

Detailed Unexploded Ordnance (UXO) Risk Assessment

Project Name	Great Northern Warehouse, Manchester
Client	GNW Developments Limited
Site Address	Great Northern Warehouse, 235 Deansgate, Manchester M3 4EN
Report Reference	DA15420-01
Date	9th November 2022
Originator	EG

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Executive Summary

Site Location and Description

The site is located in the City Centre of Manchester.

The site is bordered to the north by Peter Street and to the east by Watson Street. South of the site is Great Bridgewater Street and west of the site is Deansgate/A56.

Within the wider area is Manchester Central Convention Complex/NHS Nightingale Hospital North West east of the site and Beetham Tower south of the site.

The site is occupied by the Great Northern Warehouse, a leisure and entertainment complex.

The site is approximately centred on the OS grid reference: **SJ 83544 97814**.

Proposed Works

Information provided by the client indicates the proposed works to include the redevelopment of the Great Northern Warehouse and Deansgate Terrace, for office space and leisure uses, residential and leisure facilities development at Leisurebox; including car parking, and the redevelopment of public space at Great Northern Square.

Geology and Bomb Penetration Depth

The British Geological Survey (BGS) map shows the site to be underlain by multiple bedrock geology including Manchester Marls Formation- Mudstone in the north-east of the site. Sedimentary Bedrock formed approximately 252 to 272 million years ago in the Permian Period. The remainder of the site was occupied was underlain by Chester Formation- Sandstone. Sedimentary bedrock formed approximately 247 to 250 million years ago in the Triassic Period. Within the west of the site, superficial deposits are recorded as Glaciofluvial Sheet Deposits- sand and gravel. Superficial deposits formed up to 2 million years ago in the Quaternary Period.

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

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

UXO Risk Assessment

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

German Aerial-Delivered Ordnance

- During WWII, the site was situated within the County Borough of Manchester, which was subject to an overall low density of bombing, culminating in an average of 27.1 items of ordnance falling per 1,000 acres of land, according to official Home Office statistics. Whilst Manchester did not sustain the intense bombing campaign that other cities such as London and Coventry experienced, the area was still subject to a number of significant targeted bombing raids between 1940 and 1941. Luftwaffe target mapping indicates that Manchester Central Station and associated railway structures were a primary target located east of the site, across Watson Street.
- During WWII, the site was occupied by *Great Northern Railway Goods Station*. An area of open hard-standing ground was located in the north of the site and railway sidings were situated in the south of the site. A number of smaller structures bordered the site to the north and west.
- Whilst a number of incendiary incidents are recorded in the surrounding vicinity, the Manchester Bomb Census and Damage Map and a Christmas Blitz bomb map record no incidents within the site footprint. The closest incidents are recorded as an incendiary bomb plotted west of the site on Deansgate to Church House on the 22nd December 1940, situated approximately 20m west of the site.

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UXO Risk Assessment

- No damage is recorded *at Deansgate Goods Station* within the Manchester Bomb Census and Damage map. To corroborate with this, no damage is visible within 1946 aerial photography. Structures appear intact and no evidence of white roofing indicative of damage is visible to any of the structures within the site footprint.
- It is anticipated that the site would have been regularly accessed throughout the war and that this access would not have been impeded - no bombing or damaged buildings are recorded on site in the available records. The site was occupied by structures including Deansgate Goods Station, which in its day was considered one of the largest and most advanced railway exchanges in the country. Trains continued to run throughout WWII – thus the site would have been regularly observed and checked to ensure trains could continue to operate.
- Moreover, the site footprint also contained GNR offices on Peter Street and a development of 34 shops with offices and warehouses above them along Deansgate. Given the lack of evidence to suggest that these structures had been damaged during the war, it is likely that these shops and offices would have continued to function as normal. This increases the likelihood that a UXB would have been spotted and subsequently removed. Any unexploded ordnance falling on the open areas of undamaged sidings are also thought likely to have left evidence of their presence – buckled track, disturbed ballast etc.
- In summary, no positive evidence of bombing or damage could be found within the site footprint. Despite, the urban location of the site, and its position as a Luftwaffe target adjacent to Manchester Central Station, no bombing incidents are recorded to have directly affected the site. No damage is visible within aerial photography, and no missing structures are present on post-WWII OS mapping. As such, the site has been deemed at **Low Risk** for German aerial delivered and anti-aircraft UXO.

The Risk From Allied Ordnance

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

Post-War Development

- In 1954, the Warehouse ceased operating and closed. The main body of the Warehouse remains, with the site redeveloped into an extensive leisure and retail complex in the late 1990s/early 2000s. In addition, buildings situated within the northern section of the site adjacent to Peter Street were cleared and redeveloped into Great Northern Square.
- 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 Great Northern Warehouse, Manchester:

All Works

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

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Glossary

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

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1st Line Defence Limited
Detailed Unexploded Ordnance (UXO) Risk Assessment

Site: Great Northern Warehouse, Manchester
Client: GNW Developments Limited

1. Introduction

1.1. Background

1st Line Defence has been commissioned by GNW Developments Limited to conduct a Detailed Unexploded Ordnance (UXO) Risk Assessment for the works proposed at Great Northern Warehouse, Manchester.

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

UXO in the UK can originate from three principal sources:

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

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

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

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2. Method Statement

2.1. Report Objectives

The aim of this report is to conduct a comprehensive assessment of the potential risk from UXO at Great Northern Warehouse, 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 GNW Developments Limited.
- 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.

Research involved a visit to The National Archives and Manchester Central Library.

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3. Background to Bombing Records

3.1. General Considerations of Historical Research

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

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

3.2. German Bombing Records

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

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

3.3. Allied Records

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

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

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4. UK Regulatory Environment and Guidelines

4.1. General

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

4.2. CDM Regulations 2015

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

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

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

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

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

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

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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.

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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.

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6. The Site

6.1. Site Location

The site is located in the City Centre of Manchester.

The site is bordered to the north by Peter Street and to the east by Watson Street. South of the site is Great Bridgewater Street and west of the site is Deansgate/A56.

Within the wider area is Manchester Central Convention Complex/NHS Nightingale Hospital North West east of the site and Beetham Tower south of the site.

The site is approximately centred on the OS grid reference: **SJ 83544 97814**.

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

6.2. Site Description

The site is occupied by the Great Northern Warehouse, a leisure and entertainment complex.

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 indicates the proposed works to include the redevelopment of the Great Northern Warehouse and Deansgate Terrace, for office space and leisure uses, residential and leisure facilities development at Leisurebox; including car parking, and the redevelopment of public space at Great Northern Square.

8. Ground Conditions

8.1. General Geology

The British Geological Survey (BGS) map shows the site to be underlain by multiple bedrock geology including Manchester Marls Formation- Mudstone in the north-east of the site. Sedimentary Bedrock formed approximately 252 to 272 million years ago in the Permian Period. The remainder of the site was occupied was underlain by Chester Formation- Sandstone. Sedimentary bedrock formed approximately 247 to 250 million years ago in the Triassic Period. Within the west of the site, superficial deposits are recorded as Glaciofluvial Sheet Deposits- sand and gravel. Superficial deposits formed up to 2 million years ago in the Quaternary Period.

8.2. Site Specific Geology

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

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9. Site History

9.1. Introduction

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

9.2. Summary of the Historical Background of the Site

The Great Northern Railway Company's Goods Warehouse was built between 1896-1898. The Warehouse was a unique three-way railway goods exchange station, serving the railway, canal and road networks of Manchester. Nine acres of streets were cleared to make way for it, with the Warehouse completed in August 1899. It was the last and largest railway warehouse to be built in Manchester.

The Warehouse also consisted of a combined goods station with associated high and low-level marshalling yards and a carriage ramp for transporters access. Inside the Warehouse was a spaghetti junction of rail lines with five platforms and twenty five cranes. It consisted of five storeys and it was built to be fully fireproof – the main building is of steel-framed construction with brick jack arches and walls of red brick with blue brick bands, under a slate roof. The Warehouse was built above the Manchester and Salford Junction Canal, below which was a dock used as a transhipment area with four large bays. Two lift shafts carried goods from the canal level to the railway and warehouse levels. Goods were transferred to and from canal barges via shafts and hydraulic power. The canal was closed in 1922, partly filled and a small section of the tunnel between Brunswick Basin and Watson Street which was used as an air-raid shelter during 1940-1945.

9.3. 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**
1932-1933	1:2,500	Pre-WWII OS mapping indicates the majority of the site was occupied by G*.N.R. Goods Station,* with railway sidings situated in the southern section of the site. An area of open ground was situated within the northern section of the site, with a number of smaller structures were situated within the northern and western border of the site. The site was bordered to the north by *Peter Street* and to the east by Watson Street. South of the site was *Great Bridgewater Street* and west of the site was *Deansgat*e/ *Roman Road*. *Cheshire Line Railway Goods Station* and *Central Station* was situated east of the site.

Post-WWII		
Date	**Scale**	**Description**
1950-1951	1:2,500	This map indicates the site to have mostly remained the same, occupied by *Deansgate Goods Section*.

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9.4. 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 Central Railway Station, slum clearance around George Street and the city, Manchester 1937	This photograph presented in **Annex E,** shows a view of the site from the south-east. This photograph indicates the site was occupied by a large warehouse in the north and railway sidings in the south of the site. The photograph indicates the site was situated within a densely packed urban area, of central Manchester. A railway station was situated to the east of the site.

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10. Introduction to German Aerial Delivered Ordnance

10.1. General

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

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

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

10.2. Generic Types of WWII German Aerial Delivered Ordnance

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

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10.3. Failure Rate of German Aerial Delivered Ordnance

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

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

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

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10.4.3. Site Specific Bomb Penetration Considerations

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

- WWII geology –Chester Formation and Manchester Marls 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 an UXO Specialist on-site.

10.5. V-Weapons

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

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

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

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11. The Likelihood of Contamination from German Aerial Delivered UXBs

11.1. World War I

During WWI Britain was targeted and bombed by Zeppelin Airships as well as Gotha and Giant fixed-wing aircraft. 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 the site area.

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

11.2. World War II Bombing of the County Borough of Manchester

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

During WWII the site was located within the County Borough of Manchester, which sustained an overall low density of bombing, as represented by bomb density data figures below. Manchester was not targeted with the same intensity and frequency as other major British cities such as Liverpool, Coventry and Birmingham, however it was still subject to several major raids. The Manchester Blitz was commonly called the 'Christmas Blitz'. Raids began in August and September 1940. The heaviest raids occurred on the nights of 22/23 and 23/24 December 1940, killing an estimated 684 people and injuring 2,364.

Luftwaffe target mapping highlights Manchester Central Station and accompanying railway infrastructure as the focus of bombing, see **Annex I** for Luftwaffe Target Mapping. These targets were located adjacent to the east of the site, across Watson Street. It is also believed that raids were carried out on route to the prominent industrial hub of Salford Docks located to the west of the city. Wartime targeting systems tended to be inaccurate and consequently neighbouring targets would often sustain collateral bombing. Moreover, Manchester was protected by a number of barrage balloons which forced aircraft to approach their targets at higher altitudes, thereby further reducing bomb accuracy.

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.

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11.3. WWII Home Office Bombing Statistics

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

Record of German Ordnance Dropped on the County Borough of Manchester		
Area Acreage		**27,255**
Weapons	High Explosive bombs (all types)	712
	Parachute mines	18
	Oil bombs	7
	Phosphorus bombs	0
	Fire pots	0
	Pilotless aircraft (V-1)	1
	Long range rocket bombs (V-2)	0
Total		**738**
Number of Items per 1,000 acres		**27.1**

Source: Home Office Statistics
This table does not include UXO found during or after WWII.

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

11.4. Manchester Bomb and Damage Map

A bomb plot map compiled by Manchester City Council showing high explosive and incendiary bomb strikes on the borough was obtained from the University of Manchester Library. This is primarily concerned with the 'Manchester Blitz' period of 22nd-24th December 1940, though records various other incidents occurring on different dates in 1940 and 1941. The section showing the area of the site is presented in **Annex J**.

Manchester Bomb and Damage Map – Annex J	
Date Range	**Comments**
1940-1941	No bomb strikes or damage is recorded within the site boundary. However, a number of bomb strikes and damage is recorded in the surrounding area. In particular, incendiary bombing is recorded to the north and to the west of the site. Three incendiary strikes are recorded west of the site, the closest on *Church House* on *Deansgate* dated 22nd December 1940, another across *Longworth* west of the site and another to a structure west of the site on 21st/22nd December 1940. Two incendiary strikes are recorded to the north of the site, across *Peter Street*, dated 12th June 1941. One incendiary strike is recorded south of the site across *Great Bridgewater Street* on 23rd December 1940. Several incendiary strikes are recorded further west of the site. Although no damage is recorded on site, damage is recorded east of the site, across *Watson Street*. The western section of *Cheshire Lines Railway Goods Station* is recorded as damaged. The *Free Trade Hall* is also recorded as damaged.

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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.[2]

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 70m to the south of the site. A section of the map showing the site and its surroundings is presented in **Annex K**.

11.6. Manchester Emergency Committee's Log of Bombing Incidents 22-24 December 1940

Blitz Britain: Manchester and Salford by Graham Phythian presents a transcript of the document 'Manchester Emergency Committee's Log of Bombing Incidents 22-24 December 1940' (hence covering the 'Manchester Blitz' period). This is stated to have been obtained from the Emergency Committee Records/Police Museum and Archives, though it was not possible to obtain the original documents. Strikes in close proximity to the site are listed below. No references were found to the Deansgate Goods Station.

Log of Bombing Incidents 22-24 December 1940	
Date	**Comments**
22nd December 1940	Windmill Street and Watson Street. Incendiary bomb resulted in major incident in Free Trade Hall. This was destroyed and a so was a railway house in Watson Street. *This incident was recorded approximately 50m east of the site.*
	Incendiary bomb and slight fire in rafters at Christian Science Church, Peter Street. Extinguished and incident closed. *The precise location of this incident is unknown but is believed to have occurred north of the site.*
	Incendiary bomb at Bridgewater Street and Deansgate. Extinguished and closed. *The precise location of this incident is unknown but is believed to have occurred west of the site.*
	Incendiary bomb at Tonman Street and Deansgate – fire on roof of London metal warehouses. Extinguished by fire brigade and incident closed. *The precise location of this incident is unknown but is belied to have occurred 30m south-west of the site.*
	Incendiary bomb on roof of premises of St John's Street and Deansgate. Slight damage. Extinguished and incident closed. *This incident is recorded to have occurred approximately 50m west of the site.*
	Incendiary bomb at 36 Peter Street. *The precise location of this incident is unknown but is believed to have occurred north of the site.*
	Incendiary bomb at 11 Peter Street. Fire extinguished and closed immediately. *The precise location of this incident is unknown but is believed to have occurred north of the site.*

[2] *https://www.manchestereveningnews.co.uk/news/greater-manchester-news/manchester-blitz-bomb-sites-map-10465447*

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22nd/23rd December 1940	Southern end of Deansgate the Knott Mill railway and warehouse. Incendiary was followed by a two HE strikes. On Peter Street one of the first HE bombs destroyed the Free Trade Hall. Commercial buildings on Watson Street were also hit. *This incident was recorded to have affected the south-east and east of the site.*
23rd December 1940	Incendiary bomb dropped and quickly extinguished at Albert Hall, Peter Street. *This incident was recorded approximately 30m north-east of the site.*

11.7. National Archives 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, as well as the types of bomb used and the damage caused.

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

11.8. War Damage to Housing and Property Cards

These written records were obtained from Manchester Central Library, and record damage to residential and commercial properties in Manchester during WWII.

Relevant records in proximity to the site are transcribed below and is presented in **Annex L**:

War Damage to Property Cards		
Date Range	**Transcribed**	**Comments**
22nd December 1940	'Peter Street- Free Trade Hall Burnt out roof, walls- bad state and floors burnt out. Building wants demolishing. The whole of the contents destroyed. Windmill Street, side of building bulging and dangerous, already roped off.'	Damage is record to the Free Trade Hall on Peter Street, north of the site. This incident was recorded approximately 50m east of the site.
	'Deansgate and Peter Street, offices and shops. Slight damage to roof and ceiling. No damage to contents and no danger.'	Damage is recorded to properties to west of the site. The precise location of these incidents are unknown.
	'Peter Street and Watson Street, incendiary bomb to offices. Slightly damaged roof. 2nd and 4rd floor damaged by fire. Staircase 2nd to 3rd floor dangerous.'	Damage is recorded north and west of the site, the precise location of this incident is unknown.
1st/2nd June 1941	'4R Church of Christ, 23 Peter Street, Deangate. Slight damage to slates, no damage to walls and floors. Ceilings and window frames, glass damage. No damage to contents.'	Slight damage is at 23 Peter Street, Church of Christ. This incident is record approximately 20m north of the site.

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11.9. WWII-Era Aerial Photography

WWII-era aerial photography for the site area was obtained from the National Monuments Record Office (Historic England) / the Aerofilms Collection available from *Britain from Above*. 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-N**).

WWII-Era Aerial Photography	
Date	**Description**
7th May 1946	This aerial photograph of the site is presented in **Annex M1**. This photograph indicates the site was occupied by a large warehouse within the north of the site. An area of hard-standing is visible in the north of the site, with railway sidings in the south of the site. A number of smaller structures border the site to the north and west of the site. No obvious signs of bomb damage, such as repair works or cratering, are evident in this image. The railway tracks appear to remain in use. However, bomb damage is evident to the west of the site, across Deansgate. Some residential housing appears cleared or damaged, as highlighted in **Annex M2**.
1948	Despite this photograph being damaged, this photograph indicates the site composition to have remained the same. With the Warehouse and railway sidings visible. The 'Deansgate Goods Station' occupies the central section of the site and the railway appears to remain in use. See **Annex N**.

11.10. 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.

11.11. 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, GNW Developments Limited. will be advised.

11.12. Evaluation of German Aerial Delivered UXO Records

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Factors	Conclusion
Density of Bombing *It is important to consider the bombing density when assessing the possibility that UXBs remain in an area. High bombing density could allow for error in record keeping due to extreme damage caused to the area.*	During WWII, the site was situated within the County Borough of Manchester. According to official Home Office bombing statistics, this borough sustained an overall low density of bombing, with an average of 27.1 items of ordnance recorded per 1,000 acres of land. Luftwaffe Target Mapping indicates that the city centre was the focus of bombing, largely due to the presence of Manchester Central Station and associated railway infrastructure. The Central Station was located to the site to the east, across Watson Street. A single bomb/damage map exists for the district – which focuses on the 'Manchester Blitz' period for 22nd-24th December 1940 and sporadic incidents on other dates. No bomb strikes are recorded directly on site, however strikes are recorded in the general vicinity. Incendiary bombing is recorded to the north, south and west of the site. Several incendiary strikes are recorded to the west of the site, across Deansgate. The strike dates range. Two incendiary strikes are recorded to the north of the site, across Peter Street, dated the 12th June 1941. South of the site one incendiary strike is recorded on 23rd December 1940. The closest incendiary incident is plotted 20m west of the site. To corroborate with this, an interactive Christmas Blitz map records no incidents on site, with the closest incident 70m south of the site. The 'Manchester Emergency Committee's Log of Bombing Incidents 22-24 December 1940' was also utilised to track bombs on site. However, no records from this source referenced the site footprint – although several incendiary strikes were recorded in the general area.
Damage *If buildings or structures on a site sustained bomb or fire damage, any resulting rubble and debris could have obscured the entry holes of unexploded bombs dropped during the same or later raids. Similarly, a high explosive bomb strike in an area of open agricultural land will have caused soil disturbance, increasing the risk that a UXB entry hole would be overlooked.*	1946 RAF aerial photography indicates the presence of structures visible in pre-WWII OS mapping. These structures appear intact and do not display any obvious signs of bomb damage such as damaged tiles or missing roofing. However, aerial photography indicates that numerous structures to the west of the site, across Deansgate, appear to have been cleared or damage and there is a possible missing roof to the east. The Manchester Bomb/Damage Map does not record any damage on site, however damage is recorded to the east of the site, across Watson Street. The Western section of 'Cheshire Lines Railway Goods Station' is recorded as damaged. The 'Free Trade Hall' is also recorded as damaged. War Damage to Property Cards indicate the wider vicinity to have sustained damage, with damage recorded to the Free Trade Hall on Peter Street, Church of Christ on Peter Street and slight damage to offices and shops on offices and shops on Deansgate/Peter Street.
Ground Cover *The nature of the ground cover present during WWII would have a substantial influence on any visual indication that may indicate UXO being present.*	Pre- and post-WWII historical OS mapping and WWII-era aerial photography indicate the site was occupied by a warehouse, several offices/shops and hardstanding ground in the majority of the site. Railway sidings were located within the south of the site. These are all considered to have been generally conducive to the detection of UXO, as any anomalies would have likely been easily spotted, in particular with the railway in order to keep the line operational.

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Access Frequency *UXO in locations where access was irregular would have a greater chance of passing unnoticed than at those that were regularly occupied. The importance of a site to the war effort is also an important consideration as such sites are likely to have been both frequently visited and subject to post- raid checks for evidence of UXO.*	It is anticipated that the site received a regular degree of access in wartime, given the site was occupied by the 'Great Northern Railway Company Goods Station' and its railway sidings. This was a unique 3-way railway goods exchange station, serving the railway, canal and road networks of the Manchester region. In its day, it was considered one of the largest and most advanced railway exchanges in the country. Trains continued to run throughout WWII, therefore it is anticipated the site would have been regularly observed and maintained. Moreover, there were GNR offices on Peter Street and a development of 34 three-storey shops with offices and warehouses above them along Deansgate. It is likely that these shops and offices would have continued to function as normal, given the lack of evidence to suggest they had been damaged during the war. This increases the likelihood that a UXB would have been spotted and consequently removed.
Bomb Failure Rate	There is no evidence to suggest that the bomb failure rate in the locality of the site would have been dissimilar to the 10% normally used.
Abandoned Bombs	1st Line Defence holds no records of abandoned bombs at or within the site vicinity.
Bombing Decoy sites	1st Line Defence could find no evidence of bombing decoy sites within the site vicinity.
Bomb Disposal Tasks	1st Line Defence could find no evidence of bomb disposal tasks within the site boundary and immediate area.

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.

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12.2. Defending the UK From Aerial Attack

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

Active Defences	Passive Defences
• Anti-aircraft gun emplacements to engage enemy aircraft. • Fighter aircraft to act as interceptors. • Rockets and missiles were used later during WWII.	• Blackouts and camouflaging to hinder the identification of Luftwaffe targets. • Decoy sites were located away from targets and used dummy buildings and lighting to replicate urban, military, or industrial areas. • Barrage balloons forced enemy aircraft to greater altitudes. • Searchlights were often used to track and divert adversary bomber crews during night raids.

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

12.2.1. Anti-Aircraft Artillery (AAA)

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

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

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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.

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13.2. Evaluation of Contamination Risk from Allied UXO

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

Sources of Allied UXO Contamination	Conclusion
Military Camps *Military camps present an elevated risk from ordnance simply due to the large military presence and likelihood of associated live ordnance training.*	1st Line Defence could find no evidence of a military camp within the site.
Anti-Aircraft Defences *Anti-Aircraft defences were employed across the country. Proximity to anti-aircraft defences increases the chance of encountering AA projectiles.*	1st Line Defence could find no evidence of Anti-Aircraft defences such as a HAA or LAA gun emplacement occupying or bordering the site. The closest HAA was located approximately 1.9km 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 *The Home Guard regularly undertook training and ordnance practice in open areas, as well as burying ordnance as part of anti-invasion defences.*	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 *Defensive positions suggest the presence of military activity, which is often indicative of ordnance storage, usage or disposal.*	There is no evidence of any pillbox, emplacement or other defensive features formerly located on or bordering the site footprint.
Training or firing ranges	No evidence of training or firing ranges could be found within the site or surrounding area.
Defensive Minefields *Minefields were placed in strategic areas to defend the country in the event of a German invasion. Minefields were not always cleared with an appropriate level of vigilance.*	There is no evidence of defensive minefields affecting the site.
Ordnance Manufacture *Ordnance manufacture indicates an increased chance that items of ordnance were stored, or disposed of, within a location.*	No information of ordnance being stored, produced, or disposed of within the proposed site could be found.
Military Related Airfields	The site was not situated within the perimeters or vicinity of a military airfield.

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14. The Likelihood of UXO Contamination Summary

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

UXO Contamination Summary	
Quality of the Historical Record	The research has evaluated pre- and post-WWII Ordnance Survey maps, pre-WWII oblique aerial photography, Luftwaffe target mapping, University of Manchester bomb and damage map, an interactive 'Christmas Blitz' map, National Archives air raid damage files, 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 all comprehensive and do not always corroborate with each other. Only certain incidents of damage is recorded to properties on the Manchester Bomb Census and Damage map. It is presumed only serious damage was plotted onto the map. Whilst the War Damage to Property Cards record damage to the Church at 23 Peter Street (north of the site) no damage is recorded onto the map in the location of the Church.
German Aerial Delivered Ordnance	• During WWII, the site was situated within the County Borough of Manchester, which was subject to an overall low density of bombing, culminating in an average of 27.1 items of ordnance falling per 1,000 acres of land, according to official Home Office statistics. Whilst Manchester did not sustain the intense bombing campaign that other cities such as London and Coventry experienced, the area was still subject to a number of significant targeted bombing raids between 1940 and 1941. Luftwaffe target mapping indicates that Manchester Central Station and associated railway structures were a primary target located east of the site, across Watson Street. • During WWII, the site was occupied by *Great Northern Railway Goods Station*. An area of open hard-standing ground was located in the north of the site and railway sidings were situated in the south of the site. A number of smaller structures bordered the site to the north and west. • Whilst a number of incendiary incidents are recorded in the surrounding vicinity, the Manchester Bomb Census and Damage Map and a Christmas Blitz bomb map record no incidents within the site footprint. The closest incidents are recorded as an incendiary bomb plotted west of the site on Deansgate to Church House on the 22nd December 1940, situated approximately 20m west of the site. • No damage is recorded *at Deansgate Goods Station* within the Manchester Bomb Census and Damage map. To corroborate with this, no damage is visible within 1946 aerial photography. Structures appear intact and no evidence of white roofing indicative of damage is visible to any of the structures within the site footprint. • It is anticipated that the site would have been regularly accessed throughout the war and that this access would not have been impeded - no bombing or damaged buildings are recorded on site in the available records. The site was occupied by structures including Deansgate Goods Station, which in its day was considered one of the largest and most advanced railway exchanges in the country. Trains continued to run throughout WWII – thus the site would have been regularly observed and checked to ensure trains could continue to operate. • Moreover, the site footprint also contained GNR offices on Peter Street and a development of 34 shops with offices and warehouses above them along Deansgate. Given the lack of evidence to suggest that these structures had been damaged during the war, it is likely that these shops and offices would have continued to function as normal. This increases the likelihood that a UXB would have been spotted and subsequently removed. Any unexploded ordnance falling on the open areas of undamaged sidings are also thought likely to have left evidence of their presence – buckled track, disturbed ballast etc.

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	• In summary, no positive evidence of bombing or damage could be found within the site footprint. Despite, the urban location of the site, and its position as a Luftwaffe target adjacent to Manchester Central Station, no bombing incidents are recorded to have directly affected the site. No damage is visible within aerial photography, and no missing structures are present on post-WWII OS mapping. As such, the site has been deemed at **Low Risk** for German aerial delivered and anti-aircraft UXO.
Allied Ordnance	• There is no evidence that the site formerly had any military occupation or usage that could have led to contamination with items of Allied ordnance, such as LSA and SAA. • The conditions in which HAA or LAA projectiles may have fallen unnoticed within the site boundary are however 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

In 1954, the Warehouse ceased operating and closed. The main body of the Warehouse remains, with the site redeveloped into an extensive leisure and retail complex in the late 1990s/early 2000s. In addition, buildings situated within the northern section of the site adjacent to Peter Street were cleared and redeveloped into Great Northern Square.

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.

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16. The Likelihood of UXO Encounter

16.1. Introduction

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

The likelihood of encountering UXO on the site of proposed 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.

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17. The Likelihood of UXO Initiation

17.1. Introduction

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

17.2. Initiating Aerial Delivered Ordnance

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

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

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

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

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18. Consequences of Initiation/Encounter

18.1. Introduction

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

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

18.2. Consequences of Detonation

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

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

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19. 1st Line Defence Risk Assessment

19.1. Risk Assessment Stages

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

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

19.2. Assessed Risk Level

1st Line Defence has assessed that there is an overall **Low Risk** from German and anti-aircraft unexploded ordnance at the site of proposed works. There is also an assessed **Negligible Risk** from Allied unexploded ordnance.

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', this does not mean there is 'no' risk of encountering UXO. This report has been undertaken with due diligence, and all reasonable care has been taken to access and analyse relevant historical information. By necessity, when dealing historical evidence, and when making assessments of UXO risk, various assumptions have to be made which we have discussed and justified throughout this report. Our reports take a common-sense and practical approach to the assessment of risk, and we strive to be reasonable and pragmatic in our conclusions.

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

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20. Proposed Risk Mitigation Methodology

20.1. General

The following risk mitigation measures are recommended to support the proposed works at Great Northern Warehouse, Manchester:

Type of Work	Recommended Mitigation Measure
All Works	• **UXO Risk Management Plan** It is recommended that a site-specific plan for the management of UXO risk be written for this site. This plan should be kept on site and be referred to in the event that a suspect item of UXO is encountered at any stage of the project. It should detail the steps to be taken in the event of such a discovery, considering elements such as communication, raising the alarm, nominated responsible persons etc. Contact 1st Line Defence for help/more information. • **Site Specific UXO Awareness Briefings to all personnel conducting intrusive works.** As a minimum precaution, all personnel working on the site should be briefed on the basic identification of UXO and what to do in the event of encountering a suspect item. This should in the first instance be undertaken by a UXO Specialist. Posters and information on the risk of UXO can be held in the site office for reference.

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

1st Line Defence Limited **9th November 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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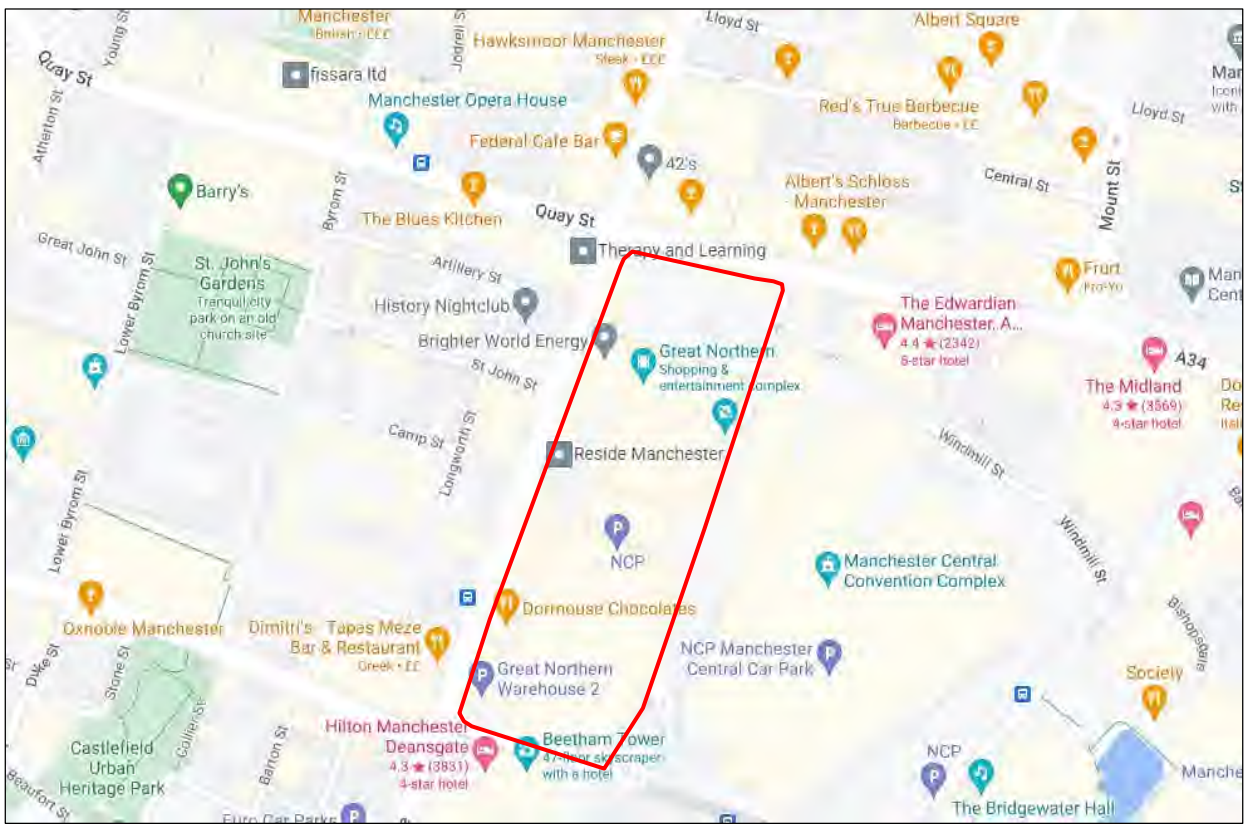
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Site Location Maps

Annex: **A**





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Client:	**GNW Developments Limited**	**Approximate site boundary**	N
Project:	**Great Northern Warehouse, Manchester**		
Ref:	**DA15420-01**	Source: Google Maps	

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Recent Aerial Photography

Annex: **B**



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Client: **GNW Developments Limited**

Approximate site boundary

N

Project: **Great Northern Warehouse, Manchester**

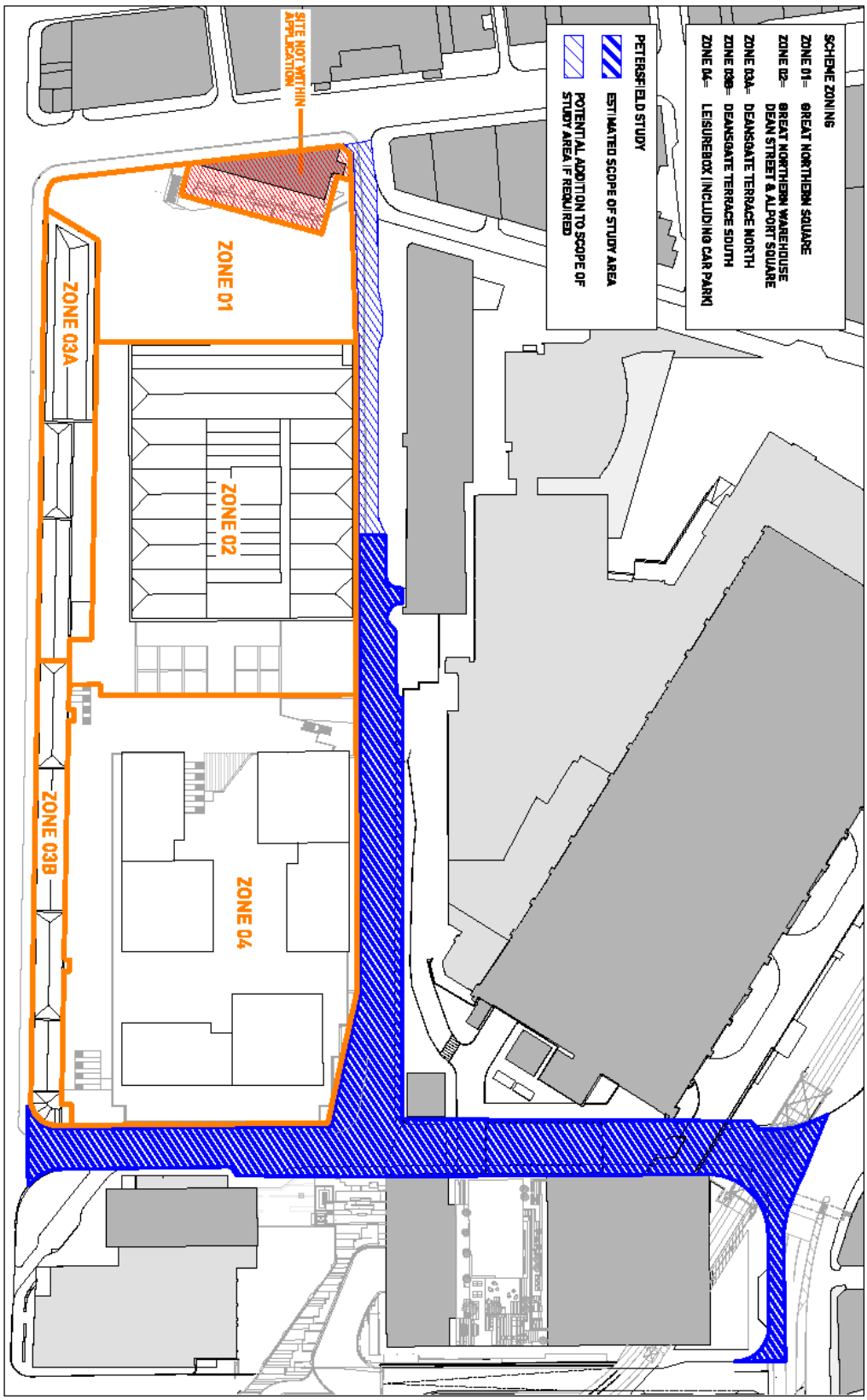
Ref: **DA15420-01**

Source: Google Earth ™ Mapping Services

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Client Provided Site Plan

Annex: C



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Ref:	**DA15420-01**	Source: GNM Developments Ltd	

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1932-1933 Historical Map

Annex: D1



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Ref: **DA15420-01**

Source: Landmark Maps

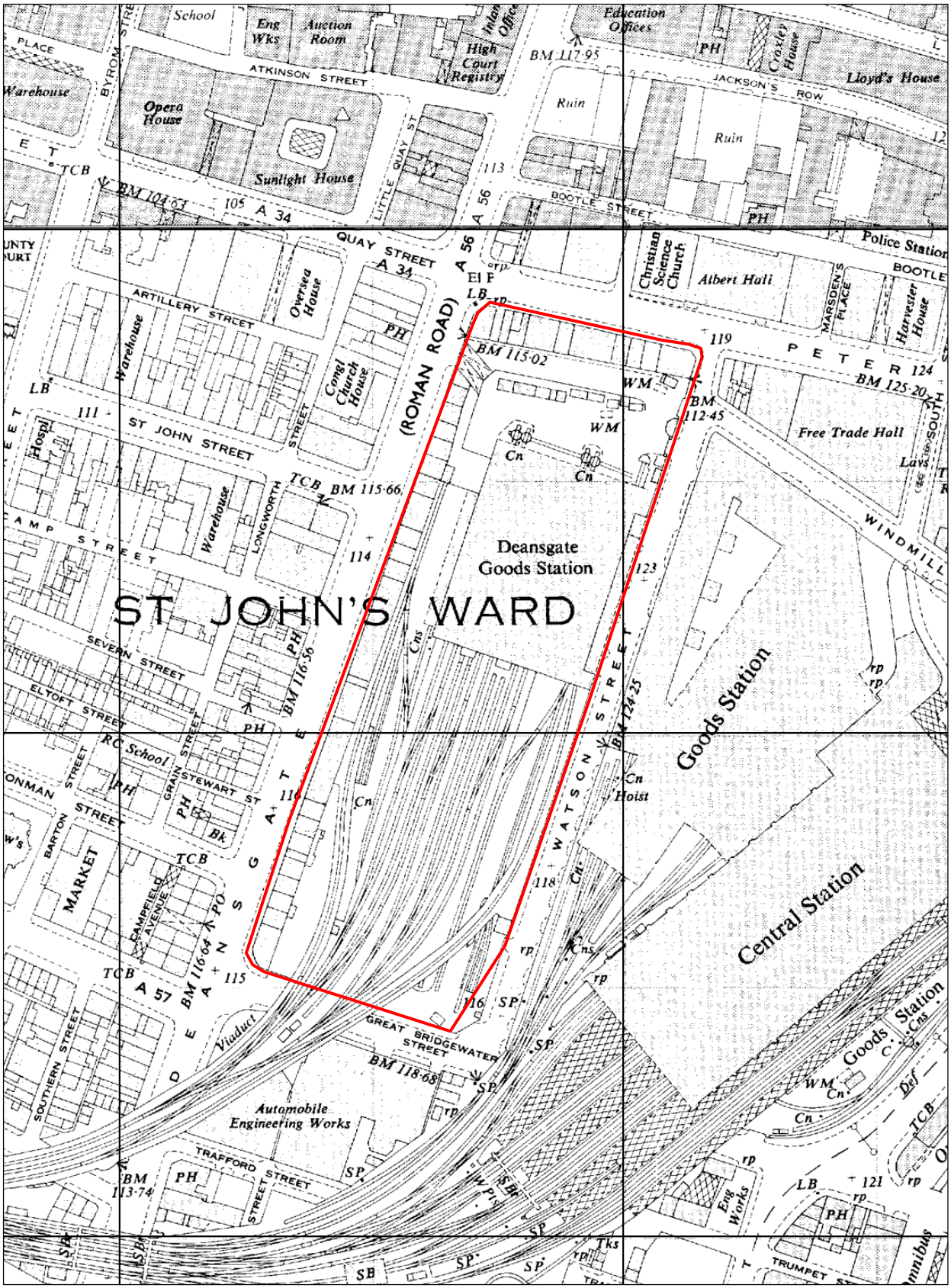
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1950-1951 Historical Map

Annex: D2



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Source: Landmark Maps

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The Central Railway Station, slum clearance around George Street and the city, Manchester, 1937

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Approximate site boundary

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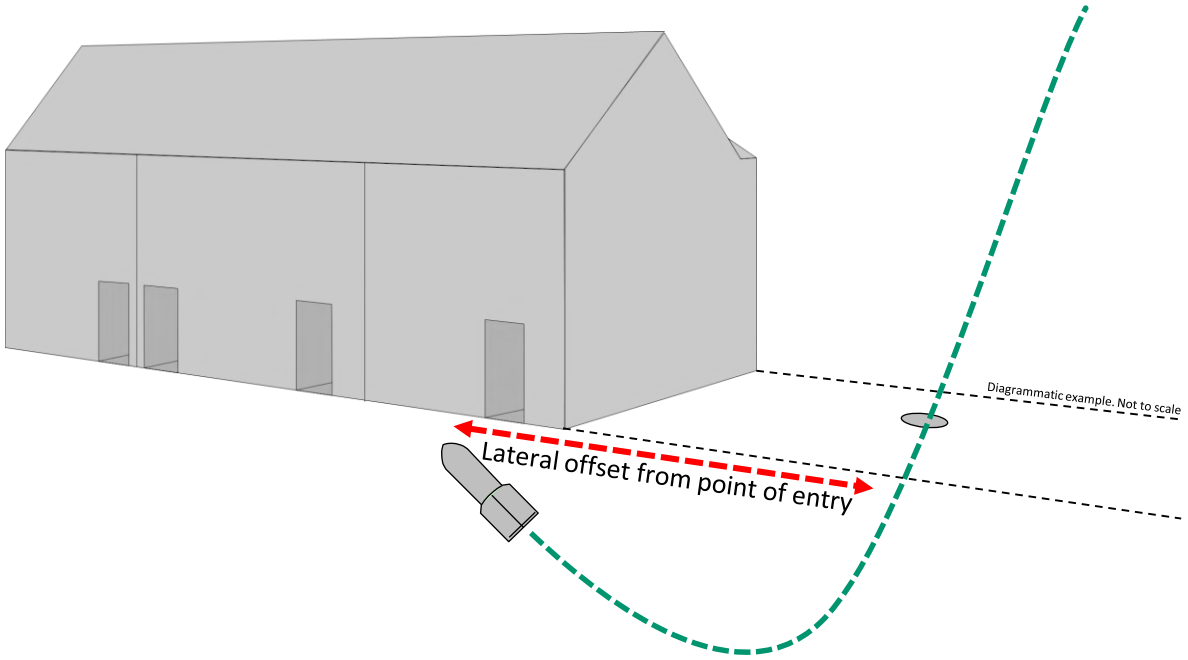
Project: **Great Northern Warehouse, Manchester**

Ref: **DA15420-01**

Source: Britain from Above

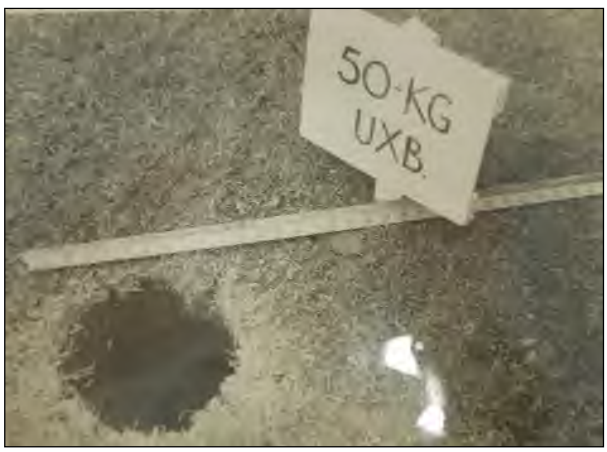
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Example of UXO Entry Hole / The 'J-curve' Effect Principle









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

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

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BBC NEWS

Bermondsey bomb: World War Two device safely removed



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

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

March 2015

BBC NEWS

Bethnal Green WW2 bomb: Experts remove unexploded device



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

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

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

August 2016

BBC NEWS

Bath WW2 bomb scare: Device defused, police say



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

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

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

May 2016

BBC NEWS

London City Airport reopens after WW2 bomb moved



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

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

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

May 2015

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Examples of Unexpected Detonation of WWII Bombs

Annex: **G2**

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

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

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

BBC NEWS

World War II bomb kills three in Germany



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

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

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

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

2nd June 2010



June 2006

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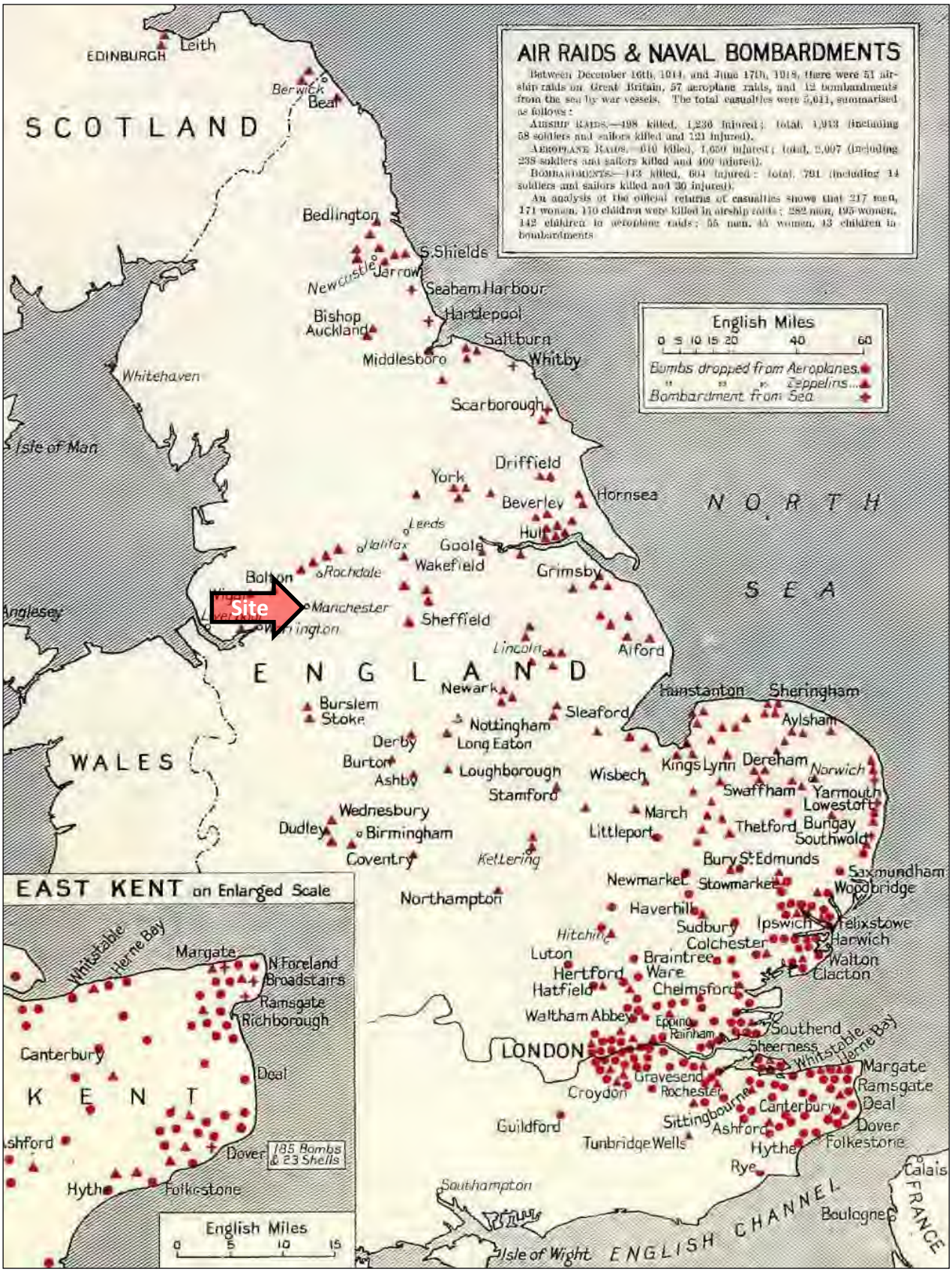
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Source: Various news sources

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WWI Map of Air Raids and Naval Bombardments

Annex: H



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Project: **Great Northern Warehouse, Manchester**

Ref: **DA15420-01**

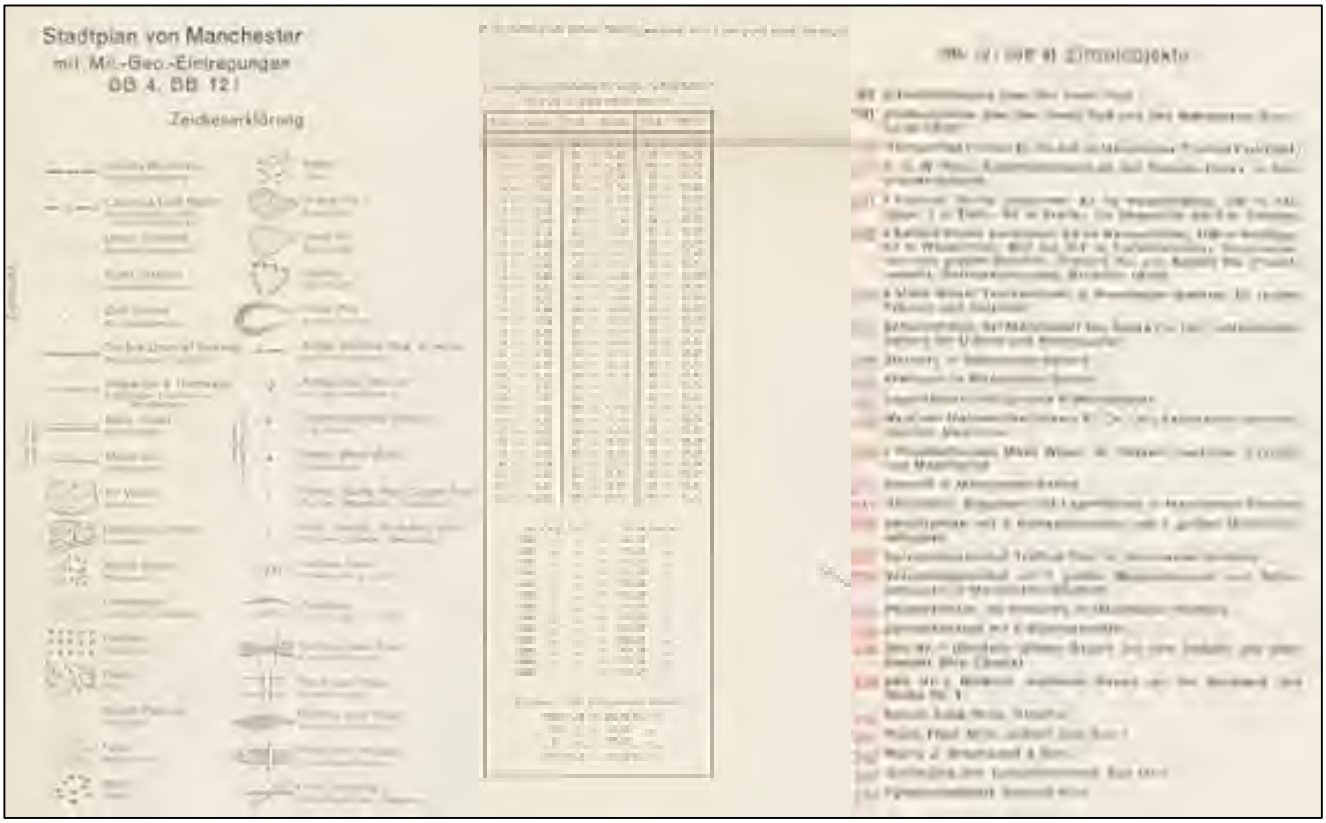
Source: J. Morris, *German Air Raids on Britain*

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Luftwaffe Target Mapping

Annex: I





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Tel: +44 (0)1992 245 020

Client: **GNW Developments Limited**

Project: **Great Northern Warehouse, Manchester**

Ref: **DA15420-01**

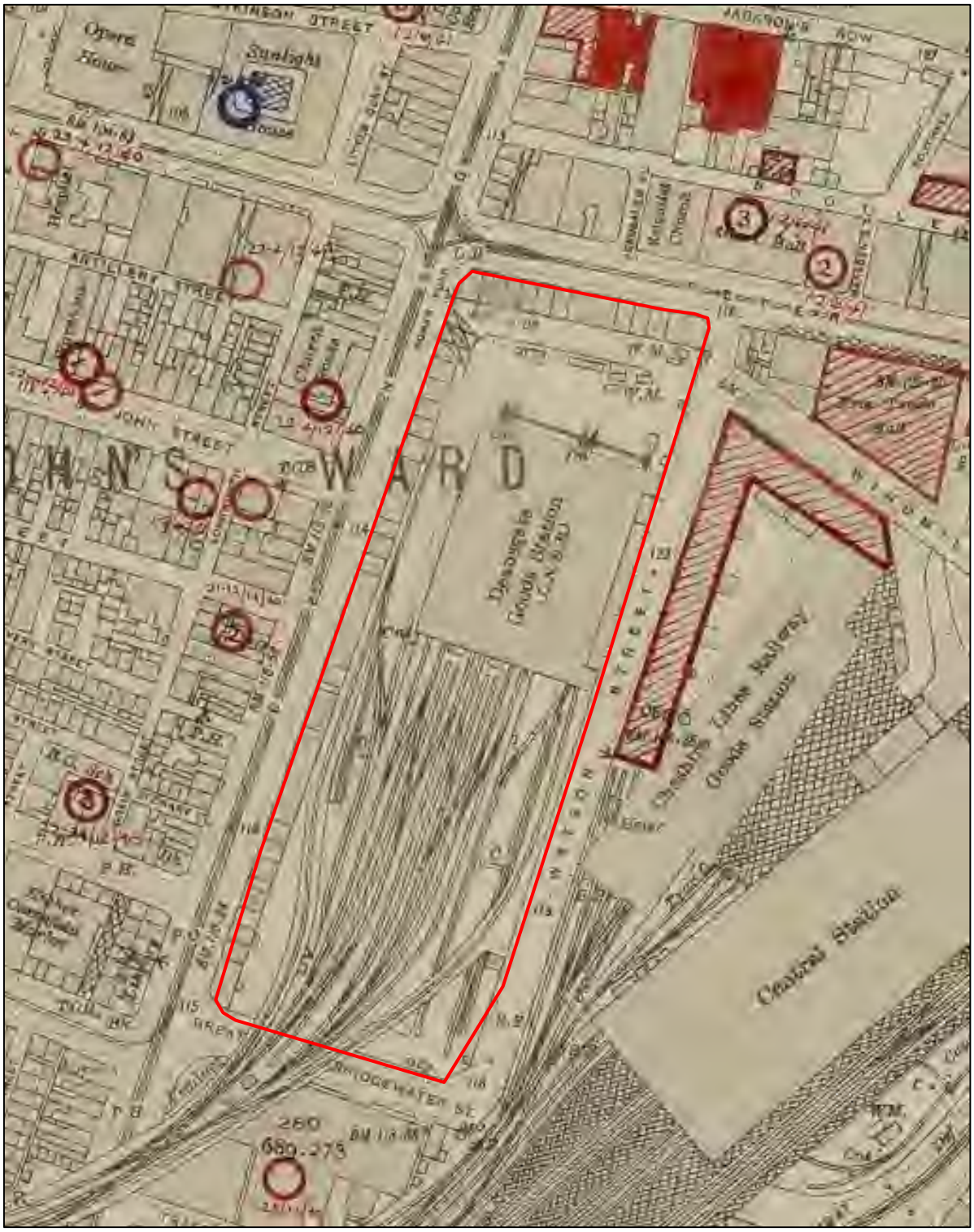
Source: Nigel J. Clarke, "Adolf Hitler's Home Counties Holiday Snaps"

N

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Manchester Bomb Census and Damage Map

Annex: J



Recorded HE bomb Recorded incendiary bomb Damaged building

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Tel: +44 (0)1992 245 020

Client: **GNW Developments Limited**

Approximate site boundary

Project: **Great Northern Warehouse, Manchester**

N

Ref: **DA15420-01**

Source: University of Manchester Library

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Interactive 'Christmas Blitz' Bomb Map

Annex: **K**



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Client: **GNW Developments Limited**

Approximate site boundary

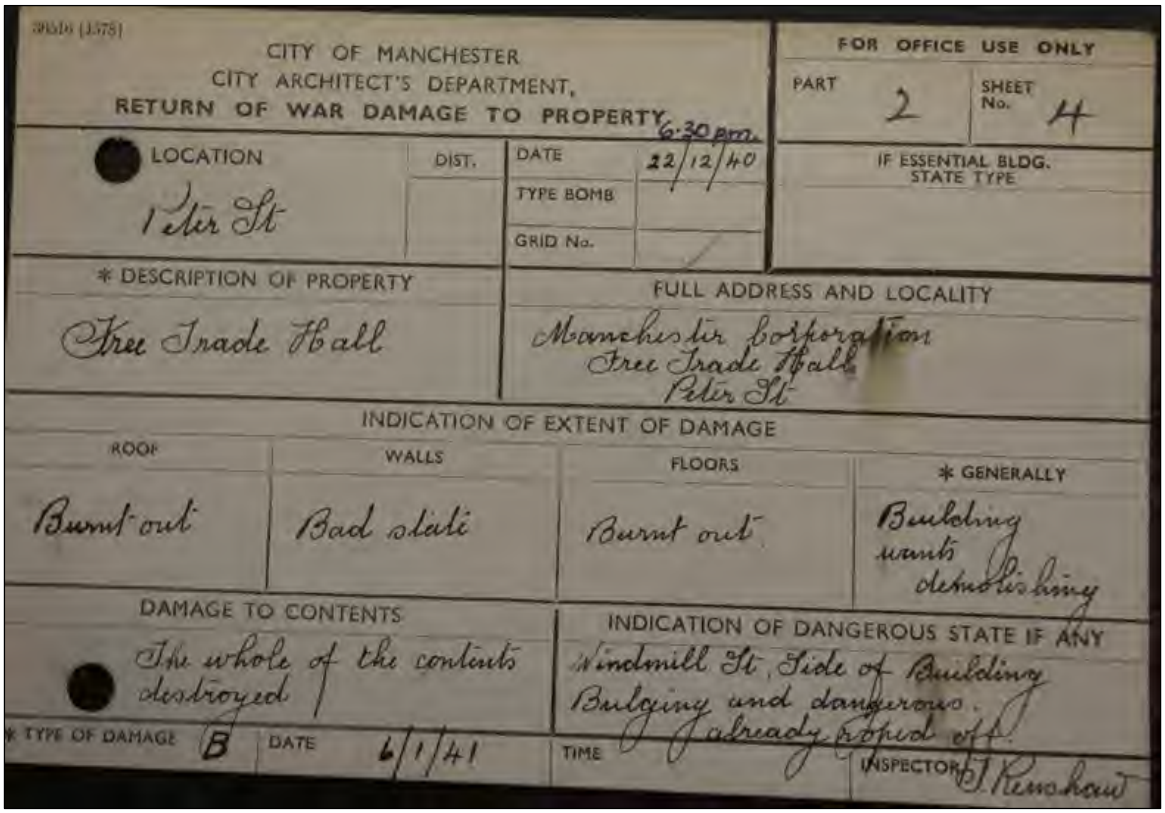
N

Project: **Great Northern Warehouse, Manchester**

Ref: **DA15420-01**

Source: Manchester Evening News

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30516 (1378)

CITY OF MANCHESTER
CITY ARCHITECT'S DEPARTMENT,
RETURN OF WAR DAMAGE TO PROPERTY

FOR OFFICE USE ONLY
PART 2 SHEET No. 4

LOCATION: Peter St
DIST.:
DATE: 22/12/40 6.30 pm.
TYPE BOMB:
GRID No.:
IF ESSENTIAL BLDG. STATE TYPE:

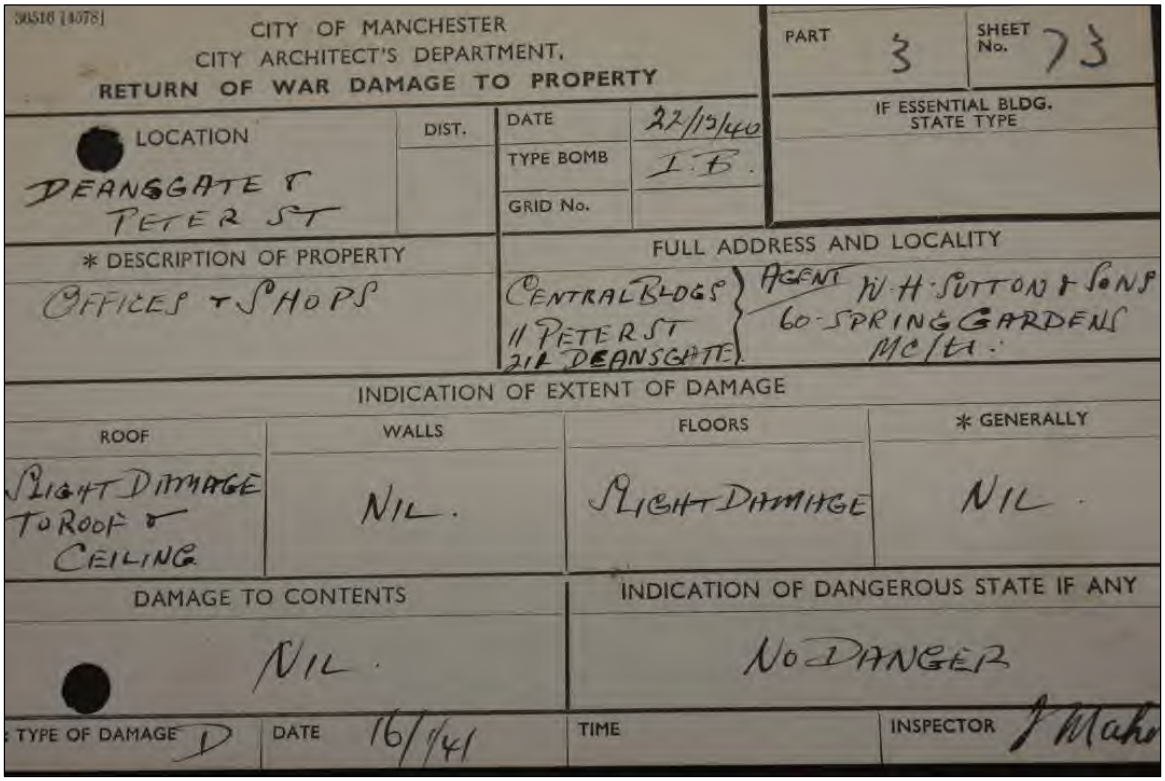
* DESCRIPTION OF PROPERTY: Free Trade Hall
FULL ADDRESS AND LOCALITY: Manchester Corporation, Free Trade Hall, Peter St

INDICATION OF EXTENT OF DAMAGE

ROOF	WALLS	FLOORS	* GENERALLY
Burnt out	Bad state	Burnt out	Building wants demolishing

DAMAGE TO CONTENTS: The whole of the contents destroyed
INDICATION OF DANGEROUS STATE IF ANY: Windmill St. Side of Building Bulging and dangerous. Already roped off.

* TYPE OF DAMAGE: B DATE: 6/1/41 TIME: INSPECTOR: J Renshaw



30516 (1378)

CITY OF MANCHESTER
CITY ARCHITECT'S DEPARTMENT,
RETURN OF WAR DAMAGE TO PROPERTY

PART 3 SHEET No. 73

LOCATION: DEANSGATE & PETER ST
DIST.:
DATE: 22/12/40
TYPE BOMB: I.B.
GRID No.:
IF ESSENTIAL BLDG. STATE TYPE:

* DESCRIPTION OF PROPERTY: OFFICES + SHOPS
FULL ADDRESS AND LOCALITY: CENTRAL BLDGS 11 PETER ST 21 DEANSGATE. AGENTS W.H. SUTTON & SONS 60 SPRING GARDENS MC/ER.

INDICATION OF EXTENT OF DAMAGE

ROOF	WALLS	FLOORS	* GENERALLY
SLIGHT DAMAGE TO ROOF & CEILING	NIL.	SLIGHT DAMAGE	NIL.

DAMAGE TO CONTENTS: NIL.
INDICATION OF DANGEROUS STATE IF ANY: NO DANGER

* TYPE OF DAMAGE: D DATE: 16/1/41 TIME: INSPECTOR: J Mahe

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36516 [4578]

CITY OF MANCHESTER
CITY ARCHITECT'S DEPARTMENT,
RETURN OF WAR DAMAGE TO PROPERTY

FOR OFFICE USE ONLY

PART 3 SHEET No. 17

LOCATION: Peter St & Watson St.

DIST.:

DATE: 22/12/40

TYPE BOMB: I.B.

GRID No.: /

IF ESSENTIAL BLDG. STATE TYPE:

* DESCRIPTION OF PROPERTY: Offices

FULL ADDRESS AND LOCALITY: Vacant Premises Trafford House 36 Peter St M/C. Owners of L.N.W. Rly Co London Rd Station M/C.

INDICATION OF EXTENT OF DAMAGE

ROOF	WALLS	FLOORS	* GENERALLY
Slightly Damaged.	Nil.	2nd + 3rd Floor landings Damaged by Fire	Staircase 2nd to 3rd Floor Damage by Fire & will require new

DAMAGE TO CONTENTS: Nil

INDICATION OF DANGEROUS STATE IF ANY: Staircase 2nd to 3rd Floor Dangerou

* TYPE OF DAMAGE C (a) DATE 4/1/41 TIME INSPECTOR J. Renshaw

CITY OF MANCHESTER
CITY ARCHITECT'S DEPARTMENT
RETURN OF WAR DAMAGE TO PROPERTY

PART 3 SHEET No 33

IF ESSENTIAL BLDG. STATE TYPE:

LOCATION: Peter St

DIST.:

DATE: 12.6.41

TYPE BOMB: I.B. & H.E

GRID No.:

* DESCRIPTION OF PROPERTY: 4th CHURCH OF CHRIST.

FULL ADDRESS AND LOCALITY: 23 PETER ST. (DEANSGATE)

INDICATION OF EXTENT OF DAMAGE

ROOF	WALLS	FLOORS	* GENERALLY
Slight damage to Slates.	No damage.	No damage	Ceilings & window frame Glass damage

DAMAGE TO CONTENTS: No damage

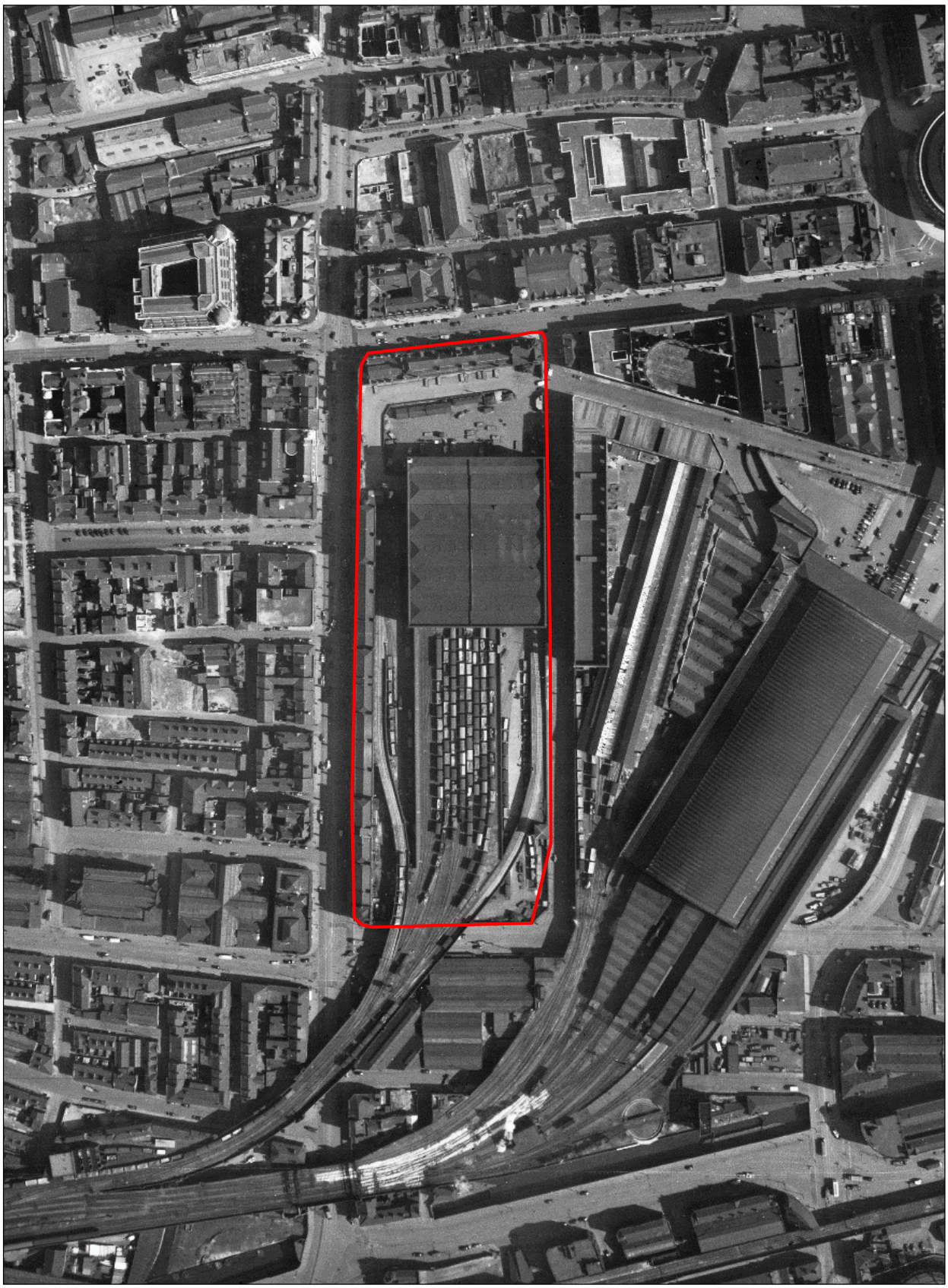
INDICATION OF DANGEROUS STATE IF ANY: —

* TYPE OF DAMAGE D. DATE 9. 6. 41 TIME INSPECTOR H. Clarke

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RAF Aerial Photography 7th May 1946

Annex: **M1**



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Client: **GNW Developments Limited**

Approximate site boundary

Project: **Great Northern Warehouse, Manchester**

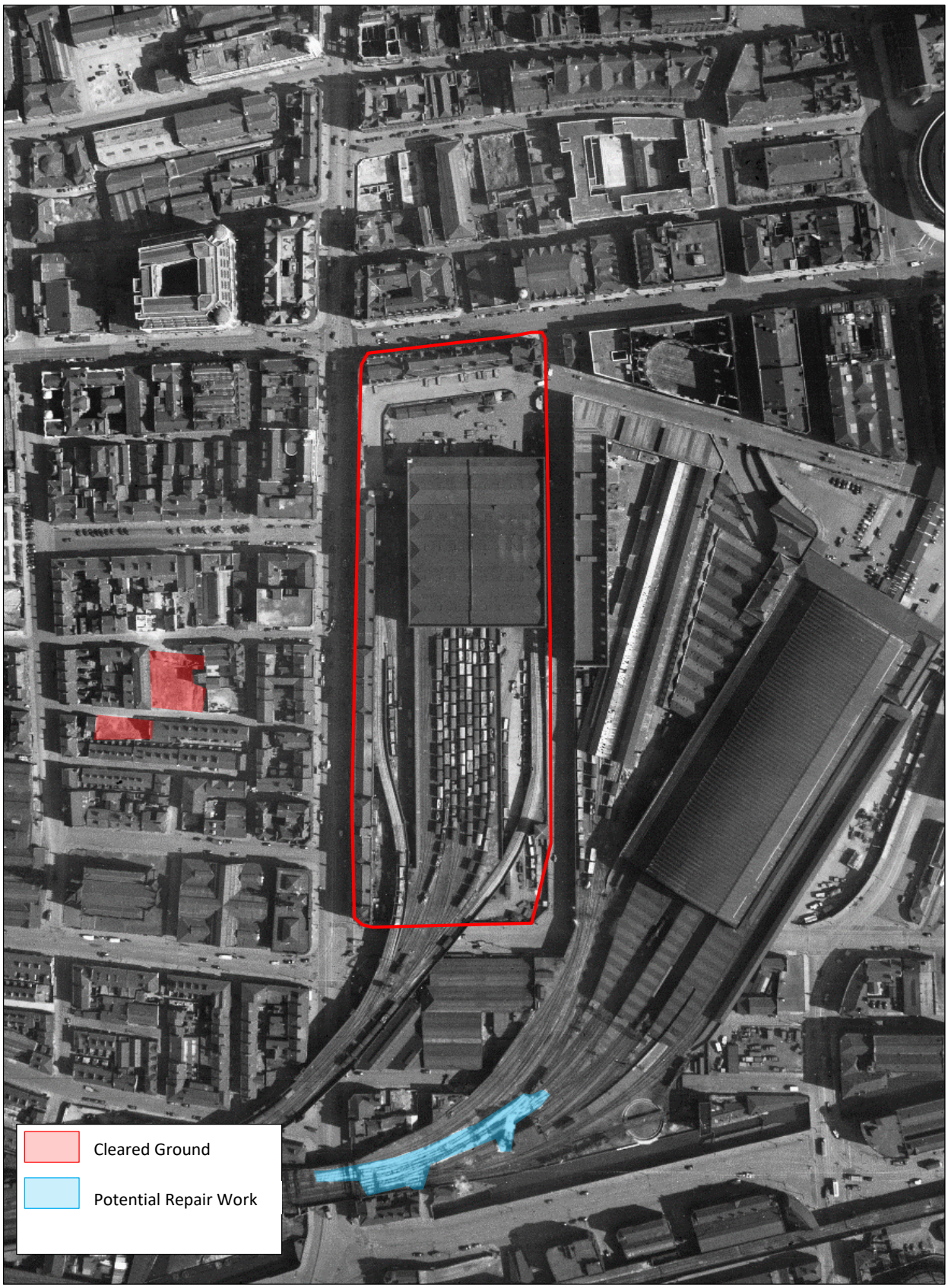
Ref: **DA15420-01**

Source: National Monuments Record Office (Historic England)

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RAF Aerial Photography 7th May 1946- Bomb Damage Overlay

Annex: **M2**



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Project: **Great Northern Warehouse, Manchester**

Ref: **DA15420-01**

Source: National Monuments Record Office (Historic England)

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1948 Oblique Aerial Photography

Annex: **N**



Deansgate Goods Station and Central Station, Manchester, 1948

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Approximate site boundary

Project: **Great Northern Warehouse, Manchester**

Ref: **DA15420-01**

Source: Britain from Above

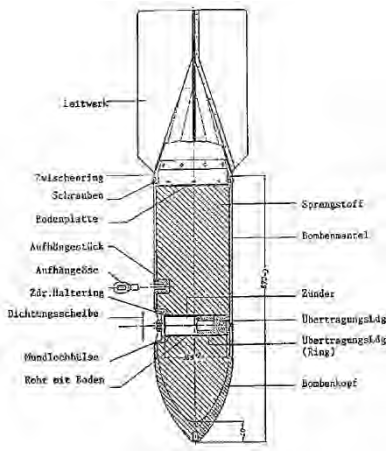
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Examples of German Bombs - HE

Appendix: i

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.

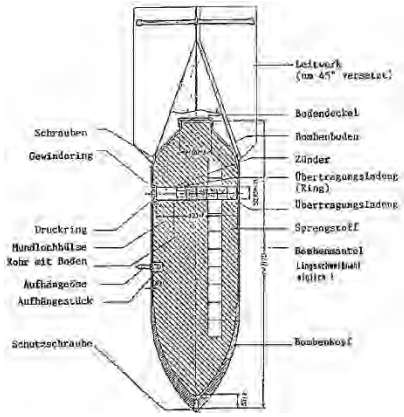






SC 250kg

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).

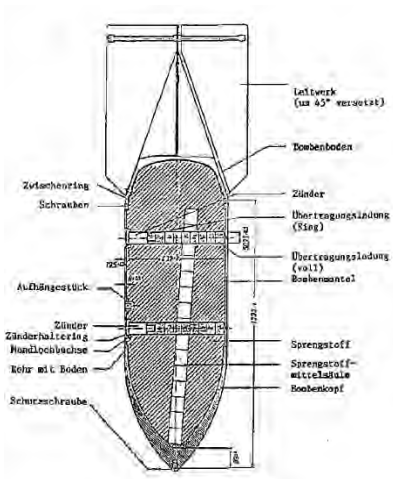






SC 500kg

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 Trialen filling have cylindrical paper wrapped pellets 1-15/16 in. in length and diameter forming







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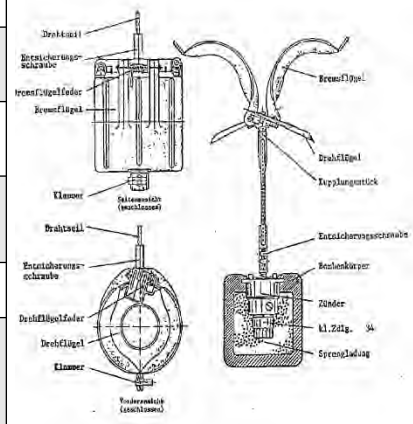
Source: Various sources

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Examples of German Bombs - HE, AP and Parachute Mines

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.

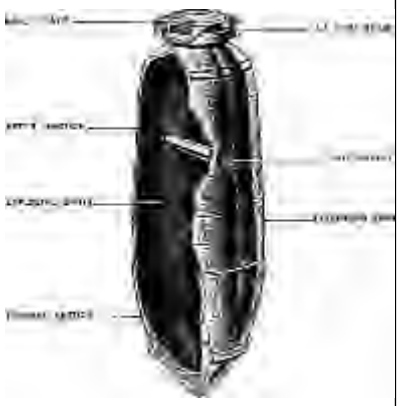


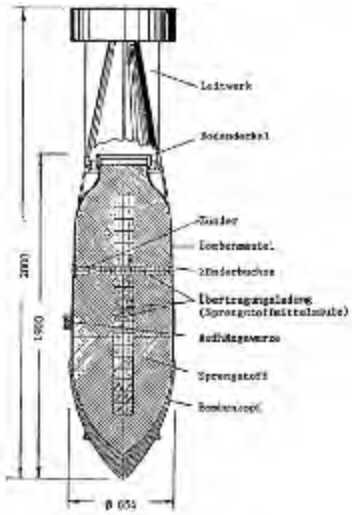




SC 1000kg

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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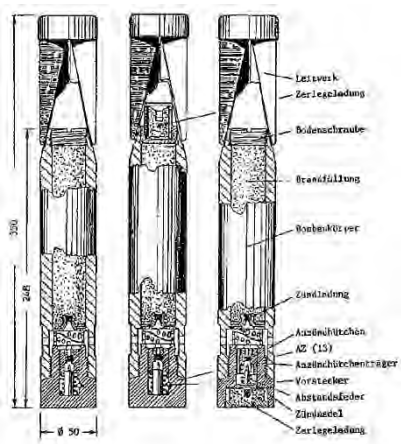
Source: Various sources

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Examples of German Bombs - Incendiary

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.

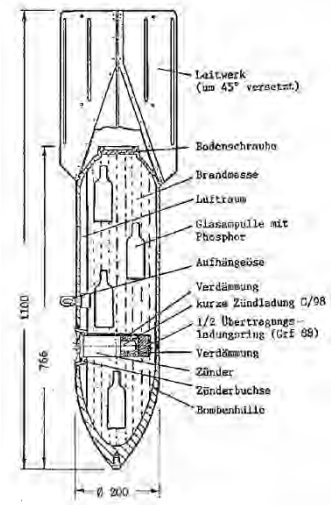


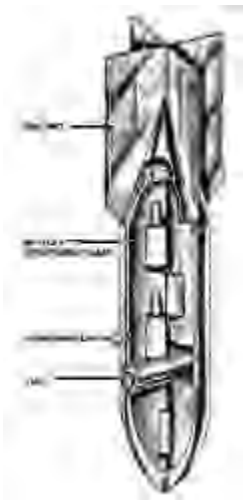




C50 A Incendiary Bomb

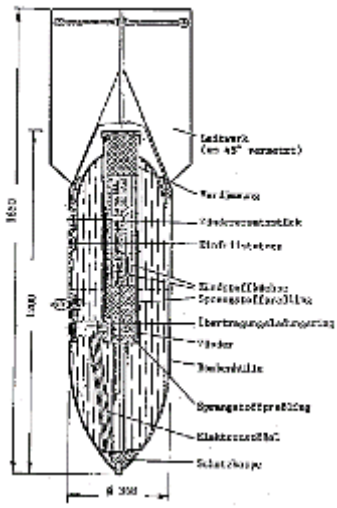
Bomb Weight	c41kg (90.4lb)
Explosive Weight	0.03kg (0.066lb)
Incendiary Filling	12kg (25.5lb) liquid filling with phosphor igniters in glass phials. Benzine 85%; Phosphorus 4%; Pure Rubber 10%
Fuze Type	Electrical impact fuze
Bomb Dimensions	1,100 x 280mm (43.2 x 8in)
Use	Against all targets where an 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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Ref: **DA15420-01**

Source: Various sources

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Examples of Anti-Aircraft Projectiles

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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