</i>			
<i>39</i>	<i>H</i>	<i>E</i>	<i>x</i>							<i>G</i>			
<i>41</i>	<i>H</i>	<i>E</i>	<i>x</i>							<i>G</i>			
<i>43</i>	<i>H</i>	<i>E</i>	<i>x</i>							<i>G</i>			
				<i>6</i>	<i>5</i>	<i>1</i>	<i>2</i>	<i>3</i>					



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Project: **ID Manchester**

Ref: **DA14968-00**

Source: **Manchester Central Library**

District <i>C</i>			<i>TEMPLE STREET.</i>							Incident Date <i>11 6 41</i>				
Sector <i>3</i>										Date Inspected <i>21 6 41</i>				
Card No.			Continued on Card No.							Inspector <i>L.H. BRADMAN</i>				
No.	H. H. & S. F.	Classifica- tion	TENANT	EXTENT OF DAMAGE								Re- Classification		
				Roofs	Chimneys	Walls	Floors	Ceilings	Doors	Windows	Frames	Class	Date	
<i>- 14</i>	<i>H</i>	<i>D+E</i>	<i>MRS. SPINDOLLS.</i>							<i>D</i>	<i>9</i>	<i>D</i>		
<i>- 16</i>	<i>H</i>		<i>X EMPTY. NIL.</i>											
<i>- 18</i>	<i>H</i>	<i>D+E</i>	<i>X</i>							<i>D</i>	<i>9</i>	<i>D</i>		
<i>20-22</i>			<i>ENGINEERS WORKS</i>											
<i>- 24</i>	<i>H</i>	<i>D+E</i>	<i>Mrs CHETHAM.</i>	<i>S</i>				<i>S</i>			<i>9</i>			
<i>- 26</i>	<i>H</i>	<i>D+E</i>	<i>X</i>	<i>S</i>				<i>S</i>			<i>9</i>			
<i>- 28</i>	<i>H</i>	<i>D+E</i>	<i>McKEW.</i>	<i>S</i>				<i>S</i>			<i>9</i>			
<i>- 30</i>	<i>H</i>	<i>D+E</i>	<i>CANTON FOR RUBINSON & CO. LONDON.</i>											
<i>- 32</i>	<i>H</i>	<i>D+E</i>	<i>Mrs DOCKER.</i>	<i>S</i>				<i>S</i>			<i>9</i>			
<i>- 34</i>	<i>H</i>	<i>D+E</i>	<i>Mrs CUNNINGHAM.</i>	<i>S</i>				<i>S</i>			<i>9</i>			
			<i>=</i>											
<i>52</i>	<i>H+S</i>	<i>D+E</i>	<i>WHITTLE.</i>	<i>S</i>							<i>9</i>			
<i>54</i>	<i>H</i>	<i>D+E</i>	<i>X</i>	<i>S</i>							<i>9</i>			
<i>56</i>	<i>H</i>	<i>D+E</i>	<i>X SILK.</i>	<i>S</i>					<i>D</i>		<i>9</i>			

CODE REFERENCE			
D = Demolished	F = Fractured	G = Glazing	H = Holed
O = Off or Displaced	P = Plastering	S = Slight	U = Unsafe



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Client: NX Consulting	
Project: ID Manchester	
Ref: DA14968-00	Source: Manchester Central Library

5011 [4378]				CITY OF MANCHESTER CITY ARCHITECT'S DEPARTMENT RETURN OF WAR DAMAGE TO PROPERTY		FOR OFFICE USE ONLY PART 3 SHEET No. 694	
LOCATION 12 Charles St & Sackville St b-on-ck.		DIST. North Side	DATE 22/12/40	TYPE BOMB HE	IF ESSENTIAL BLDG. STATE TYPE		
* DESCRIPTION OF PROPERTY Workshop.			FULL ADDRESS AND LOCALITY A & P Stevens 12 Charles St. off Sackville St. b-on-ck.				
INDICATION OF EXTENT OF DAMAGE							
ROOF Extensive Damage Glas, glass etc.	WALLS No Damage	FLOORS No Damage.	* GENERALLY Glas & glass damaged caused by Blast.				
DAMAGE TO CONTENTS Nil.			INDICATION OF DANGEROUS STATE IF ANY No Danger.				
* TYPE OF DAMAGE C(a)			DATE 28/1/42	TIME	INSPECTOR J. R. Newhouse		

[4378]				CITY OF MANCHESTER CITY ARCHITECT'S DEPARTMENT RETURN OF WAR DAMAGE TO PROPERTY		FOR OFFICE USE ONLY PART SHEET No. ✓	
OWNER Buttsworth Clifford & Co 1 Charles Street		OCCUPIER	DATE 1/2-6-41	TYPE BOMB HE	IF ESSENTIAL BLDG. STATE TYPE		
* DESCRIPTION OF PROPERTY Sawmills & Offices			FULL ADDRESS AND LOCALITY Buttsworth, Clifford & Co 1 Charles Street, Manchester.				
INDICATION OF EXTENT OF DAMAGE							
ROOF No damage	WALLS No damage	FLOORS No damage	* GENERALLY Blast damage to windows				
DAMAGE TO CONTENTS			INDICATION OF DANGEROUS STATE IF ANY				
TYPE OF DAMAGE E			DATE 27-7-41	TIME	INSPECTOR G. F. Peak		



1ST LINE DEFENCE

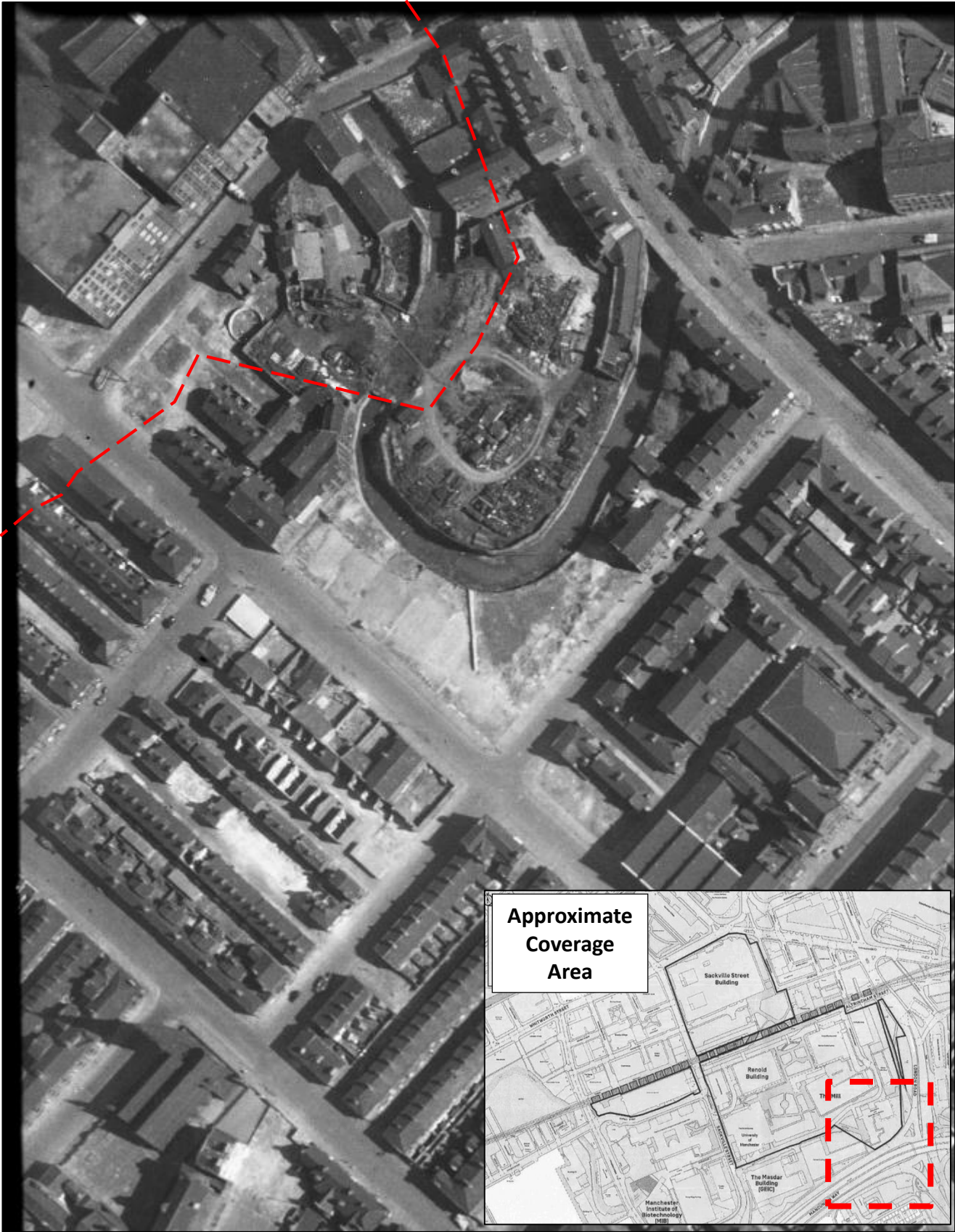
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Approximate Coverage Area



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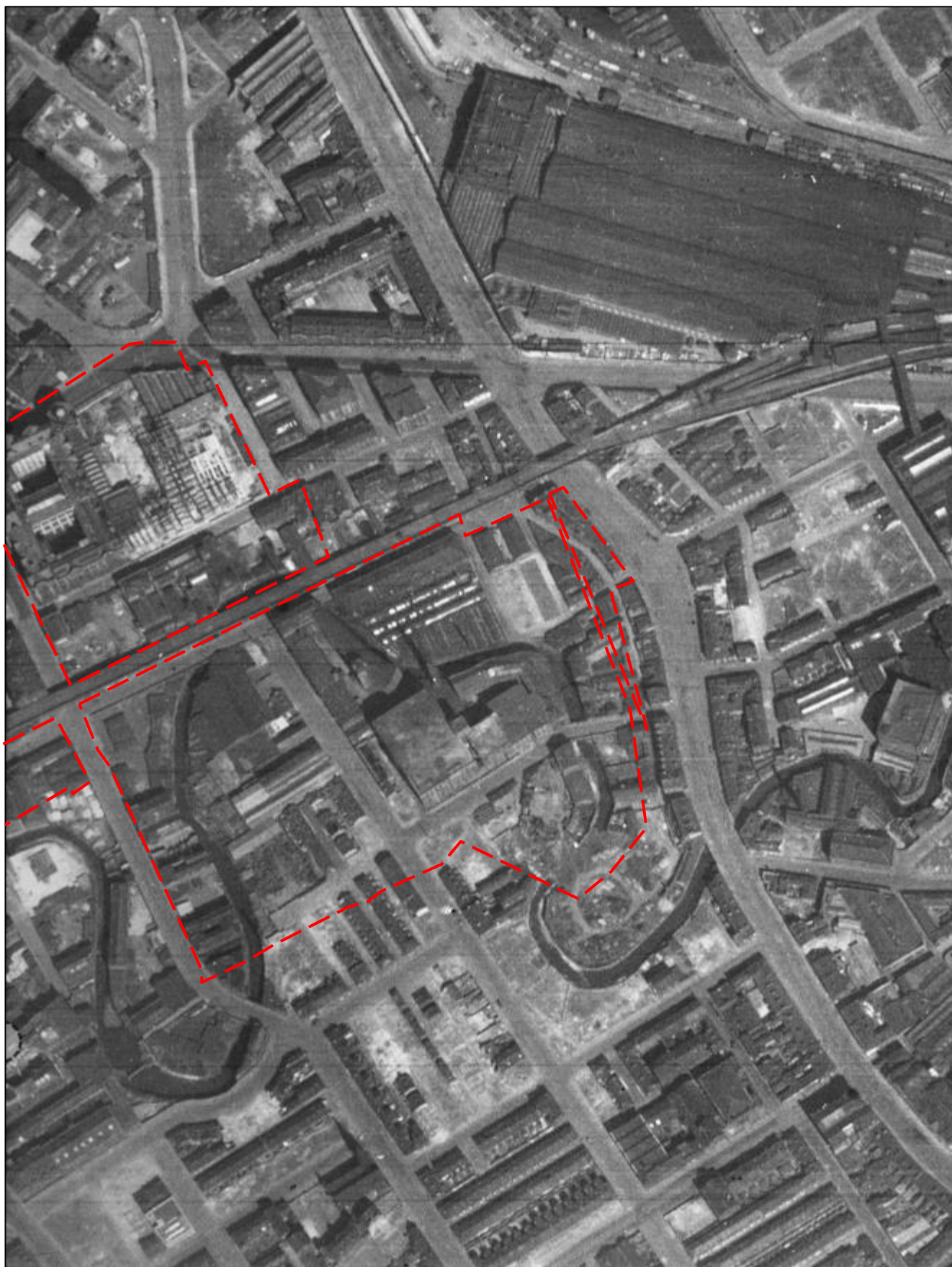
Project: **ID Manchester**

Ref: **DA14968-00**

Source: National Monuments Record Office (Historic England)

 Approximate site boundary





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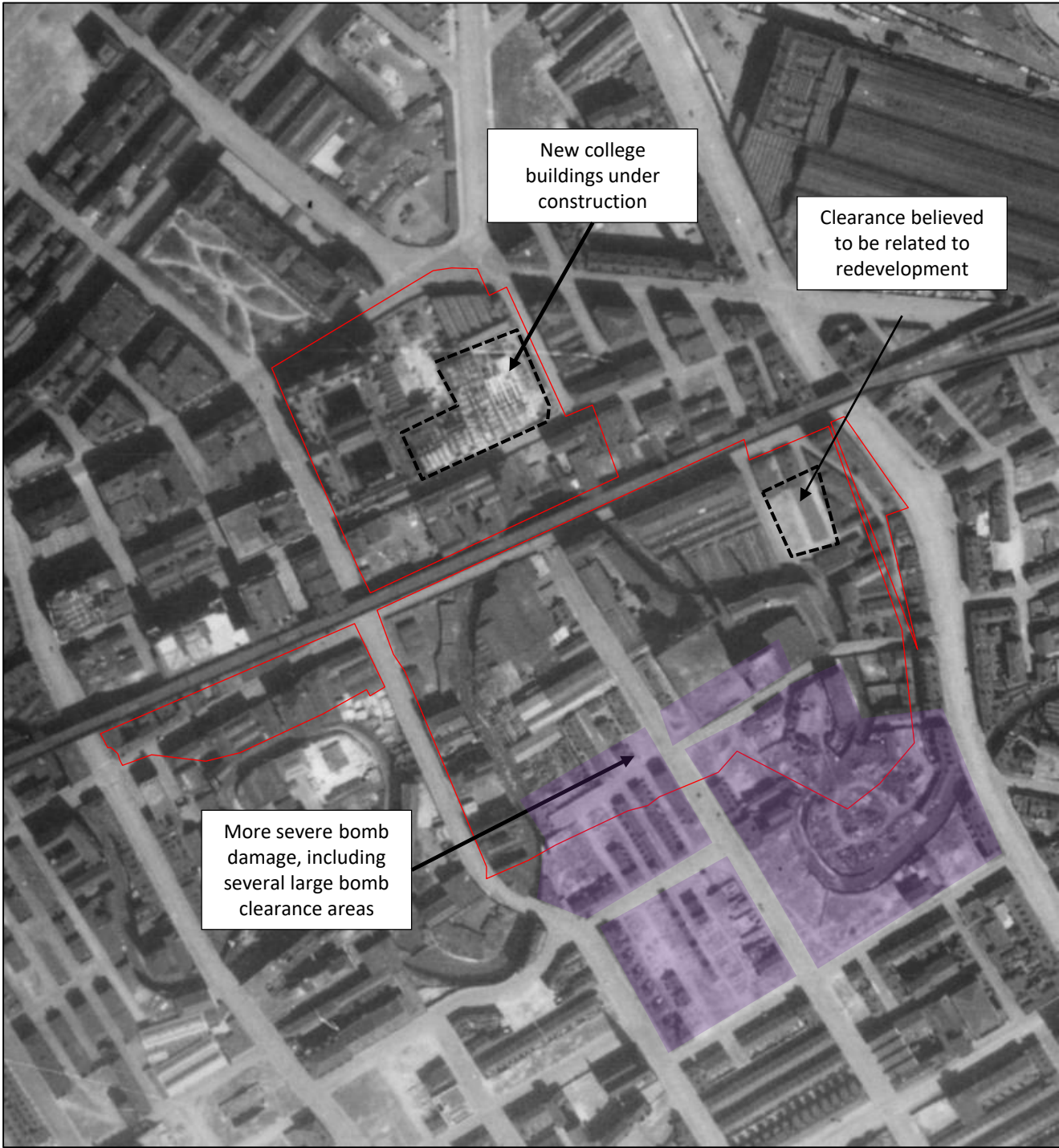
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 **Approximate site boundary**





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 **Approximate site boundary**





For indicative purposes – not to scale.
Please note that this assessed risk map may not take into account all post-war redevelopment/excavations on site.

- Low Risk
- Medium Risk

- All Risk Areas:**
- Site Specific Unexploded Ordnance Awareness Briefings to all personnel conducting intrusive works
 - UXO Risk Management Plan
- Medium Risk Area:**
- Unexploded Ordnance (UXO) Specialist Presence on Site to support shallow intrusive works
 - Intrusive Magnetometer Survey of all Borehole and pile locations down to a maximum bomb penetration depth



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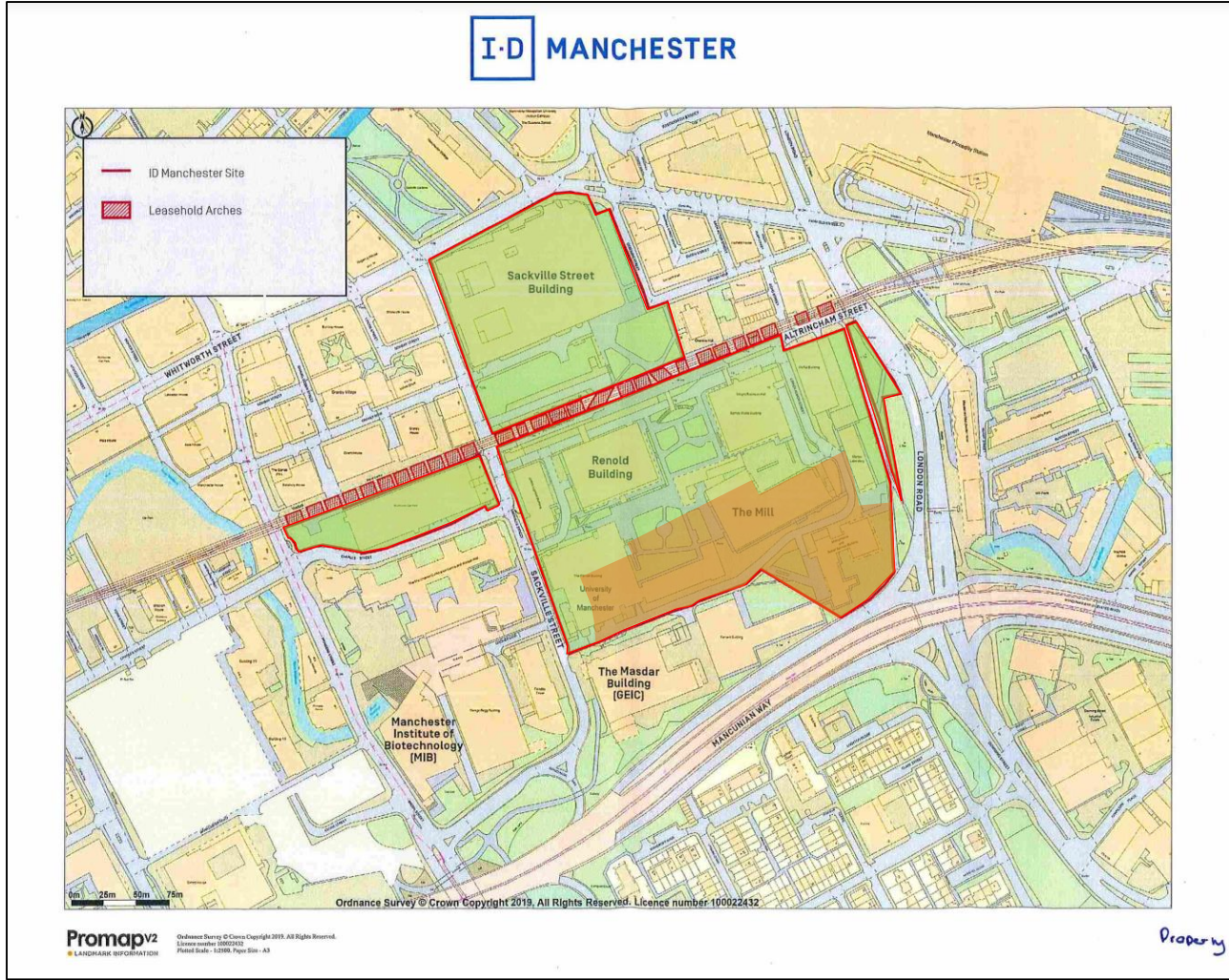
Project: **ID Manchester**

Ref: **DA14968-00**

Source: 1st Line Defence

— Approximate site boundary





For indicative purposes – not to scale.
Please note that this assessed risk map may not take into account all post-war redevelopment/excavations on site.

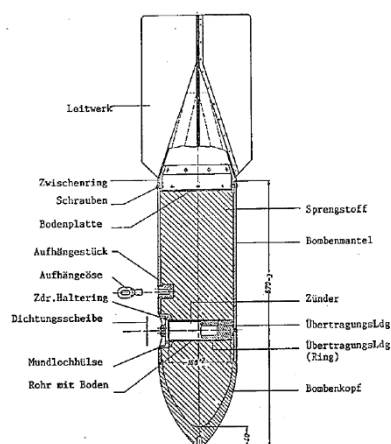
- Low Risk
- Medium Risk

- All Risk Areas:**
- Site Specific Unexploded Ordnance Awareness Briefings to all personnel conducting intrusive works
 - UXO Risk Management Plan
- Medium Risk Area:**
- Unexploded Ordnance (UXO) Specialist Presence on Site to support shallow intrusive works
 - Intrusive Magnetometer Survey of all Borehole and pile locations down to a maximum bomb penetration depth

Examples of German Bombs - HE

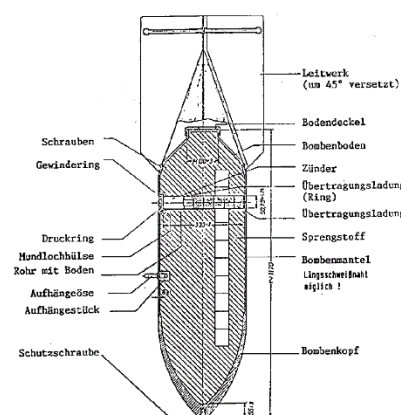
SC 50kg

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.



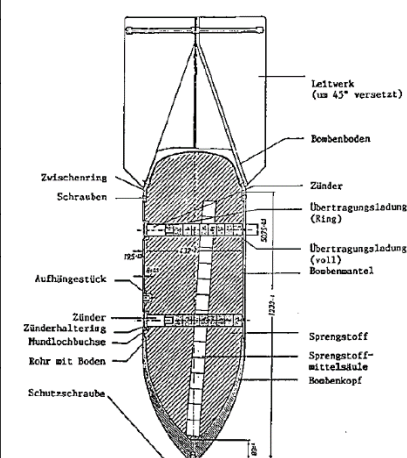
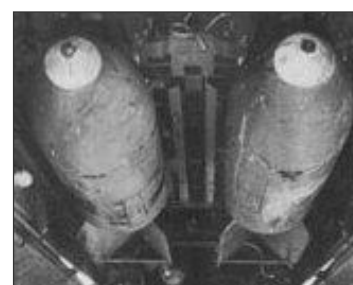
SC 250kg

Bomb Weight	245-256kg (540-564lb)
Explosive Weight	125-130kg (276-287lb)
Fuze Type	Electrical impact/mechanical time delay fuze.
Bomb Dimensions	1640 x 512mm (64.57 x 20.16in)
Body Diameter	368mm (14.5in)
Use	Against railway installations, embankments, flyovers, underpasses, large buildings and below-ground installations.
Remarks	It could be carried by almost all German bomber aircraft, and was used to notable effect by the Junkers Ju-87 Stuka (Sturzkampfflugzeug or dive-bomber).



SC 500kg

Bomb Weight	480-520kg (1,058-1,146lb)
Explosive Weight	250-260kg (551-573lb)
Fuze Type	Electrical impact/mechanical time delay fuze.
Bomb Dimensions	1957 x 640mm (77 x 25.2in)
Body Diameter	470mm (18.5in)
Use	Against fixed airfield installations, hangars, assembly halls, flyovers, underpasses, high-rise buildings and below-ground installations.
Remarks	40/60 or 50/50 Amatol TNT, trialene. Bombs recovered with Trialene filling have cylindrical paper wrapped pellets 1-15/16 in. in length and diameter forming



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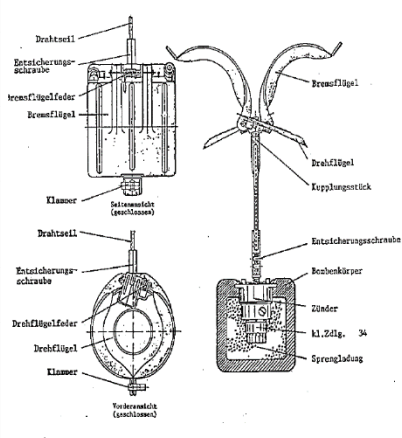
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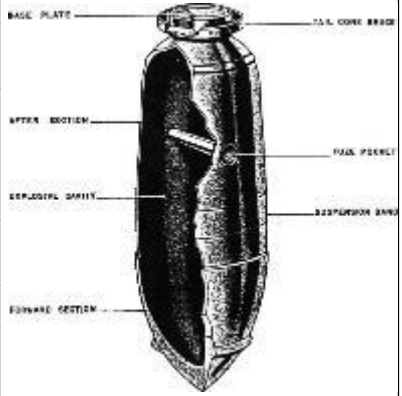
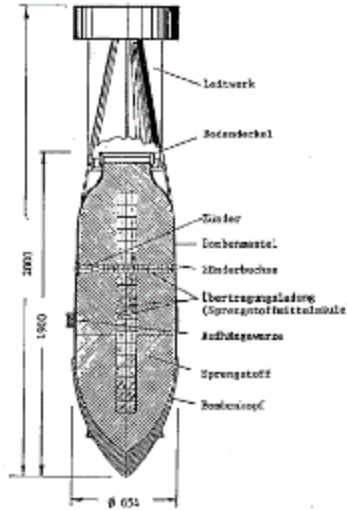
SD2 Butterfly Bomb

Bomb Weight	2kg (4.41lb)			
Explosive Weight	7.5oz (212.6 grams) of TNT surrounded by a layer of bituminous composition.			
Fuze Type	41 fuze (time) , 67 fuze (clockwork time delay) or 70 fuze (anti-handling device)			
Bomb Dimensions	Length 240 mm Width 140 mm Height 310 mm			
Body Diameter	3in (7.62 cm) diameter, 3.1in (7.874) long			
Use	It was designed as an anti-personnel/fragmentation weapon. They were delivered by air, being dropped in containers that opened at a predetermined height, thus scattering the bombs.			
Remarks	The smallest and most common conventional German bomb. Nearly 70% of bombs dropped on the UK were 50kg.			

Parachute Mine (Luftmine B / LMB)

Bomb Weight	987.017kg (2176lb)		
Explosive Weight	125-130kg (276-287lb)		
Fuze Type	Impact/ Time delay / hydrostatic pressure fuze		
Bomb Dimensions	1640 x 512mm (64.57 x 20.16in)		
Body Diameter	368mm (14.5in)		
Use	Against civilian, military and industrial targets. Designed to detonate above ground level to maximise damage to a wider area.		
Remarks	Parachute Mines were normally carried by HE 115 (Naval operations), HE 111 and JU 88 aircraft types. Deployed a parachute when dropped in order to control its descent.		

SC 1000kg

Bomb Weight	996-1061kg (1,058-1,146lb)			
Explosive Weight	530-620kg (551-573lb)			
Fuze Type	Electrical impact/mechanical time delay fuze.			
Filling	Mixture of 40% amatol and 60% TNT, but when used as an anti-shipping bomb it was filled with Trialen 105, a mixture of 15% RDX, 70% TNT and 15% aluminium powder.			
Bomb Dimensions	2800 x 654mm (77 x 25.2in)			
Body Diameter	654mm (18.5in)			
Use	SC type bombs are General Purpose Bombs used primarily for general demolition work. Constructed of parallel walls with comparatively heavy noses. They are usually of three piece welded construction			

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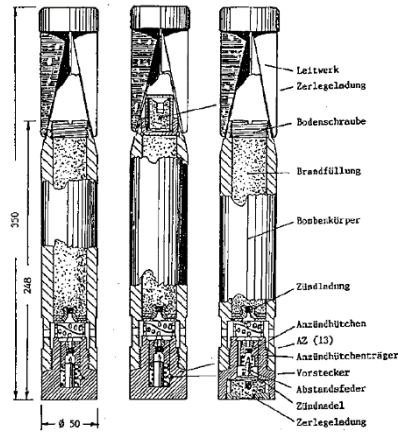
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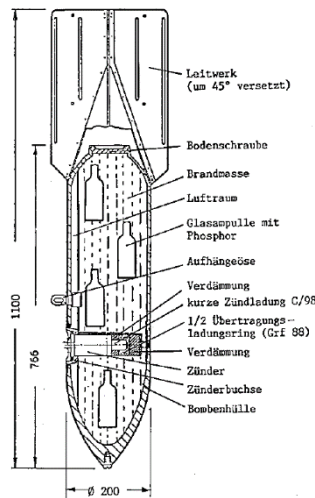
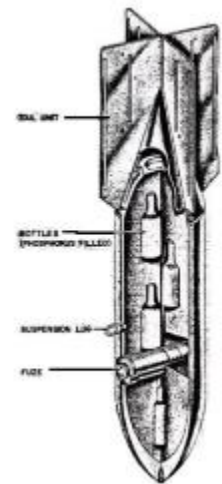
1kg Incendiary Bomb

Bomb Weight	1.0 and 1.3kg (2.2 and 2.87lb)
Explosive Weight	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	Magnesium alloy case. Sometimes fitted with high explosive charge. The body is a cylindrical alloy casting threaded internally at the nose to receive the fuze holder and fuze.



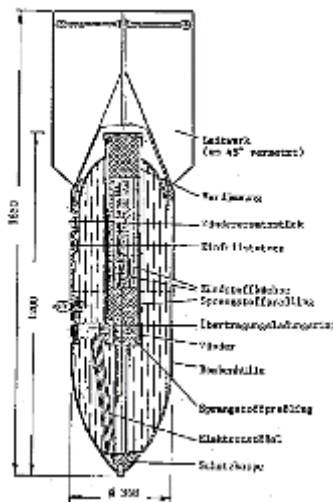
C50 A Incendiary Bomb

Bomb Weight	c41kg (90.4lb)
Explosive Weight	0.03kg (0.066lb)
Incendiary Filling	12kg (25.5lb) liquid filling with phosphor igniters in glass phials. Benzine 85%; Phosphorus 4%; Pure Rubber 10%
Fuze Type	Electrical impact fuze
Bomb Dimensions	1,100 x 280mm (43.2 x 8in)
Use	Against all targets where an incendiary effect is to be expected
Remarks	Early fill was a phosphorous/carbon disulphide incendiary mixture



Flam C-250 Oil Bomb

Bomb Weight	125kg (276lb)
Explosive Weight	1kg (2.2lb)
Fuze Type	Super-fast electrical impact fuze
Filling	Mixture of 30% petrol and 70% crude oil
Bomb Dimensions	1,650 x 512.2mm (65 x 20.2in)
Body Diameter	368mm (14.5in)
Use	Often used for surprise attacks on living targets, against troop barracks and industrial installations. Thin casing – not designed for ground penetration



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QF 3.7 Inch WWII Anti-Aircraft Projectile

Projectile Weight	28lb (12.6 kg)
Explosive Weight	2.52lbs
Fuze Type	Mechanical Time Fuze
Dimensions	3.7in x 14.7in (94mm x 360mm)
Rate of Fire	10 to 20 rounds per minute
Use	High Explosive Anti-Aircraft projectile. 4.5in projectiles were also used in this role.
Ceiling	30,000ft to 59,000ft



40mm Bofors Projectile

Projectile Weight	1.96lb (0.86kg)
Explosive Weight	300g (0.6lb)
Fuze Type	Proximity and Mechanical Time Fuze
Rate of Fire	120 rounds per minute
Projectile Dimensions	40mm x 310mm (1.6in x 12.2in)
Ceiling	23,000ft (7000m)



Unrotated Projectile (UP) – Z Battery

Projectile Weight	84lb (24.5kg)
Warhead Weight	4.28lb (1.94kg)
Warhead	Aerial Mine with a No. 700 / 720 fuze
Filling	High Explosive
Dimensions	1930mm x 82.6mm (76 x 3.25in)
Use	As a short range rocket-firing anti-aircraft weapon developed for the Royal Navy. It was used extensively by British ships during the early days of World War II. The UP was also used in ground-based single and 128-round launchers known as Z Batteries.



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