



International Unexploded Ordnance Risk Mitigation

Many People...
...One Aim



**EXPLOSIVE ORDNANCE
DESKTOP STUDY
FOR:**

PROJECT 21013

**HOUGH END SPORTS FIELDS
PRINCESS ROAD
MANCHESTER**

elliswilliams



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EXPLOSIVE ORDNANCE DESKTOP STUDY

Of

HOUGH END SPORTS FIELD PRINCESS ROAD MANCHESTER

Conducted by EOD Contracts Limited

On behalf of

elliswilliams

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TERMS AND DEFINITIONS

Anti-Aircraft Shells (AA)

Small High Explosive Shells (HE) shells ranging up to 100mm in diameter.

Battlefield Area Clearance (BAC)

The systematic clearance of munitions from military property or old battle sites e.g. ranges, airfields etc.

Borehole Search

The placing of boreholes in a set pattern, then using a magnetometer to take readings at specific depths along each borehole. When used with a geophysical survey system this will give a magnetic signature of the area. The depth of the borehole and the pattern will depend upon the type of Unexploded Bombs (UXB) and the geology of the ground.

Doodle Bug (See Pilotless Aircraft)

Explosive Ordnance (EO)

All munitions containing explosives, nuclear fission/fusion materials and or biological and chemical agents. This includes bombs and warheads; guided and ballistic missiles; artillery, mortar, rocket and Small Arms Ammunition (SAA); all mines, torpedoes and depth charges; pyrotechnics; clusters and dispensers; cartridge and propellant actuated devices; electro-explosive devices; clandestine and improvised explosive devices (IED); and all similar or related items or components explosive in nature.

Explosive Ordnance Clearance (EOC)

See BAC.

Explosive Ordnance Disposal (EOD)

The detection, identification, field evaluation, render safe, recovery and disposal of **UXO**.

Geophysical Survey

The survey of an area using a Magnetometer and geophysical gathering device, after interpretation, this will produce a geophysical map and an object list for any metallic anomalies.

High Explosive (HE)

High explosives burn/detonate at rates of up to 9,000 m/per second.

Incendiary Bomb (IB)

Incendiary bombs ranged from 1kg in size to 500kg the larger sizes were sometimes called Oil Bombs. Fills range from thermite mixtures, phosphorus to kerosene.

Intrusive Survey

The use of a cone penetrometer (MagCone) or drilled boreholes (MagDrill) to take magnetometer test in a set pattern (see borehole search), or to prove pile positions.

Land Service Ammunition (LSA)

LSA is defined as “All items containing explosives or pyrotechnic compounds which are placed, thrown or projected so as to cause damage to men and equipment during land warfare.

Long Range Rocket (LRR)

The long-range rocket sometimes codenamed Big Ben is the V2 rocket designed to deliver an approximate payload of 1000 kg.

Oil Bomb (OB)

A bomb containing a flammable liquid, normally the KC 250 Flam or the C 500 flam.

Pilotless Aircraft (PAC)

A flying bomb (Fly) or doodlebug is the V1 rocket or predecessors designed to deliver an explosive payload of approximately 500kg - 800kg.

Parachute Mine (PM)

Air dropped mine may have been used as a blast effect bomb maximum explosive content 1600lb always fitted with anti-handling and anti-stripping equipment.

Unexploded Bomb (UXB)

Any air dropped bomb that has failed to operate.

Unexploded Ordnance (UXO)

Explosive ordnance that has been primed, fused, armed or otherwise prepared for use or used. It may have been fired, dropped, launched or projected yet remains unexploded either through malfunction or design or for any other cause.

Vengeance Weapons (V)

V1 see Pilotless Aircraft.

V2 see Long Range Rocket.

WWI

First World War 1 (1914 – 1918)

WWII

Second World War 2 (1939 – 1945)

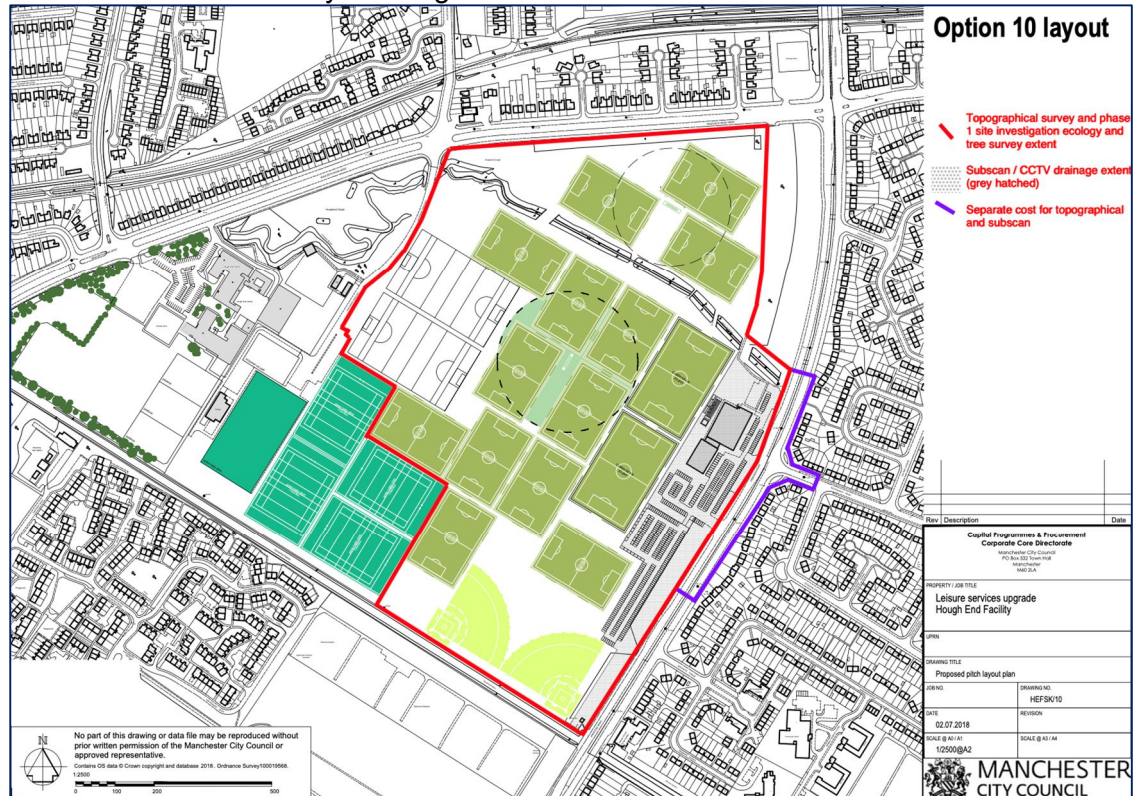
EXECUTIVE SUMMARY

1

INSTRUCTION

EOD Contracts Ltd (ECL), have been commissioned by EWA (hereafter, “the Client”) to undertake a desktop study for potential historic Unexploded Ordnance (UXO) contamination for the future works being carried out within the Highlighted areas provided within the CLIENTS drawing below (**Photo 1.1**).

Photo 1.1: Site boundary/drawing.

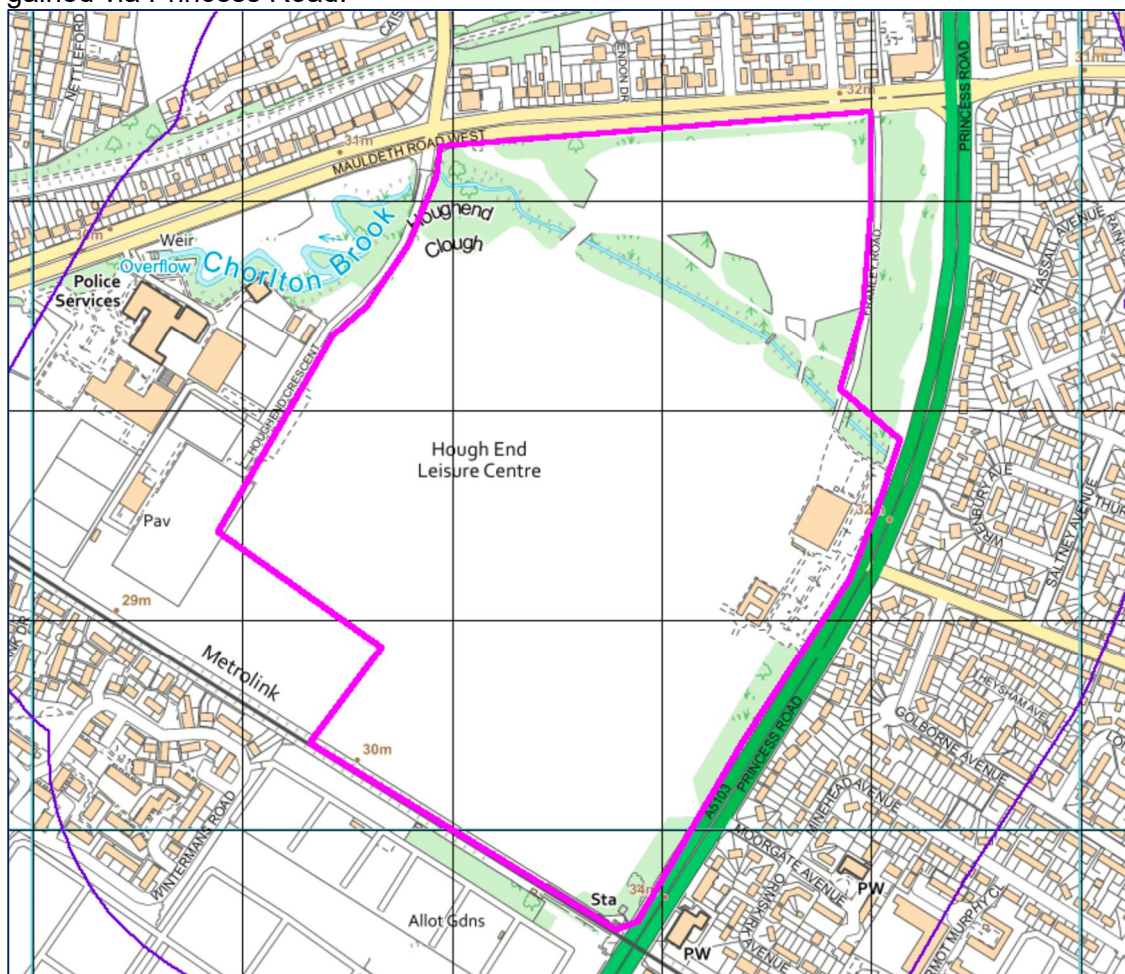


2 SCOPE OF WORK

The scope of this EO Risk Assessment/Desk Study is to assess the likelihood of buried EO/UXO within the environs of “the site” (See **Photo 1.1**), in view of further development. A further aim was to evaluate the implication from UXO contamination during any future intrusive land use.

2.1 LOCATION

The Site area is located within the M20 postcode of Manchester. Access to the Site is gained via Princess Road.



TITLE	DESCRIPTION (CENTRE OF SITE)
Site Post Code	M20 1NA
Grid Reference	SJ 834933 / SJ 8348793333
OS (X)	383487
OS (Y)	393333

3 SOURCES OF UXO CONTAMINATION

3.1 Through the use of thorough research (utilising both modern and historic data) EOD Contracts Ltd deem that the main source of UXO contamination pertaining to the site are as follows.

- Air delivered ordnance bombs and sub munitions/incendiaries.

4 KEY FINDINGS

- 4.1 Based on the information researched by EOD Contracts Ltd for the proposed works being carried out at Hough End Sports Fields, Manchester, EOD Contracts Ltd can conclude the following.
- 4.2 There are no recorded incidents of the site being the subject of bombardment throughout WW1.
- 4.3 No evidence of the Site being targeted could be identified through the use of the Manchester City Council Archives. Close proximity bombing however did occur. Due to the nature of the Site throughout this period and the frequency of bombs that landed within close proximity to the Sites boundary it is possible for bombs to have landed within the site area and not been recorded.
- 4.4 The Site would not have been considered a viable target by the Luftwaffe. However, Manchester itself would have been considered a target rich environment.
- 4.5 There was a recorded HAA Gun Emplacement recorded at Hough End Sports Field.
- 4.6 The Site has been the subject of some major construction works (northern half of the Site was developed into a housing estate). However, these buildings have subsequently been removed and the land returned to its former use as playing fields. Any works carried out within the northern half of the Site can still be considered a **MEDIUM** risk, as the bomb penetration depth would have been deeper than the intrusive works carried at the time.
- 4.7 Therefore (to summarise) EOD Contracts Ltd deem that there is a **MEDIUM** Risk pertaining to items of UXO being located within the Site location.

5 RECOMMENDATIONS

- 5.1 It is recommended that the following risk mitigation strategy be executed during phases of the project indicated previously indicated as a **MEDIUM** risk.
- 5.2 Communicating the risks, all stakeholders should be made aware of the UXO situation on the site and the possible impact it may have on the project works and day to day running of the district. Clients have a legal duty under the Construction Design & Management Regulations (CDM) and Health & Safety at Work legislation to provide Designers and Contractors with project specific information needed to identify hazards and risks associated with the design and construction work. The possibility that UXO may be encountered on site falls within the category of a significant risk and as such it should be addressed as early as possible in the lifecycle of the project.
- 5.3 Further planning; the risks posed by UXO should be brought to the attention of the Project CDM Coordinators and other individuals with a responsibility for project safety and operations at the site. The matter of UXO should be considered critical to project safety and one requiring high priority action.
- 5.4 UXO safety awareness training should be given at all levels of site personnel and selected individuals on the project staff with relevant responsibilities. A competent person as part of the project safety induction course should provide the awareness training. It should be reinforced with specific safety briefings and toolbox talks to individuals involved in conducting intrusive earthworks.
- 5.5 Project overview and the responsibilities of those working on site with regard to duty of care and public safety.
- 5.6 UXO recognition and safety procedures to be followed on discovery of a suspicious object or the alarm being sounded.
- 5.7 Emergency procedures to be followed in the event of an explosion. Evacuation routes, muster stations and accounting for personnel.
- 5.8 Work permits, works methodology and specific UXO risk mitigation methods. Post-incident inspections and returning to normal works.
- 5.9 Prior to any intrusive piling or drilling commencing, UXO safety testing and appropriate clearance certification into the ground to sufficient depth to provide clearance from UXO. This can be done using a progressive drilling process or (where large numbers of piles are to be placed and ground permitting) using a vehicle borne hydraulic system to push a magnetometer into the ground to test for the presence of UXO prior to piling.
- 5.10 UXO safety monitoring of all “at risk” excavations, including geotechnical or archaeological trial pits to be conducted during the project. This should be provided by a UK Home Office Authorised EOD/UXO Contractor using qualified EOD Engineer with specialist locators and detectors to scan the ground ahead of the excavation wherever possible.

6 SPECIFICALLY

- 6.1 Geotechnical investigations, percussive drilling/trial pits/window/samples, require an EOD Engineer over watch.
- 6.2 The removal of all building foundations within the site footprint can be removed down to natural ground level (including basements).
- 6.5 New foundations with piling should be mitigated by the insertion of a magnetometer to encompass the pile position, this would be carried out using a CPT rig (magcone), the expected radius of the magcone is 1.5m therefore multiple piles could be checked.
- 6.6 Non-Intrusive Magnetometer surveys generally prove inconclusive on “Brownfield sites”, this is due to the high ferromagnetic background, therefore this methodology is not recommended for this site and shallow excavations should be overseen by a qualified EOD Engineer. This methodology could however be used on the grassed areas within the site confines.

- 7.0 EOD Contracts Ltd can supply a turnkey solution to your UXO requirements. Therefore, the following mitigation strategies can be supplied for land or water-based operations:**
- 7.1** Intrusive survey using CPT (*Cone Pressure Testing*) or borehole equipment, *supplying risk mitigation to all Borehole and Pile locations, down to a maximum bomb penetration depth determined within this document.*
- 7.2** Non-Intrusive Survey using multiple array system with DGPS (*Digital Global targets be identified.*
- 7.3** Offshore, near-shore, estuarine and freshwater water environments magnetic, side scan and bathymetric supported by state of the art DGPS.
- 7.4** The aforementioned surveys are supported with post processing of data and intrusive investigations if required.
- 7.5** EOD Engineer over watch using Suitably Qualified and Experienced Personnel, normally former British Army, Navy or RAF Bomb Disposal specialists.
- 7.6** Explosive Ordnance Safety Presentations.
- 7.7** EOD Contracts Ltd now offer Utility/Services Detection.

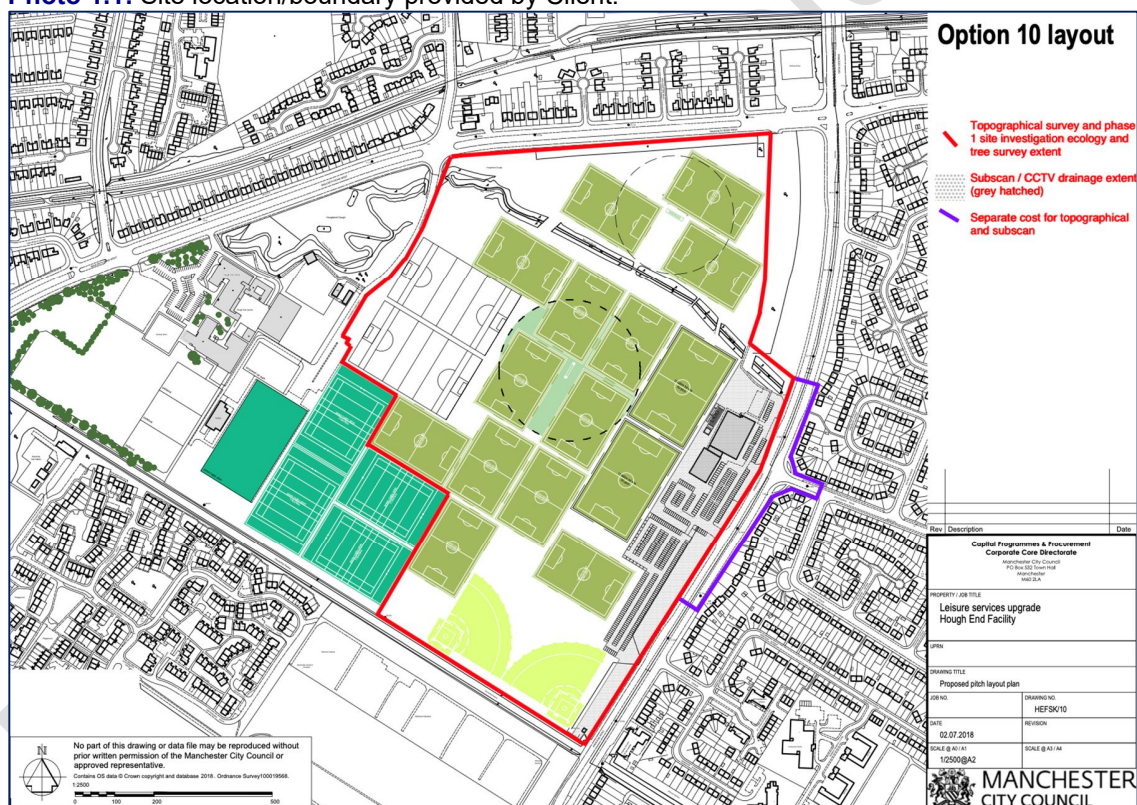


1.0 INTRODUCTION

1.1 Instruction

EOD Contracts Ltd (ECL), have been commissioned by the Client to undertake a desktop study for potential historic Unexploded Ordnance (UXO) contamination for the future works being carried out within the Highlighted areas provided within the CLIENTS drawing below (**Photo 1.1**).

Photo 1.1: Site location/boundary provided by Client.



1.2 Scope of Work

The scope of this EO Risk Assessment/Desk Study is to assess the likelihood of buried EO/UXO within the environs of “the sites”, in view of further development. A further aim was to evaluate the implication from UXO contamination during any future intrusive land use.

1.3 Restrictions

It must be emphasized that a desk study can only indicate the potential for UXO to be present on the site. A geophysical survey and intrusive investigation are fundamentally important to provide proof that the site is free of the UXO threat.

This study was written with the site conditions prevailing at the time of the study and no liability can be accepted for any change in the condition of the area.

Please note that our appraisal relies on the accuracy of the information contained in the documents consulted and that EOD Contracts Ltd will in no circumstances be held responsible for the accuracy of such information or data supplied.

1.4 Sensitive Documentation

Information may be classified, restricted or deemed to be confidential in nature to EOD Contracts Limited, where such material has been gained a summary of the documentation has been approved.

1.5 Objective

The objective of this document is to define the UXO contamination routes as defined in Unexploded ordnance (UXO) A guide for the construction industry (C681) dated July 2015 and offer remediation methodologies if required.

2.0 SOURCES OF INFORMATION

Research of the site's history, with regard to military usage, bombing raids and bomb impacts has been undertaken to establish the following:

- Frequency and intensity of enemy bombing raids for the site and immediate vicinity up to 500m.
- Bomb impacts and associated damage on the Site and in the immediate vicinity.
- The potential for UXO to remain on the Site and in the vicinity.
- Records of UXO removal activities for the Site and immediate vicinity.

The main sources of information consulted include:

- EOD Contracts Ltd company records
- Ministry of Defence records
- Central and Local Government Records
- Public Records Office (Kew)
- Historic Maps and Air Photography
- Open-Source information (Internet)
- Drawing Number – Clients RED Line.

2.1 Ministry of Defence (MOD) Records

33 Engineer Regiment (Explosive Ordnance Disposal) Royal Engineers is the unit responsible for maintaining the records concerning conventional Bomb incidents, reports, clearances and related UXO matters. These records are known to be incomplete and are no longer supplied. Based on in-house information released by the MOD previously, it is considered unlikely that any information released will have any significant impact on the findings of this study.

2.2 Attack Record Keeping

In general, the quality and accuracy of bombing and shelling records prior to 1939 varied greatly from one region to another. Records relating to the limited air attacks on the United Kingdom are considered to be sufficiently accurate in urban areas to provide a reasonable level of confidence in determining the likelihood that an area was or was not bombed during this period. Wartime records, maps etc held within the civil archives are considerably more comprehensive than those still in existence within the MOD, where it is acknowledged that large numbers of records have been disposed of since 1945. Records from some areas, particularly rural districts or near large bodies of water should still be regarded as an incomplete picture of the extent and effect of the bombing campaign.

2.3 Attack Record Accuracy.

While an Air Raid was in progress it was inevitable that mistakes would be made in the transcription of rushed verbal reports into the written records. Discrepancies did occur between the total of bombs dropped against detonations witnessed. In some cases, records were made several hours after the event and mistakes were inevitable. Some reports were drafted before the full extent of the raid had been determined which has led to significant omissions in the records. Reports of raids on rural areas were often witnessed and submitted by untrained individuals and passed through third parties before being recorded. Suspect UXB's occasionally went unreported by local farmers and

freeholders who saw the event as insignificant or were reluctant to report their findings for fear of valuable land or crops being destroyed by the authorities in their attempts to find the UXB.

2.4 Errors and Omissions

The accuracy of bombing records has been shown to vary greatly; this may have been a result of the individual record keeper's expertise. Additionally, in some cases, errors occurred as a result of poor or incomplete transcription and copying. Some "errors and omissions" were intentional, designed to serve as dis-information to confuse German intelligence. So long after the event, official verification of such incidents has often proven to be impossible to obtain. At present, UXBs are found on construction sites and other locations where there had been no documentary evidence to suggest their presence. These events, although infrequent, do serve as confirmation that records cannot be considered definitive.

2.5 Bibliography

The significant published documents referred to during this study are listed below:

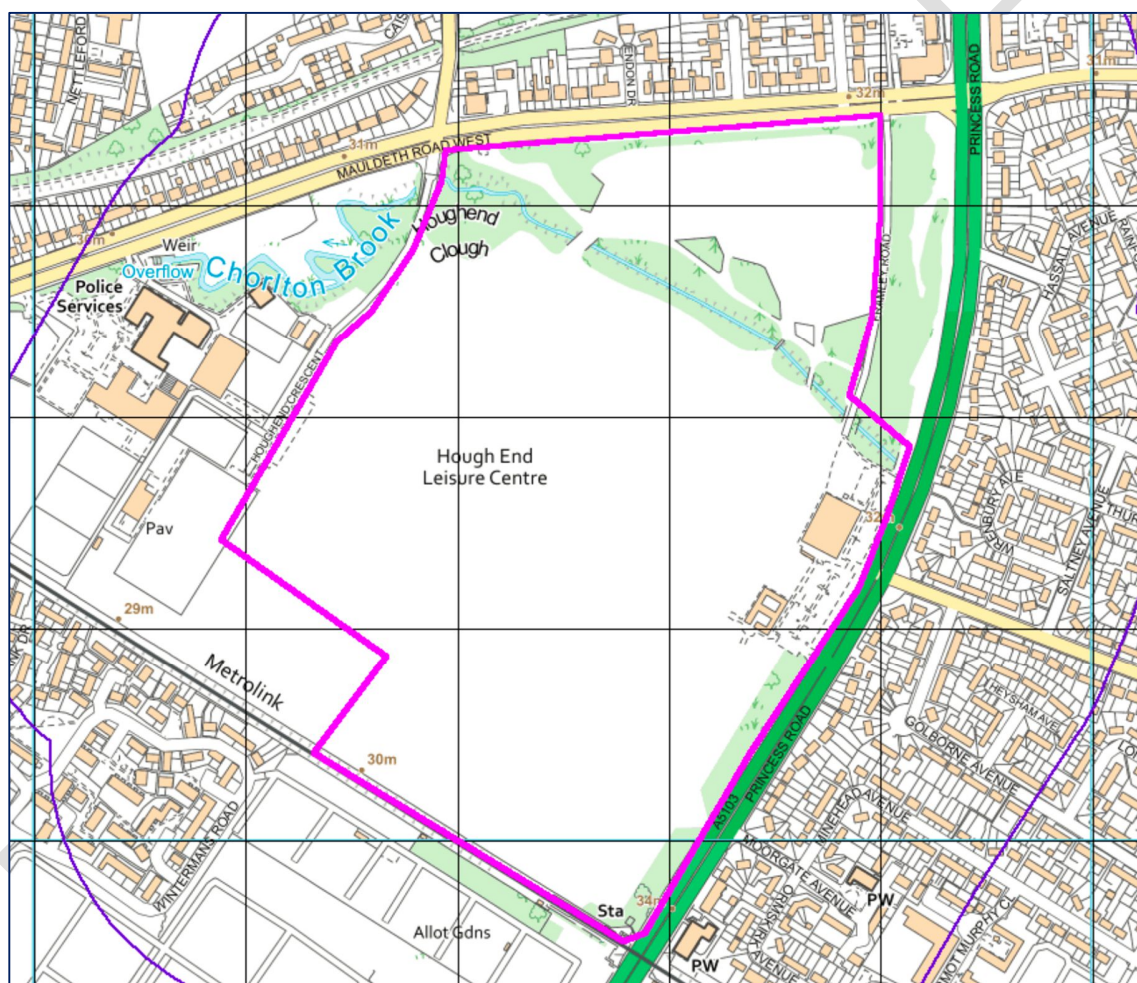
- HO 193 series from National Archives
- HO 198 series from National Archives
- The Blitz Then and Now Volumes 1 to 3
- AA Command Colin Dobinson
- German Air Raids on Britain 1914-1918
- Manchester City Council Records/Archives
- Osprey- Campaign 227 -London 1917–18 - The Bomber Blitz
- Osprey - Campaign 193 - London 1914-17 - The Zeppelin Menace
- <https://www.manchestereveningnews.co.uk/news/greater-manchester-news/manchester-christmas-blitz-1940-five-10509677>
- <https://www.iwm.org.uk/history/the-manchester-blitz>
- <https://www.library.manchester.ac.uk/search-resources/special-collections/guide-to-special-collections/map-collection/online-map-collection/>

3.0 SITE DESCRIPTION AND DETAILS

3.1 Location

The Site area is located within the M20 postcode of Manchester. Access to the Site is gained via Princess Road.

TITLE	DESCRIPTION (CENTRE OF SITE)
Site Post Code	M20 1NA
Grid Reference	SJ 834933 / SJ 8348793333
OS (X)	383487
OS (Y)	393333



3.2 Description

Photo 3.1: The Site area at present is unoccupied with exception of the leisure Centre which is located on the eastern edge of the Site Boundary. The area is mostly grassed and utilised as sports fields.



3.3 Geology

Lithological Description:

In the Cheshire Basin and northwards into Cumbria, the formation comprises red-brown to brick-red, fine- to medium-grained, generally pebble-free, cross-bedded sandstones, with sporadic siltstones. The sand grains are well rounded and indicate an aeolian origin; in Cumbria, they are coarse- to very coarse-grained. There are thin units of fluvial sandstones that have subangular to subrounded sand grains and more common beds of mudstone. Southwards, these pass into bright orange-red to dark brick-red, generally silty or argillaceous, fine- to medium-grained, micaceous sandstones with subordinate siltstone and mudstone beds. The sand grains are subangular to subrounded and pebbles are rare.

Definition of Lower Boundary:

The lower boundary, at the top of a sequence dominated by pebbly sandstones and conglomerates of the Chester Formation, is transitional. It may be taken at the highest occurrence of pebbles, either as a conglomerate or a pebbly sandstone. In Cumbria it is sharp and is taken at the upward change to typical aeolian sandstones from typical fluvial sandstones, which are finer grained and better cemented.

Definition of Upper Boundary:

It is overlain unconformably by the Helsby Sandstone Formation. In Cumbria, it is placed at the top of a thick (40 to 50 m) fluvial sandstone unit that is well-cemented and overlain by coarser, less well-cemented aeolian sandstones of the Helsby Sandstone Formation. It is not a formational boundary with characteristic features on borehole geophysical logs.

Thickness:

Thicknesses are variable across the country. In Cumbria the Sellafield boreholes proved 469 to 529 m. In the West Midlands and the Worcester Basin it is up to 284 m thick. In the Cheshire Basin, in the Knutsford Borehole, pebbles indicative of the Chester Formation were encountered at 1870 to 1878 m depth, giving a thickness of about 920 m for the Wilmslow Sandstone; this includes 325 m of strata below the 'Top Silicified Zone' which, in the EISB and regions 8 and 9, has been used to mark the base of the Wilmslow Sandstone Formation (Jackson et al., 1987).

Geographical Limits:

The Wilmslow Sandstone is exposed from just south of Stourport, across the West Midlands to Stoke-on-Trent and Lichfield, from Macclesfield to Manchester and Liverpool, and as far north as Ormskirk. In Lancashire, north of Ormskirk, it cannot be distinguished from the Helsby Sandstone and Chester formations. In Cumbria it is a distinctive unit of aeolian facies with thin fluvial interbeds. It is present in the subsurface in the Worcester and Needwood basins but absent in the Wessex and Somerset basins. There is some uncertainty about its presence between the West Midlands and the Needwood Basin. It is absent to the east of the Worcester Basin and up the eastern side of England to Doncaster. North of Doncaster, the SSG is undifferentiated and the Wilmslow Sandstone Formation cannot be distinguished.

Source: <https://webapps.bgs.ac.uk/lexicon/lexicon.cfm?pub=WLSF>

3.4 Current Site Use

See 3.2 Description & Annex A.

3.5 Future Works

At the time of writing this report it is understood that the site will be redeveloped. Therefore, it is assumed that the following intrusive construction works will be carried out:

NOTE: *The full scope of works has not been made available to ECL at the time of writing this report.*

- Geotechnical investigations, percussive drilling/trial pits/window/samples
- Removal of building foundations to natural ground level
- Foundations with large diameter rotary bored piling

4.0 HISTORICAL REVIEW

4.1 Historical Mapping & Aerial Photograph

Annex B contains all historic maps from which the below data has been analysed.

- Historic Map 1938 – The Site at this time appears to contain no structures within its boundary. The Site is identified as playing fields.
- Aerial Photo 1955 – The Site has undergone significant changes post WW2, with the northern half of the Site now being occupied with what appears to be a housing estate. The southern half of the Site still remains undeveloped and listed as playing fields.
- Historic Map 1981 – the housing estate that occupied the northern half of the Site has subsequently been removed, with that area of land being reverted back to what appears to be grassed.
- Modern-day Map 2020, the Site at present is appears undeveloped with the exception of the leisure centre which sits on the eastern edge of the Site boundary.

4.2 WWI

Although many people associate wartime bombing with The Blitz during World War II, the first airborne terror campaign in Britain took place during the First World War. Air raids in World War One caused significant damage and took many lives. German raids on Britain, for example, caused 1,413 deaths and 3,409 injuries. Air raids provided an unprecedented means of striking at resources vital to an enemy's war effort. Many of the novel features of the war in the air between 1914 and 1918—the lighting restrictions and blackouts, the air raid warnings and the improvised shelters—became central aspects of the Second World War less than 30 years later. The East End of London was one of the most heavily targeted places. Poplar, in particular, was struck badly by some of the air raids during the First World War. Initially these were at night by Zeppelins, which bombed the area indiscriminately, leading to the death of innocent civilians.

The first daylight bombing attack on London by a fixed-wing aircraft took place on 13 June 1917. Fourteen German Gotha G bombers led by Squadron Commander Hauptmann Ernst Brandenburg flew over Essex and began dropping their bombs. It was a hot day, and the sky was hazy; nevertheless, onlookers in London's East End were able to see 'a dozen or so big aeroplanes scintillating like so many huge silver dragonflies'. These three-seater bombers were carrying shrapnel bombs, which, were dropped just before noon. Numerous bombs fell in rapid succession in various districts. In the East End alone 104 people were killed, 154 seriously injured and 269 slightly injured.

The gravest incident that day was a direct hit on a primary school in Poplar. In the Upper North Street School at the time were girls' class on the top floor, a boys' class on the middle floor and an infant class of about 50 students on the ground floor. The bomb fell through the roof into the girls' class; it then proceeded to fall through the boys' classroom before finally exploding in the infant class. Eighteen students were killed, of whom sixteen were aged from 4 to 6 years old. The tragedy shocked the British public at the time.

There are no recorded incidents of Manchester being subjected to any direct strikes during WWI.

4.3 WWII

4.4 The Blitz Around Britain

The 'Blitz' – from the German term Blitzkrieg ('lightning war') – was the sustained campaign of aerial bombing attacks on British towns and cities carried out by the Luftwaffe (German Air Force) from September 1940 until May 1941.

The Blitz began on 7 September, 'Black Saturday', when German bombers attacked London, leaving 430 dead and 1,600 injured. London was then bombed for 57 consecutive nights, and often during daytime too. London experienced regular attacks and on 10-11 May 1941 was hit by its biggest raid. German bombers dropped 711 tons of high explosive and 2,393 incendiaries. 1,436 civilians were killed. However, this proved to be the last major raid until January 1943.

While London was bombed more heavily and more often than anywhere else in Britain, the Blitz was an attack on the whole country. Very few areas were left untouched by air raids. In relatively small compact cities, the impact of a severe air raid could be devastating.

From mid-November 1940, major provincial cities and industrial centres were targeted. In early 1941 another wave of attacks began, primarily against ports. Respite finally came from June when much of the Luftwaffe was directed against Russia and targets in the Mediterranean.

4.5 Manchester during the Blitz

Manchester and its surrounding area were a major centre of industry during the Second World War. Many large firms were concentrated in the Trafford Park area, making it an important target for the Luftwaffe. Major producers included the aircraft manufacturers A V Roe that produced Manchester and Lancaster Bombers; Ford also employed 17,000 workers making aero engines in a huge new factory complex. During the raids on 22nd – 24th December 1940, the Metropolitan-Vickers works in Mosley Road was just one of the areas factories that was badly damaged. In a later raid 1n 1941 Manchester United's Stadium was hit by a bomb and remained out of action till 1949.

Manchester was attacked on the night of 22nd – 23rd December and again the following night of 23rd – 24th December 1940 (the Christmas raids). On the first night of the raids over 272 tons of HE Bombs was dropped, followed the next night by a further 195 tons. In cooperation to this the Luftwaffe also dropped around 2000 Incendiary bomblets across the city.

Additionally, to these raids, Manchester also suffered smaller attacks, including one in June 1941 when the Blitz was thought to be over. The city had three major raids over the Blitz period (a major raid being defined when over 100 tons of HE Bombs have been dropped) in total, more than 578 tons of explosives were aimed at the city making it the 11th most heavily raided city in Britain.

During the Christmas Raids over 600 fires were started by Incendiary bombs, unfortunately the majority of these were allowed to burn causing further damage. This was due to the cities 3,500 full and part time fire fighters had not returned from Liverpool where they had been sent several days before to help fight fires caused by previous raids. In

some cases, the Army was utilised to demolish surrounding buildings to stop the fire from spreading further. Some of the fires continued to burn throughout the day on the 23rd December, providing a beacon for the German Luftwaffe upon its return that night.

So far as the city's infrastructure was concerned, following the Christmas raids both of Manchester's railway stations had been hit, as were the major bus stations. Deansgate and Oxford Road were blocked by debris from damaged buildings; bomb craters and UXBs meant that whole sections of the city had to be cordoned off. Water supplies were also affected, and electricity was rationed.

4.6 Abandoned Bombs/UXO

EOD Contracts records could find no evidence of any items of UXO abandoned in or around the subject site.

4.7 Anti-Aircraft Artillery

A HAA Gun Emplacement does appear to have been situated within Hough End Playing fields.

4.8 Prior Clearance Operations

EOD Contracts could find no evidence to suggest that there have been any prior UXO clearance operations in or around the site footprint.

4.9 V1 & V2 Bomb strikes

On Christmas Eve 1944, Heinkel He111 bombers flying over the Yorkshire coast launched 45 flying bombs at Manchester. No V-1s landed in Manchester itself, but 27 people in neighbouring Oldham were killed by a stray bomb. Another 17 people were killed elsewhere and 109 wounded overall. RAF De Havilland Mosquitos shot down one German bomber over the North Sea and severely damaged another, causing it to crash land in Germany

5.0 SOURCES OF UXO CONTAMINATION

The main source of UXO contamination that are deemed a threat to the Site are:

- Air delivered ordnance bombs and sub-munitions/incendiaries.
- HAA Gun Emplacement.

5.1 GENERAL

EOD Contracts conclude that a **MEDIUM** risk is considered to exist with respect to UXO for areas within the site footprint.

- The Sites surrounding area was the subject of bombardment throughout WW2.
- There were no recorded incidents of the Site being targeted throughout this period. However, the ground conditions prevailing at the time does mean that bomb strikes could have gone unnoticed.

UXOs are essentially dangerous; therefore, further information on UXO and Safety is detailed in **Annex E**.

5.2 BOMB PENETRATION DEPTHS

5.3 Weapon Sub-surface Penetration.

Weapons penetrate a significant depth into the ground and other types of ammunition are designed to permit the weapon time to penetrate deeply into the target before detonating a short time after coming to rest or a considerable number of hours afterwards. The second reason is where the weapon has failed to function as designed becoming a UXB. A number of studies have been carried out into weapon penetration and it is an inevitable consequence of a number of variable factors acting on the bombs trajectory that figures can and do differ significantly. Careful consideration must be given to the weapon's velocity, trajectory and shape. Also surface conditions and subsurface geology. The largest of the common German bombs, (500kg) can penetrate to significant depths given favourable conditions for penetration. In the case of projectiles and shells, the potential for deep penetration is significantly less.

5.4 Penetration Assumptions.

A number of assumptions were used in determining the maximum threat depth within the project footprint, which were.

5.5 Factors Affecting Penetration

The penetration of sub-surface bombs will be affected by the following:

- Height of release
- Weight, shape and design of bomb
- Aerodynamic qualities
- Angle of flight and impact
- Nature of impact surface
- Nature of sub soil

The expected bomb depths for the site assuming the following criteria:

- 15,000 feet, the vast majority of bombs were dropped from height to avoid AA fire and balloons
- General Purpose Bombs of 50kg to 1000kg
- Near Vertical impact 80 to 90 degrees
- Surface geotechnical conditions are made ground
- Subsurface geotechnical conditions are generally clays.

Therefore, the expected depths for Air dropped UXBs on site are indicated in **RED** in the following table:

TABLE 5.1: Bomb Penetration Depths

Sub Soil Type	Bomb Weights			
	50kg	250kg	500kg	1000kg
Soft Rock	2.442	5.016	6.006	7.062
Gravel	2.442	5.016	6.006	7.062
Sand	2.442	5.016	6.006	7.062
Chalk	3.7	7.6	9.1	10.7
Shingle	3.7	7.6	9.1	10.7
Dry Clay	3.7	7.6	9.1	10.7
Wet Sand	5.55	11.4	13.65	16.05
Wet Clay	5.55	11.4	13.65	16.05
Average Offset (m)	0.8-1.6	1.6-3.7	3-4.5	3.4-5.3

Bombs on penetration of the surface do not follow a straight-line trajectory they can and do curve; this is called a “J” curve where the bomb’s path bends back towards the surface. This gives what is known as the Offset, which may place a bomb under a structure and at a shallow depth.

Figure 5.1 – 5.3: Sub-Surface Trajectories & Safety Buffers

Figure 5.1: Common Sub-Surface Trajectory & **Figure 5.2:** Anomalous Sub-Surface Trajectory

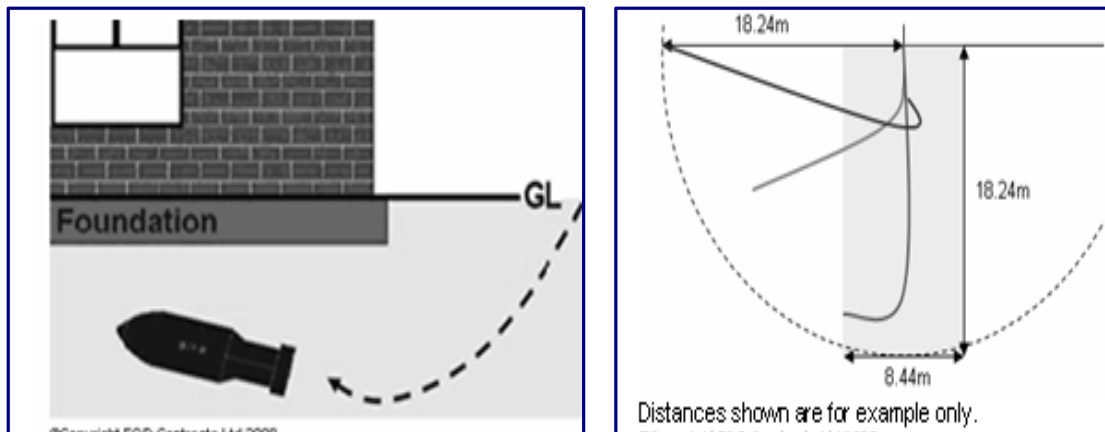
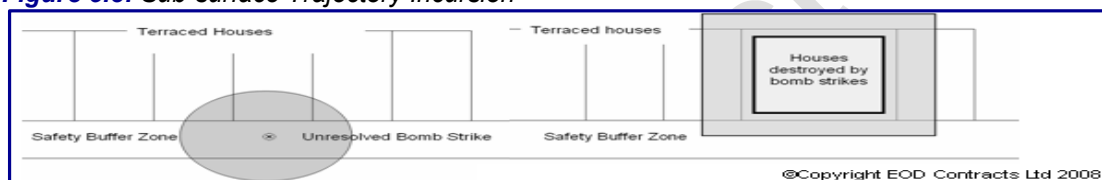


Figure 5.3: Sub-surface Trajectory Incursion



NOTE: the common sub-surface trajectory will follow a path best described as a 'J' curve. The curve can result in a weapon coming to rest some distance from its impact point. The distance from impact point to resting place is referred to as the "Off set Distance and is normally considered to be 1/3 of the depth. This mechanism can permit a weapon to strike outside a building and travel below ground finally coming to rest within the building footprint. Where a strike is known to have occurred close to a building or structure such as a dock wall, a danger zone should be considered to exist around the area of the strike of sufficient size to accommodate the likely sub-surface travel distance for the weapon.

NOTE: the typical offset distance is shown as the shaded area, on rare occasions a near surface deflection of the weapon can occur and the offset distance can be substantially increased up to 5/4 of the penetration depth. This mechanism does however reduce the penetration depth considerably with the net result that while the offset is increased the overall travel distance is for the most part unaffected.

NOTE: scenario 1 (Figure 5.1) shows a hypothetical bomb strike outside a structure or building. The strike location has been accurately identified and as a consequence; a potential danger zone (circular shaded area) can be placed around the point of impact. Scenario 2 shown top right; depicts a direct HE bomb or Incendiary strike within a building which totally destroyed the building. In circumstances such as this UXB entry the building rubble may have concealed hole and the weapon may still be present within the building footprint or it may have travelled sub-surface and come to rest outside the footprint. Here the danger zone (square shaded Area) extends outwards on all sides of the original building footprint.

5.6 Recent UXO finds within the UK

The present-day threat of finding items of UXO within the UK is still high, as highlighted within **Annex F**.

6.0 RISK ASSESSMENT

6.1 Risk Assessment

Assessing both the likelihood of occurrence and the consequences of the encounter has derived the overall risk for the site from unexploded ordnance. Review of the site's history and geographic location can provide an overall likelihood of encounter factor, which is used in the subsequent determination of a risk level when a Figure can be determined for the consequence.

6.2 Likelihood of Encounter

Given the study findings and other criteria (See **Annex G** Tables) it is considered that there is a **MEDIUM** risk of encountering UXO within the site footprint. This finding is based on assessment of all of the available information.

6.3 Consequence of Encounter

The consequence (See **Annex E**) of an uncontrolled encounter with UXO, given its lethal design and its unpredictable nature could be catastrophic and warrants a high severity factor. With regards to the consequences, the following factors were considered:

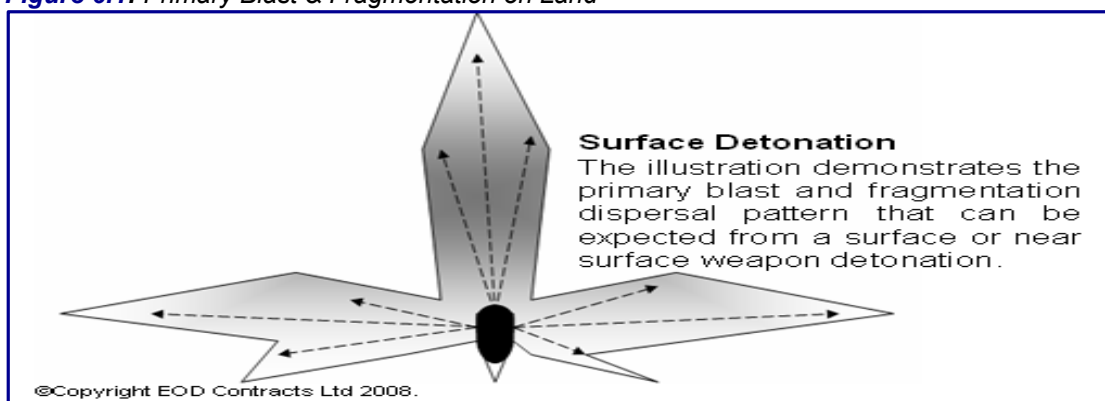
The project works may make use of a number of common ground investigation and construction techniques in its methodology during the project. Any intrusive groundwork has the potential to encounter UXO.

Intrusive earthwork, piling driving and dynamic ground compaction are by nature, aggressive, significant force (kN) is often required to achieve the desired results. As a precaution it is prudent to assume that any external stimulus, no matter how slight, may result in an unstable weapon detonating.

Records of encounters with UXO, particularly where plant machinery has been involved have resulted in detonations of the items with varying degrees of consequence; ranging from slight injuries sustained to piling contractors when a bomb detonated at 6.0m bgl to fatal injuries sustained to a construction worker while conducting near surface machine works on a motorway.

Detonation on land; the effects of a detonation at depth will be more localised and less destructive than one occurring on the surface. Figure 6.1 shows an illustration of the primary blast and fragmentation dispersal from explosive ordnance when it detonates on the surface. The weapon's design, and other key factors such as the ratio of explosive charge weight to total weapon weight (CWR) and the Net Explosive Quantity (NEQ) will determine the size and effects of a blast. The effects will also be enhanced or reduced by a number of factors including, the presence of other energetic materials in close proximity to the blast or if the weapon is buried or exposed on the surface. As a guide Figure 6.1 gives an indication of the likely blast radius for common types of UXO.

Figure 6.1: Primary Blast & Fragmentation on Land



In addition to the dangers of explosion, many common chemicals used in the manufacture of explosive ordnance fillings are; in sufficient quantity, and level of exposure, toxic or poisonous. Although it is unlikely that such chemicals would be encountered in significant quantity to represent a significant risk to personnel, leakage or venting could pose a risk to the local marine environment. In addition to heavy metals; copper, lead, zinc etc used in the weapon body and fuze, hydrocarbon propellants such as Kerosene may also be present.

6.4 Risk Level

The overall risk has been determined to apply to all of the ground within the site footprint.

The prevailing risk level has been determined to be **MEDIUM** risk.

6.5 Encounter Consequences

It is acknowledged that when viewed from a “likelihood versus consequence” scenario; the consequences of an explosion may have the potential to include:

- Multiple casualties or fatalities.
- Extensive damage to high value private and public assets and property.
- Significant delays to the construction project.

6.6 Those at Risk

The risk is considered to have the potential to pose a direct and indirect threat to a wide range of individuals and facilities. While the impact on fixed assets can be estimated based on the asset's proximity to the seat of the explosion. The impact to transient assets and people will, for the most part, be the result of both; proximity to the explosion and the time at which the event occurs. The overall impact therefore has the potential to range from little more than a minor localised event to a level, which may be considered to be a more widespread major incident involving some or all of the following:

- Construction and other specialist personnel carrying out the work.
- General public in open spaces, at their places of work and transient population on foot or road users in proximity to the construction work.
- Public services including transport, water, gas and electricity supplies.

- Public facilities, including buildings, vehicles, other high value assets and equipment.
- Private business property including construction equipment.
- Private residential property in proximity to the work.

6.7 At Risk Activities

Based on our understanding of the scope of the most common construction projects, it is considered that a wide range of intrusive processes may be required to complete the project. Any intrusive groundwork's have the potential to encounter UXO and each activity therefore has a degree of risk attached to it. The severity or level of the risk is derived as a consequence of activity's; location, methodology and volume or quantity of risk material to be worked, at risk activities are considered to include:

- Intrusive geotechnical and archaeological investigations including drilling and pitting.
- Foundation construction, trenching and other excavations.
- Intrusive construction works, which may include piling. The study findings and other criteria (See [Annex G](#) Tables) it is considered that there is a **MEDIUM** risk of encountering UXO within the site footprint.

7.0 CONCLUSIONS

Based on the information researched by EOD Contracts Ltd for the proposed works being carried out at Hough End Sports Fields, Manchester, EOD Contracts Ltd can conclude the following.

There are no recorded incidents of the site being the subject of bombardment throughout WW1.

No evidence of the Site being targeted could be identified through the use of the Manchester City Council Archives. Close proximity bombing however did occur. Due to the nature of the Site throughout this period and the frequency of bombs that landed within close proximity to the Sites boundary it is possible for bombs to have landed within the site area and not been recorded.

The Site would not have been considered a viable target by the Luftwaffe. However, Manchester itself would have been considered a target rich environment.

There was a recorded HAA Gun Emplacement recorded at Hough End Sports Field.

The Site has been the subject of some major construction works (northern half of the Site was developed into a housing estate). However, these buildings have subsequently been removed and the land returned to its former use as playing fields. Any works carried out within the northern half of the Site can still be considered a **MEDIUM** risk, as the bomb penetration depth would have been deeper than the intrusive works carried at the time.

Therefore (to summarise) EOD Contracts Ltd deem that there is a **MEDIUM** Risk pertaining to items of UXO being located within the Site location.

8.0 RECOMMENDATIONS

It is recommended that the following risk mitigation strategy be executed during phases of the project indicated previously indicated as a **MEDIUM** risk.

Communicating the risks, all stakeholders should be made aware of the UXO situation on the site and the possible impact it may have on the project works and day to day running of the district. Clients have a legal duty under the Construction Design & Management Regulations (CDM) and Health & Safety at Work legislation to provide Designers and Contractors with project specific information needed to identify hazards and risks associated with the design and construction work. The possibility that UXO may be encountered on site falls within the category of a significant risk and as such it should be addressed as early as possible in the lifecycle of the project.

Further planning; the risks posed by UXO should be brought to the attention of the Project CDM Coordinators and other individuals with a responsibility for project safety and operations at the site. The matter of UXO should be considered critical to project safety and one requiring high priority action.

UXO safety awareness training should be given at all levels of site personnel and selected individuals on the project staff with relevant responsibilities. A competent person as part of the project safety induction course should provide the awareness training. It should be reinforced with specific safety briefings and toolbox talks to individuals involved in conducting intrusive earthworks.

Project overview and the responsibilities of those working on site with regard to duty of care and public safety.

UXO recognition and safety procedures to be followed on discovery of a suspicious object or the alarm being sounded.

Emergency procedures to be followed in the event of an explosion. Evacuation routes, muster stations and accounting for personnel.

Work permits, works methodology and specific UXO risk mitigation methods. Post-incident inspections and returning to normal works.

Prior to any intrusive piling or drilling commencing, UXO safety testing and appropriate clearance certification into the ground to sufficient depth to provide clearance from UXO. This can be done using a progressive drilling process or (where large numbers of piles are to be placed and ground permitting) using a vehicle borne hydraulic system to push a magnetometer into the ground to test for the presence of UXO prior to piling.

UXO safety monitoring of all “at risk” excavations, including geotechnical or archaeological trial pits to be conducted during the project. This should be provided by a UK Home Office Authorised EOD/UXO Contractor using qualified EOD Engineer with specialist locators and detectors to scan the ground ahead of the excavation wherever possible.

9.0 SPECIFICALLY

Geotechnical investigations, percussive drilling/trial pits/window/samples, require an EOD Engineer over watch.

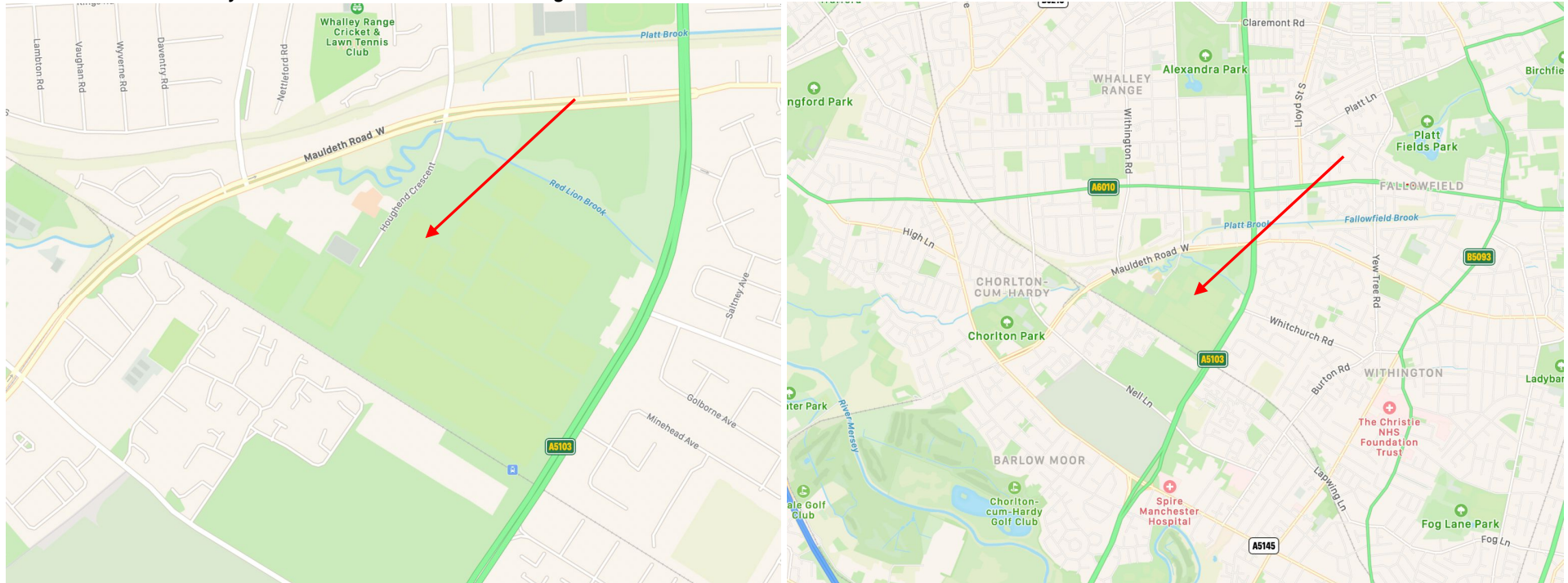
The removal of all buildings within the site footprint can be removed down to natural ground level (including basements).

New foundations with piling should be mitigated by the insertion of a magnetometer to encompass the pile position, this would be carried out using a CPT rig (magcone), the expected radius of the magcone is 1.5m therefore multiple piles could be checked.

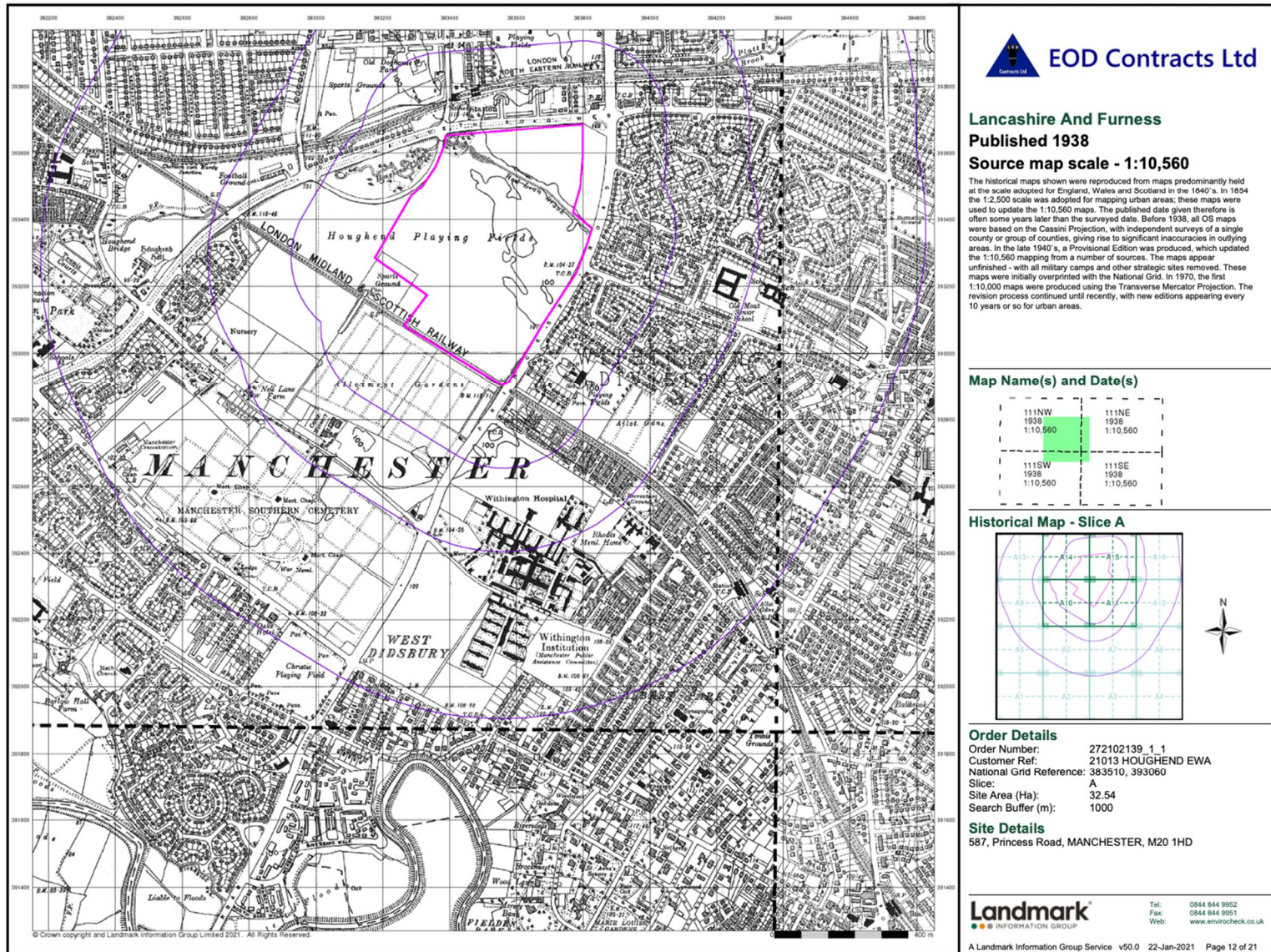
Non-Intrusive Magnetometer surveys generally prove inconclusive on “Brownfield sites”, this is due to the high ferromagnetic background, therefore this methodology is not recommended for this site and shallow excavations should be overseen by a qualified EOD Engineer. This methodology could however be used on the grassed areas within the site confines.

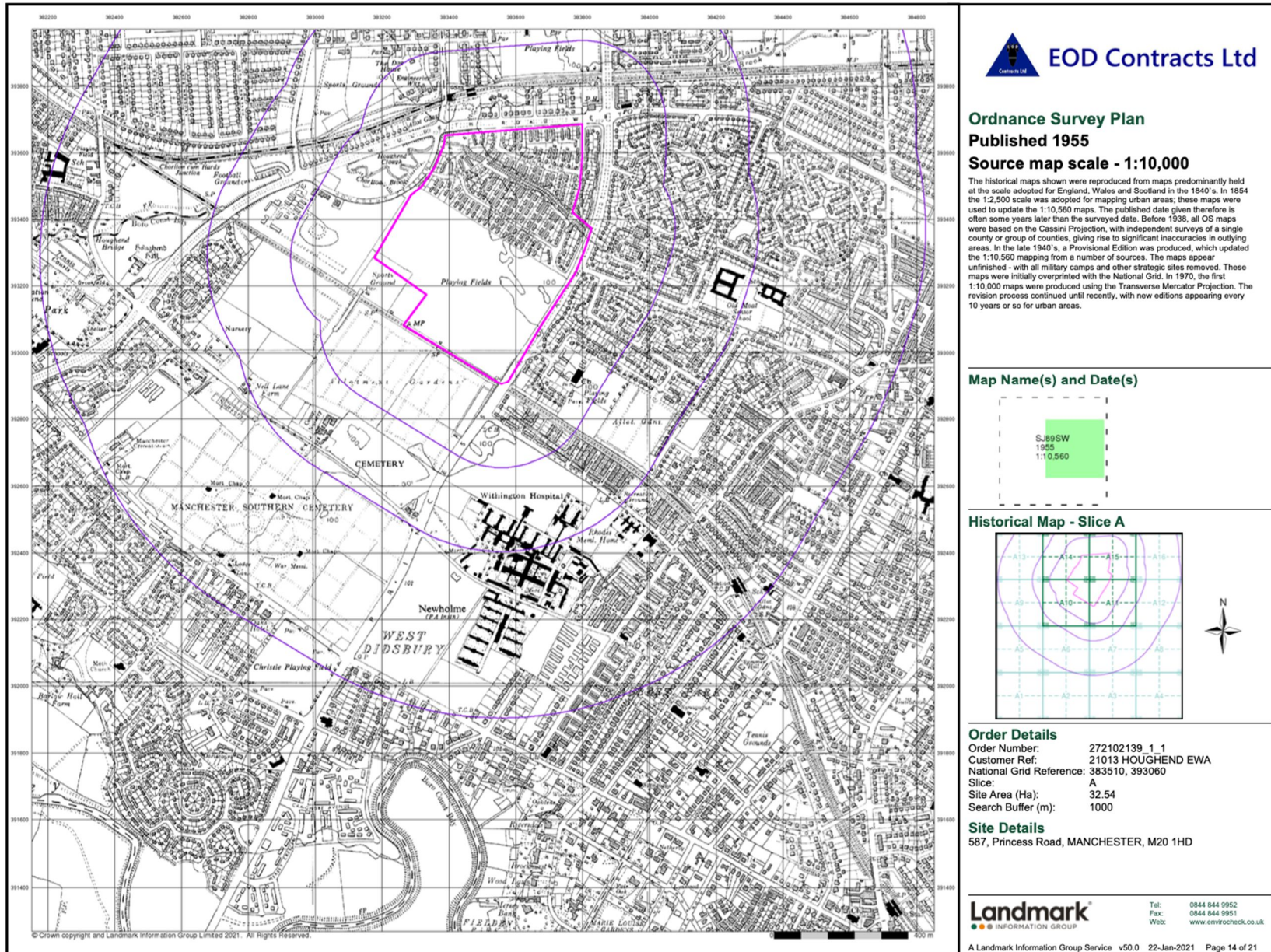
SITE LOCATION

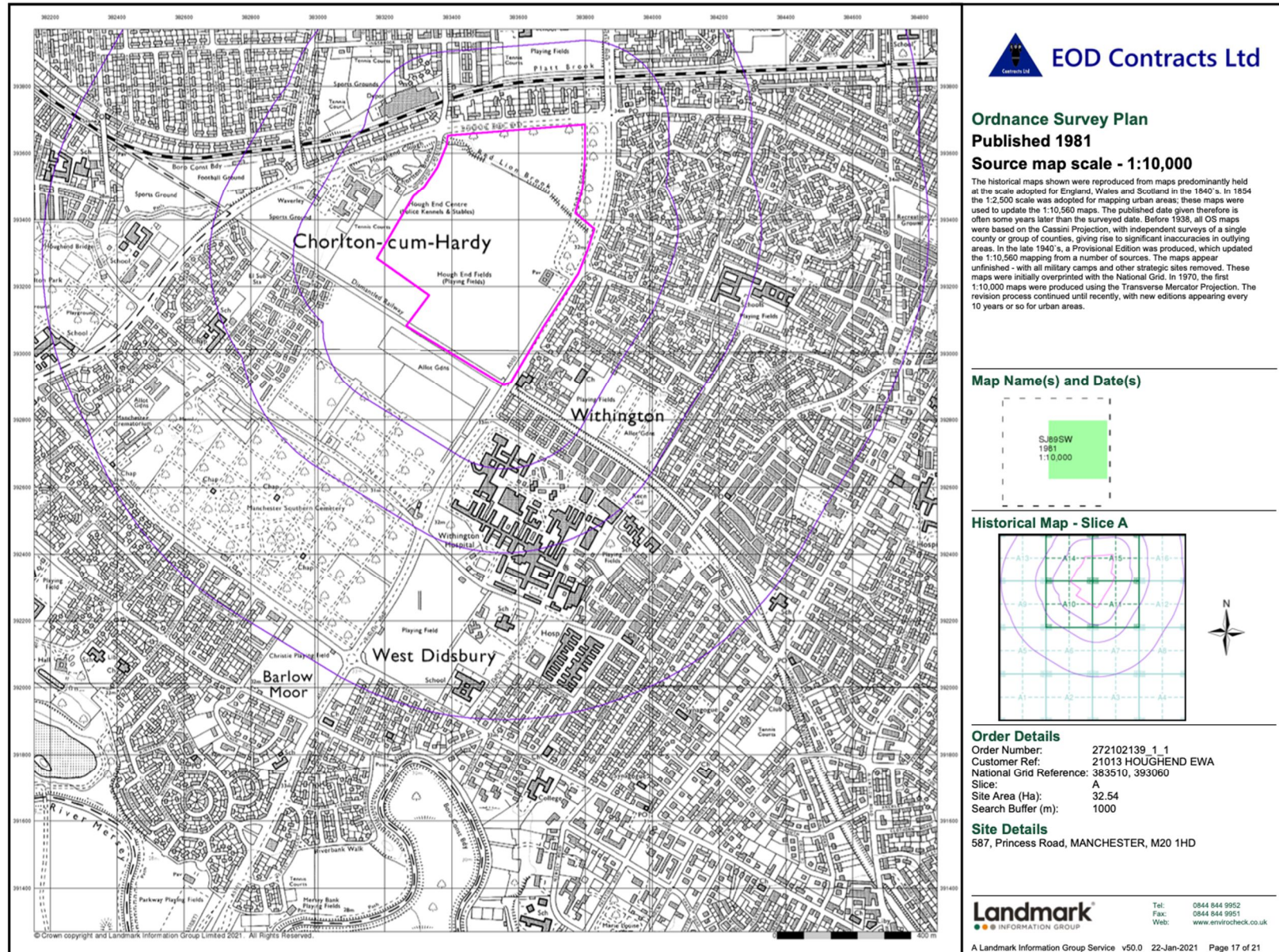
NOTE: Site indicated by red arrow. Access to the Site is gained via Princess Rd.

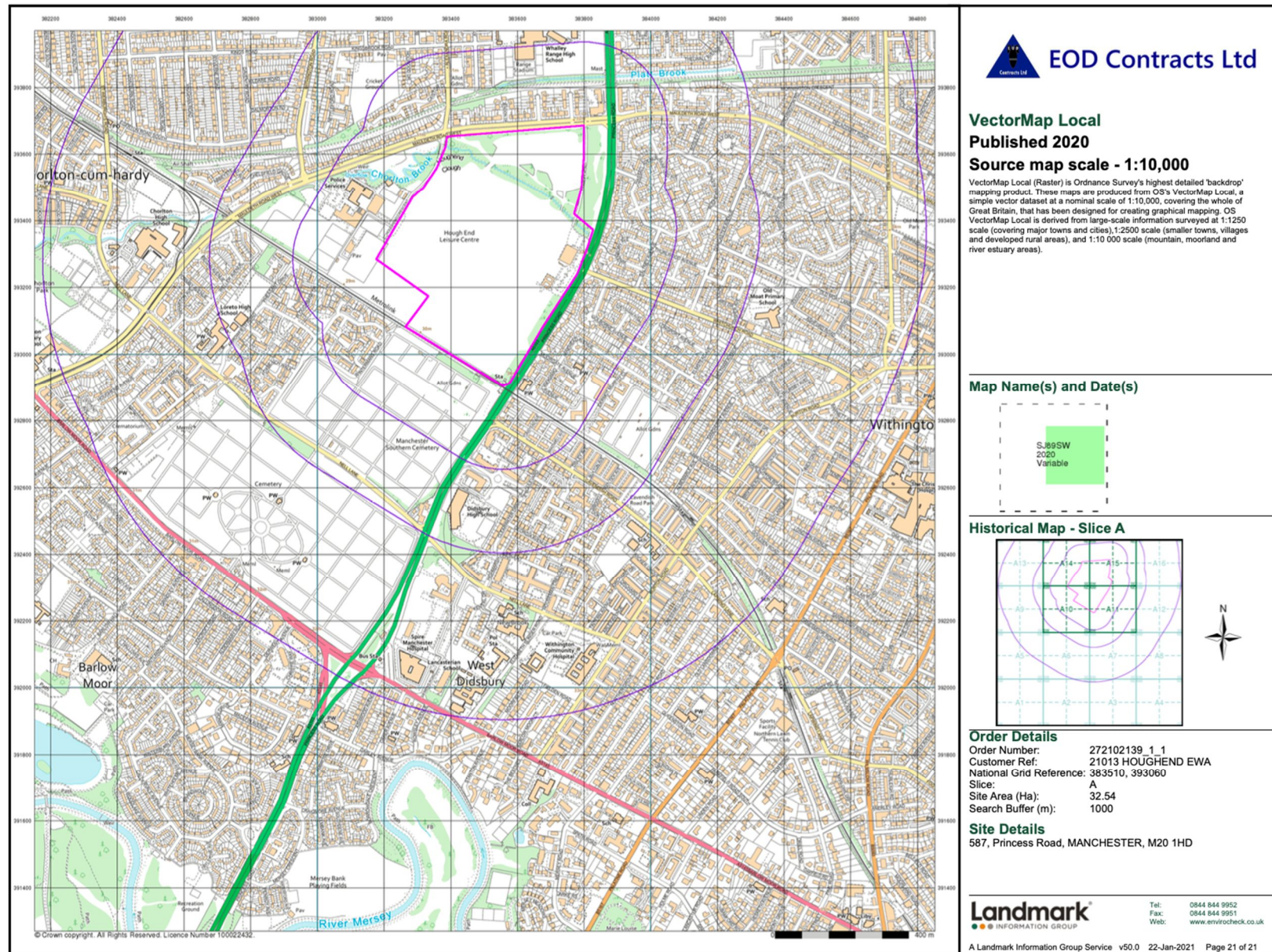


HISTORIC MAPPING

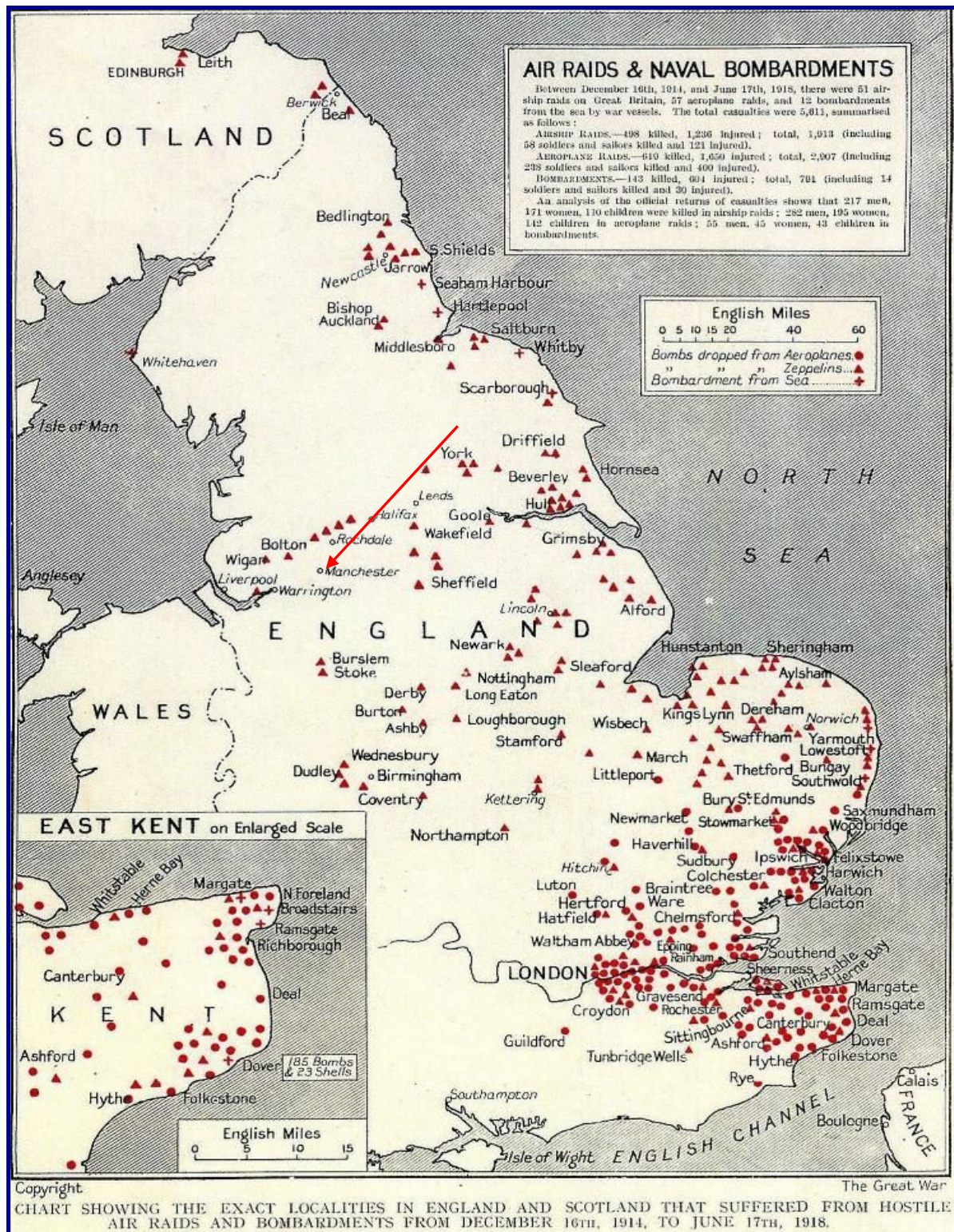








BOMB RAIDS WWI



NOTE: Site indicated by red arrow.

BOMB IMPACT MAPS

MEDIUM RISK

Map Series: Manchester City Council Bomb Damage Maps

Key:

IBs	Indicated where applicable (usually denoted by hashed lines over a wide area)
UXB	
HE Bomb	
Para Mine	

Map Reference OS: Not known

Site Position: Site shaded in Red.

NOTE: The below maps highlight Bomb damage caused throughout WW2 (Manchester Blitz Period) the varying degrees of Red indicates more damage sustained (shaded red – repairable/Dark red – beyond repair). The red circles indicate HE Bomb Strikes and the red circle coloured blue highlights a UXB. The Site does not indicate any bombs within its confines. However, due to the nature of the ground conditions throughout WW2 it would have been possible for bombs to have landed within its confines and remained undetected to this day.





EXPLOSIVE ORDNANCE SAFETY AND INFORMATION

UNEXPLODED ORDNANCE

Since the end of WWII, there have been a limited number of recorded incidents in the UK where bombs have detonated during engineering works, though a significant number of bombs have been discovered.

The threat to any proposed investigation or development on the site may arise from the effects of a partial or full detonation of a bomb or ordnance item. The major effects usually being shock, blast, heat and shrapnel damage. It should be noted that the detonation of a 50kg buried bomb could damage brick/concrete structures up to 16m away and unprotected personnel on the surface up to 70m away from the blast. Larger ordnance is obviously more destructive. Table 1 denotes recommended safe distance for UXO.

Table 1: Safety Distances for Personnel

UXO (Kg)	Safety Distances (m)			
	Surface UXO		Buried UXO	
	Protected	Unprotected	Protected	Unprotected
2	20	200	10	20
10	50	400	20	50
50	70	900	40	70
250	185	1100	120	185
500	200	1250	140	200
1000	275	1375	185	275
3000	450	1750	300	450
5000	575	1850	400	575

Explosives rarely become inert or lose effectiveness with age. Over time, fuzing mechanisms can become more sensitive and therefore more prone to detonation.

This applies equally to items that have been submersed in water or embedded in silt, clay, peat or similar materials.

Once initiated, the effects of the detonation of the explosive ordnance such as shells or bombs are usually extremely fast, often catastrophic and invariably traumatic to the personnel involved.

The degradation of a shell or bomb may also offer a source of explosive contamination into the underlying soils. Although this contamination may still present an explosion hazard, it is not generally recognised that explosives offer a significant toxicological risk at concentrations well below that at which a detonation risk exists.

TYPES OF ORDNANCE

German Air Delivered Ordnance. Technical information on the nature and characteristics of the ordnance used by the German Air Force during both world wars has been available for a number of years. Assessment that began during the 1930's has continued to the present day. Experts have conducted research in many countries as part of national research programmes and as individual research projects. Consequently, a well-informed assessment of the threat posed by unexploded

ordnance, and the hazards that they represent, can be made with a high degree of confidence.

Terminology. It should be noted that two terms used in bomb records can lead to some confusion as to their meaning and therefore significance. The term Unexploded Bomb (UXB) refers to a bomb that has fallen, failed to function and has been subsequently dealt with and removed from the site. The term Abandoned Bomb (A/UXB) refers to a UXB that could not be found or recovered, or the decision was taken not to pursue the matter further. Consequently the unexploded bomb remains where it came to rest when it was dropped or fell to the present day. It should also be noted the word ‘bomb’ can be used to describe an airdropped bomb or a shell as in some cases no differentiation was made and the term was interchangeable.

Abandoned Bombs. The records of known abandoned unexploded bomb locations in the London area were released in response to a written Parliamentary Question from Simon Hughes. (Hansard: Volume; 282. Dated 15th October 1996). The information was provided by the Ministry of Defence (MOD) and supplied under an indemnity.

Explosive Ordnance Failure Rates. Over the course of both World Wars a considerable quantity of ordnance dropped on UK targets failed to function as designed and subsequently penetrated the ground without exploding. Information gathered during the war by the MOD and its research partners provide typical failure rates for different types of ordnance. Figures significant to this study are:

- 10% of all German airdropped bombs failed to function as intended.
- 30% of all anti-aircraft and other types of shells failed to function as intended.

Deductions & Considerations. The following points were considered as part of the assessment and have been given due consideration:

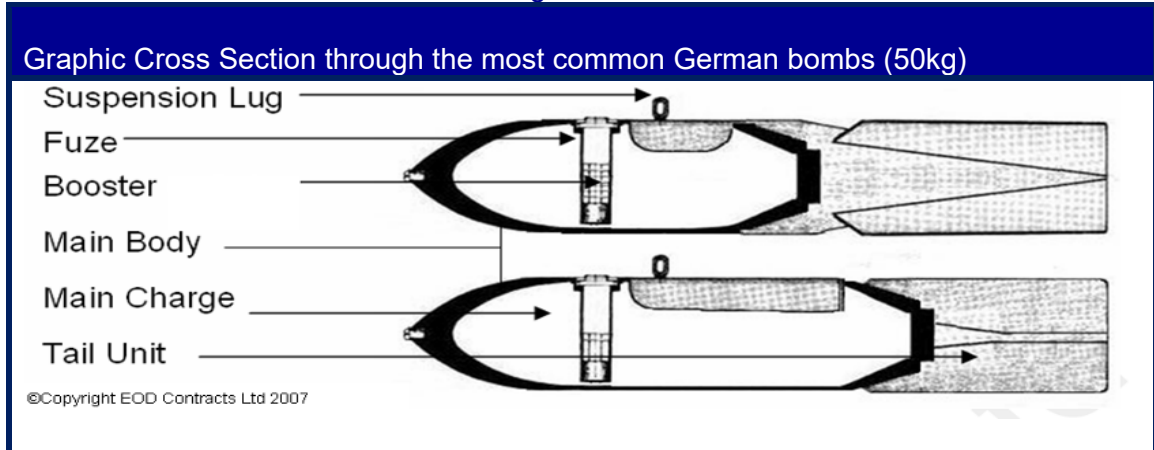
Records were found that indicated that the general area was subjected to heavy bombing.

Bombs, which struck previously, hit or burned out targets and did not function; consequently their impact was unseen and therefore no report was ever made.

In all likelihood, the local anti-aircraft battery would have fired a far higher number of shells than the bombers dropped HE bombs. Contamination by anti aircraft shells cannot be ruled out.

Generic German Bomb Types. The majority of German bombs dropped were 50kg in weight, accounting for approximately 16% of the total bombs dropped. The range of common bombs increased in weight to a maximum of 1700kg. Regardless of size, German bombs were fitted with one or more Electrical Condenser Resistance (ECR) fuzes many of which included a mechanical component. The fuzes were mounted transversely in the bomb body with the booster directly below, and in contact with, the fuze. The booster; sometimes referred to as the Gaine, is composed of a sensitive explosive material (Picric Acid). Picric Acid is known to deteriorate over time becoming increasingly unstable. The internal layout of two common German bombs and a German fuze is shown in Figures 6.1 & 6.2.

FIGURE 1: Generic German Bomb Design.



NOTE: the diagram shows that there can be a significant difference in the quantity of High Explosive contained within bombs of similar size and shape; the Grade 1 bomb on the bottom having 30% more HE than the Grade 2 shown at the top. This serves to demonstrate the importance of an accurate identification of any item of UXO.

FIGURE 2: Generic German Bomb Fuze Design.

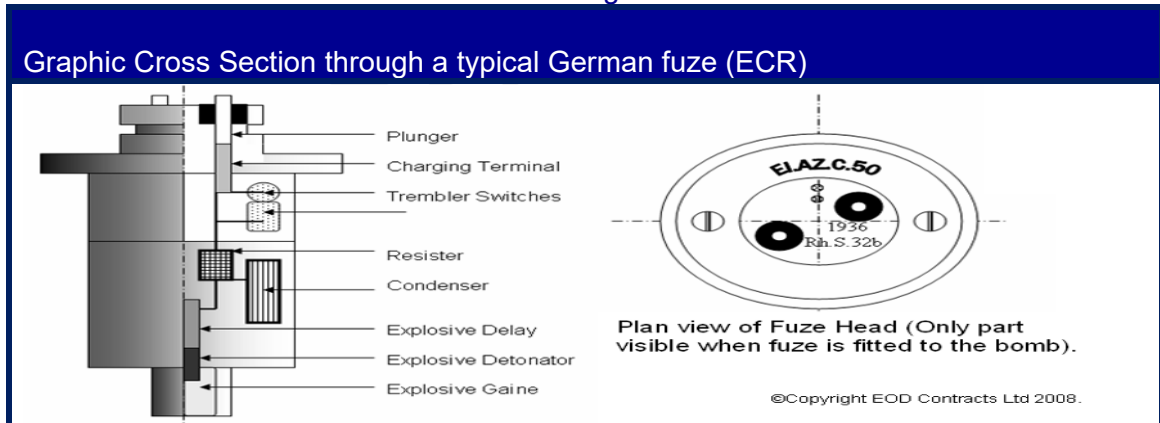


FIGURE 3: Range of HE bombs dropped on the United Kingdom.



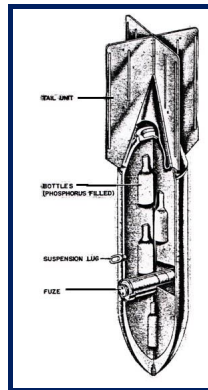
NOTE: The smaller sub-munitions (Bomblets) seen to the right, ranged in size between 1 and 3kg, were dropped in large numbers and were intended as incendiary bombs, anti-personnel bombs or as bombs filling both roles. The smaller bomblets were dropped in larger container bombs designed to hold between 360 and 620 of the bomblets. The containers were designed to burst open at a predetermined height above ground level, dispersing the bomblets over a wide area. Air raid damage was far greater by using both incendiary, and HE bombs on a single raid. The fires started by the incendiaries being rapidly spread by the blast waves from the HE bomb. This scenario was shown to devastating effect on the 14th February 1945 in the German city of Dresden. Where fires started and spread by the bombing increased to a point where the oxygen was being sucked into the flames at such a high speed that the fire became a “Fire Storm”. At the time the city's population had increased due to a high number of refugees fleeing the Russian advance to the east, the exact civilian death toll from fire and suffocation will never be known, but is considered to be somewhere between 25,000 and 100,000.

High Explosive (HE) Bomb. Some of the most common type of ordnance to be dropped on the United Kingdom, HE bombs are often the type encountered as UXBs. Relatively thick cased, they are still recovered in remarkably good condition. Ranging in size from 50 to 1700 kg, their typical release height (1,500m) allowed them to penetrate deep into the ground as a result of design or flaw. Towards the end of the bombing campaign, as steel became scarce the German Engineers produced a range of bombs that used steel reinforced concrete as the bomb body. Figure 6.3 shows the range of steel HE bombs dropped on the UK.

Incendiary Bomb. The larger incendiary bombs, containing bottles of white phosphorus and an incendiary mixture contained within a thin steel case were designed to burst on contact with the ground. A fixed dispenser on the aircraft delivered the smaller type of bomb or ‘Bomblet’ to the target area in container bombs or; both types of container would open dispersing the smaller Incendiary bombs. Relatively small and light they were unlikely to penetrate the ground to any significant depth. However, once concealed in bomb damage rubble or below water they were easily missed and are still unearthed today from in-fill and drained land. Later versions of the incendiary bomb contained an additional explosive charge used as a short delay “Booby Trap” device that contained a significant amount of high explosive. The Booby Trap component was designed to kill or injure fire fighters and hinder the damage control. See Figure 4.

FIGURE 4: Incendiary Bombs.

Common German Incendiary Bombs



Left, 1kg incendiary bomblet, and right a 50kg incendiary bomb containing bottles of white phosphorus.

NOTE: Incendiary bomblets were made of a flammable alloy similar in appearance to aluminium, which resists corrosion well. The tail unit was made of thin tin-plate steel and is more prone to have rusted away. Some Incendiary models were fitted with a High Explosive (HE) steel nose. With the tail and explosive nose attached the bomb was 480mm long.

Blast Bomb / Parachute Mine. The parachute mine was extensively used on land and at sea and was fitted with specialist fuzes designed to trigger the weapon at a predetermined altitude, water depth or to switch on other magnetic influence mechanisms to trigger the weapon when a ship approached (Magnetic or Acoustic influence). While early versions were based on the standard 1000kg SD Bomb case others were specially designed and manufactured with an aluminium body, making them extremely difficult to detect using magnetometers. The thin cased versions would normally disintegrate on impact on land and are normally considered to pose little threat to work on land based projects, but the risk increases significantly on projects over water or in marshland. Thicker cased versions however will survive impact and pose a significant risk regardless of the local ground conditions. (See Figure 5)

FIGURE 5: Common Airdropped Mines.

Parachute & Ground Mines



NOTE: all mine fuzes were designed to arm after deployment from the ship, submarine or aircraft, some fuze designs incorporated anti-removal booby traps. Unexploded mines found today are the result of a failure within the arming mechanism or procedure whereby the mine never fully armed. Sudden shock or jarring of a weapon in this state has the potential to complete the arming sequence and could result in the mine detonating with lethal consequences.

Non-Steel Cased Bombs. Used primarily in the construction of training or practice bombs, some high explosive variants were introduced towards the end of the war. With resources running scarce, German Engineers produced a small number of blast bombs with a concrete body. The design utilised a steel framework onto which concrete was cast. The explosive filling was also contained within a thin steel container within the bomb body. Very few “concrete” bombs were dropped on the UK. In common with standard steel cased weapons, this type of bomb can be detected using standard magnetometer detection techniques (albeit; providing a smaller ferromagnetic signature than its all steel counterparts). This type of bomb represents a very small percentage of the total number of bombs dropped worldwide and are not considered a significant threat, particularly when viewed from an overall bomb threat in the UK.

Anti-Personnel Bomb. Generally these were small weapons of 1-3 kilograms in weight and are often referred to as ‘Bomblets’ and possessing similar ground penetration ability as the Incendiary Bomblets. They were often located during the post-raid searches. This type of bomb has been recovered within the bomb rubble being cleared or used as in-fill on construction projects and poses the same potential to function as the Incendiary bomb with a greater potential to cause localised casualties.

Specialist Bomb. These types of bombs were designed to meet a specific mission requirement. Typically, this would be a design modification or special fusing to enable the bomb to destroy hardened/armoured targets or deep buried and sub-marine targets. Similar to the more common HE bombs, they differ in that they rarely contain large amounts of high explosive. Therefore the consequence of a detonation is reduced but remains a significant risk, particularly when the detonation occurs on or near the surface.

Depth Bombs & Depth Charges. These types of weapons were designed to meet a specific mission requirement. Typically, the modifications would include the type of explosive filling and special fusing to enable the bomb to penetrate to a significant depth into the ground or water before detonating. Depth bombs intended for maritime attack and sub-marine targets would be fitted with one or more fuzes, one of which would be a hydrostatic fuze designed to detonate the bomb at a predetermined depth. The bomb would be fitted with an anti skip ring to reduce the deflection of the bomb as it entered the water. Similar in many ways to Depth Bombs, Depth Charges were exclusively designed to detonate at a predetermined depth. This was achieved by fitting the Charge with a short time delay or hydrostatic fuze. Depth bombs; having a similar configuration to general purpose bombs had the potential to penetrate deeply into the sea bed where an attack occurred in the relatively shallower water of a dock.

Unmanned Rocket Bombs & Missiles. The most famous in this category of weapons were the V1 (Fi103 flying bomb) commonly known as the Doodlebug and the Larger V2 (A4 missile). Both V1 & V2 with high explosive warheads containing 850kg & 1000kg (respectively) represent some of the largest weapons to land in the United Kingdom. Both types were built in a similar manner to an aircraft and would generally disintegrate on impact even if the warhead failed to detonate. The impact would spread debris over a wide area which was difficult to miss and any resulting unexploded 'V' weapons were comprehensively dealt with at the time. For this reason they are rarely encountered on land. However, where a 'V' weapon landed in water the opportunity for the event to have been missed and/or follow-up action abandoned was greater and they continue to pose a significant risk. Other, less well known rocket bombs were also produced by the Luftwaffe to attack maritime targets. Some were equipped with TV/Radio guidance from the parent bomber. Two of the most common were the Fritz X which consisted of an adapted SD1400kg bomb and the Henschel Hs293 which was based on a smaller 500kg bomb. No record of one having been recovered on land as a UXB can be found but these large HE bombs are considered to pose a significant risk, particularly to maritime projects. No records were found to indicate this type of bomb was ever used on targets in the area.

Photoflash Bomb. This type of bomb was dropped by specialist "Pathfinder" aircraft and although this type of bomb can be included with the category of specialist bombs, it is worthy of specific comment due to the danger it may still pose. Photoflash bombs were designed to explode with a blinding flash, rather like a camera flashbulb. They were used to enable photographs to be taken of targets at night and also served to identify ground targets for other aircraft to attack. The speed at which the highly energetic filling detonated, and energy it produced in doing so, was significant. Although these bombs were thin skinned and are prone to corrosion the functioning of one can be compared to a high explosive bomb detonation.

High Explosive Shells & Projectiles. As mentioned previously, one of the most common sources of UXO contamination encountered in the United Kingdom is High Explosive Shells and Projectiles. This is most commonly found to be as the result of firing practice ranges, bombardment and anti-aircraft defence, the latter often positioned to defend Major cities and Strategic installations and ports from German Bombing. Anti Aircraft Shells and projectiles are generally smaller (Up to 4.7" inch diameter) than the airdropped bombs and as a consequence were more easily missed amongst the bomb rubble. However, coastal bombardment guns could fire a shell weighing 1000kg, (larger than most common airdropped bombs) and capable of significant ground penetration. The generic layout of a projectile can be found at Figure 6.6. It should be noted that the fatal incident on the German autobahn in 2006 was thought to be the result of a shell or projectile detonating, not an airdropped bomb as first reported.

The Fuzes used in Anti-Aircraft Ammunition were designed to ensure the projectile would detonate in contact with the target, or at a pre-set altitude, or in close proximity to the target. The fuzes employed different means to achieve this, including; direct impact, or indirect impact, Barometric, Delay and Electro-magnetic influence. Some were fitted with more than one fuze, which served to reduce the chance of the projectile falling to earth and detonating. Artillery fuzes are activated during the firing process, using the projectile's acceleration or spin within the gun barrel to switch off the safety mechanisms. For this reason fired projectiles are considered more dangerous than unfired ones.

FIGURE 6: Generic Shell Design

Generic High Explosive (HE) Shells (recent finds on site around the UK)



Other Types of Ordnance. The following additional sources of ordnance types have been considered, and inherent risks taken account of:

Flares and Pyrotechnics. Flares and pyrotechnics were used for a variety of reasons throughout the war and continue to be found today in the most unlikely places. However, due to the thin casings of these weapons a high level of corrosion is likely to have occurred since manufacture. Depending on the specific nature of the weapon, this effectively renders them inert with the exception of any white phosphorous content or explosive gain.

Land Service Ammunition (LSA). While as the name implies this type of ammunition was designed for use on land, it was also issued to naval personnel for close protection of vessels and their crew and to provide a limited offensive capability even to relatively small craft. This type of ammunition includes some shells and projectiles such as those covered previously. Other natures of LSA range from Small Arms Ammunition (SAA), having little or no high explosive content to Grenades, Mortars and Rockets which may pose a risk of detonation due to their explosive content and the design of their fuzes (impact) which; if subjected to sufficient shock or friction may result in the weapon functioning. (See Figure 7)

FIGURE 7: Common Categories of Land Service Ammunition

Land Service Ammunition

Small Arms Ammunition



Grenades



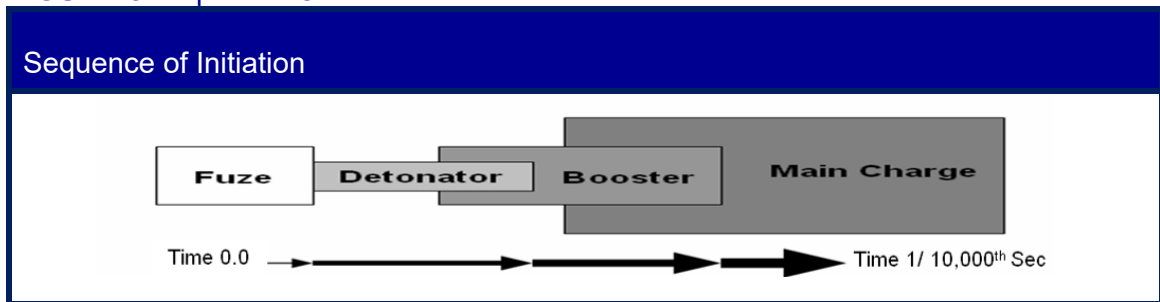
Mortar Bombs



Initiation of Unexploded Ordnance. Explosive Ordnance is highly unlikely to spontaneously explode. The energetic chemical compounds, (Explosives) used in weapon manufacture are chosen to be as stable as possible and they all require a significant application of additional energy to create the right conditions for detonation to

occur. If stored correctly, most explosive materials are designed to remain stable for the duration of their expected lifespan (typically 20 years). During this time, the correct functioning of the weapon is achieved by means of the 'Initiation Train' (See Figure 8).

FIGURE 8: Explosive Ordnance Initiation Train.



Initiation Train. This is a means by which, once the safety features have been switched off or removed, a chain reaction occurs through the weapon. Starting within the fusing system as a small ignition or spark, causing a detonator to explode, which in turn causes the booster charge to detonate with a greater energy and ending in the full detonation of the main explosive filling. Each part of the process has in-built safety features to prevent an unintended detonation. A failure in any of the components within the Initiation Train can result in a UXO. In the case of a UXB; the chain reaction has broken down and the Initiation Train is brought to a halt, albeit, a temporary one. There are a number of ways that sufficient energy could be introduced to the otherwise stable UXB / UXO that may allow the Initiation Train to set off once more, overcoming the initial reason for failure. In addition to subjecting the weapon to excessive heat, such as a fire, the most common methods to bring about an explosive detonation in such items are considered to be:

Direct impact onto the main body of the bomb by mechanical excavation or pile driving: Such an occurrence can cause the bomb to detonate, should the point of impact be on the bomb fuze; less force would be required to bring about a full or partial explosive detonation.

Re-starting the clock timer in the bomb fuze. Only a small percentage of bombs were fitted with clockwork fuzes. It is likely that corrosion has taken place within the fuze that may prevent the clockwork mechanism from functioning. However, the restarting of the clock is by no means a scenario that can be completely ruled out. This is considered to be one of the two most credible mechanisms by which sufficient energy could be introduced to the bomb and result in a detonation.

Induction of a static charge or exposure to an external power source (Electrical Services), causing a current in an electrical fuze. The majority of German bombs employed an electrical component within the fuzes, it is likely that corrosion would have taken place within the fuze mechanism and that it would no longer contain, or conduct sufficient electrical charge to initiate the bomb.

Friction initiating the sensitive fuze explosive. Some chemical constituents may have deteriorated, due to oxidisation. Components designed with a high degree of stability at the time of manufacture may no longer be as safe. **This is considered to be the most likely mechanism by which sufficient energy could be introduced to the bomb and result in a detonation.**



Unexploded World War 2 bomb found on a Soho building site

LONDON | LONDON | SOHO | ⌚ Monday 3 February 2020, 3:33pm

Bomb disposal teams have removed an unexploded Second World War bomb from a busy area of central London.

Officers were called to a building site near Dean Street in Soho at 1.42pm after reports of the suspected explosive device.

Videos posted on Twitter showed people leaving buildings and gathering as police set up a cordon.

Witnesses described "lots of commotion" as the area surrounding the site was shut off. A Royal Engineers bomb disposal unit was called in and removed the half-tonne device. Shortly after 8.30pm, the Metropolitan Police's Soho team said the cordons in Oxford Street, Charing Cross Road, Shaftesbury Avenue, Lexington Street and Poland Street had been lifted.

A Ministry of Defence spokeswoman said: "An Army explosive ordnance disposal team has been called out to Soho to support the Metropolitan Police after discovery of a 500kg Second World War device.

"The Army EOD team have confirmed the bomb was safe to remove overnight to a location where it will be detonated," the spokesperson continued.

"Military personnel are regularly required to assist with the disposal of historic ordnance such as this, ensuring every situation is dealt with as quickly as possible for the safety of the general public."

<https://www.itv.com/news/london/2020-02-03/suspected-world-war-2-bomb-discovered-at-building-site-in-soho>



Bomb disposal teams called to Luton after 'cannonball' found on a building site

ANGLIA | BOMB | CANNONBALL | POLICE

🕒 Friday 13 March 2020, 12:00pm



Bomb disposal teams and police cordoned off an area in Luton today (Friday 13) after what is thought to have been a cannonball was found on a building site. Hitchin Road was closed between Stopsley Way and Stockingstone Road.

Police were called at around 10.30am after someone reported seeing something suspicious on a nearby construction site.

Bedfordshire police say the explosive ordnance disposal team were called as a precaution. The roads have since reopened.

<https://www.itv.com/news/anglia/2020-03-13/bomb-disposal-teams-called-to-luton-after-cannonball-found-on-a-building-site>



World War 2 bomb 'found yards away from West Ham's London Stadium' ahead of Arsenal clash

The Hammers' clash with Arsenal on December 9 could now be postponed although their match with Tottenham next Saturday will go ahead as planned



Police cordoned off an area after an object believed to be a bomb was found near the stadium (Image: PA)

A bomb that dates back to World War Two has reportedly been found just yards away from West Ham's London Stadium. Ongoing work on an apartment development nearby had to be halted after the bomb was discovered on Friday morning.

Police officers set up a 150 metre cordon around the site after they were called to the scene just before midday, reports the Sun .

The area has been declared safe by experts for the time being, with a specialist mining team set to attend the site on November 25.

West Ham's match with Arsenal scheduled for December 9 is now under threat of postponement if there is any change in the safety status of the site.

Due to the timeframe of the visit from specialists, the Hammers clash with Tottenham next Saturday November 23 is due to go ahead as planned.

"It's crazy to think of all the people walking around here during the Olympics and we had no idea it was here.

"The bomb is in a tricky position, so could take up to two weeks to sort it out, which takes us into the second week of December.

"We will continue our efforts to safely establish what the object is but the park and its venues will continue to remain open." "Between now and 25 November teams will be putting together a plan of what to do." However, despite suggestions that the object is a bomb, a spokesman for the London Legacy Development Corporation (LLDC) who handle Olympic Park, were keen to stress the item is as yet unidentified.

Andover Advertiser

02nd March 2019



Schools and homes have been evacuated after a Second World War bomb was discovered on a building site.

Army bomb disposal experts are on the scene after the unexploded device was found in Brent, north-west London.

Work on the site is expected to continue until at least Friday afternoon, Brent Council said. A police cordon has been established at the scene and will be extended to around 300m on Friday morning, forcing more residents to leave their homes.

More than 50 people are currently staying at a rest centre set up at St Martin's Church on Mortimer Road, Kensal Green.

Several British Red Cross volunteers are on hand to provide support to affected residents. Scotland Yard said it was called to The Avenue, near Brondesbury Park, at around 11.30am on Thursday following the discovery.

Nearby schools, businesses and residents were evacuated, and roads closed.

MailOnline

5th February 2019

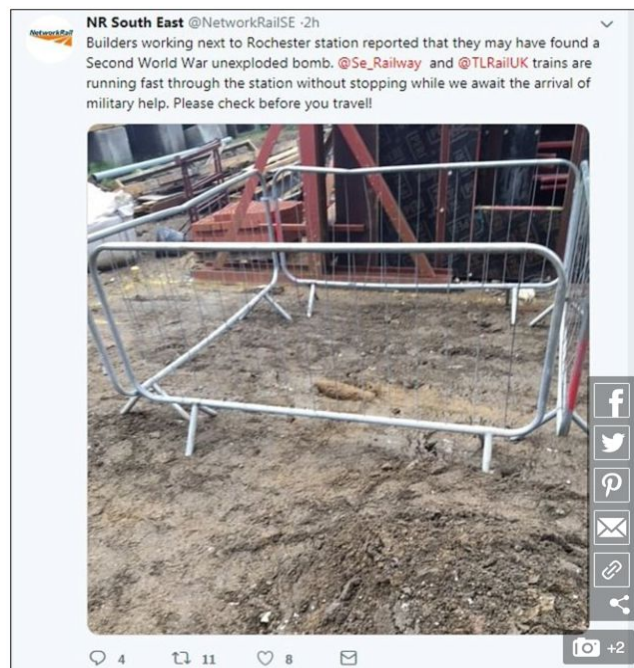
Railway station is evacuated and trains ordered not to stop when builders find unexploded World War Two bomb;

- Rochester Station was closed for over two hours after the bomb was found
- The military and British Transport Police were called in to deal with the threat
- While they worked trains were allowed to run fast through the station
- Builders at a nearby construction site found the shell in the mud at around 1pm

A railway station was evacuated this afternoon after a WWII bomb was discovered by builders working in Rochester, Kent.

British Transport Police and military personnel descended on the train station following the construction workers finding the unexploded shell underground.

The station was evacuated at 1.25pm and trains could run fast through the station while they worked to remove the hazard.



By 3pm - and in time for rush hour - the bomb had been safely removed by the bomb squad and Rochester Station could resume normal service.

South Eastern Tweeted: 'Builders working next to Rochester station reported that they may have found a Second World War unexploded bomb.

'@Se_Railway (Southeastern) and @TLRailUK (Thameslink) trains are running fast through the station without stopping while we await the arrival of military help. Please check before you travel!'

The WWII bomb was discovered on a building site off the station's land, but close enough that trains were unable to stop as a safety precaution.

Later on Network Rail updated passengers and wrote: 'The bomb has been removed and normal service has resumed. Thank you for your patience.'

Risk Assessment Tables

Table 1: Summary of Potential Contamination Sources

Source	Applicable	Not Applicable
Enemy Attack & Counter Measures		
Bombing WW1		☒
Manned Aircraft Bombing WW2 (potentially)	☒	
Unmanned V1 & V2 Rocket Attack		☒
Shelling		☒
Anti-Shipping Mines & Depth Charges		☒
Anti-Aircraft Shells & Rockets		☒
Beach Mines & Coastal Defences.		☒
Airfield/Key Point Defensive Mines/Charges		☒
Abandoned Unexploded Bomb (A/UXB)		☒
Migration of UXO		
UXO Migration in Rubble & Infill		☒
UXO Migration by Tide & River Current		☒
UXO Migration by Marine Dredging		☒
Shipwrecks		☒
Dispersal by Explosion, Fire & Accident		☒
Aeroplane Crash		☒
Private Collections		☒
MOD Facilities		
Bombing Range		☒
Artillery, Mortar & Tank Range		☒
Grenade Range		☒
Small Arms Firing Range		☒
Weapon Research & Development Facilities		☒
Ammunition Burial Grounds		☒
Docks & Harbour Facilities		☒
Offshore Ammunition Dumping Grounds		☒
Ammunition Storage & Manufacture Sites		☒
Airfields & Air Stations		☒
Bombing Decoy Site		☒
Army Barracks & Camps		☒
MOD Training / Concentration Areas		☒
Home Guard & SOE Weapon Caches		☒

Table 2: Airdropped Weapon Strike Indicators (UK)

Item	Increasing Potential level →			
Site Location	Rural	Small Town	Brown Field Large Towns	Cities
Site Description and Use	Greenfield or Agricultural Land	Near Strategic Target	Adjacent to Strategic Target	Strategic Target
Site History	No history of Attack	Near area of Attack	Immediate Area Attacked	Direct Attack
Strategic Target: Military Installation, Industrial or Munitions Manufacturer, Power Station, Gas or Water Works, Port, Dock, Railway Yard, Decoy Site.				

Table 3: Site Specific Bomb Penetration Assessment

Table of Site Specific Bomb Penetration Assessment			
Input Figures			
Bomb Weight	Release Height	Velocity on Impact	Angle of Strike
500 kg	5000 m	340 m.s ⁻¹	10° to vertical
Geology	Typically, firm to stiff clays and silts with varying amounts of sand, gravel and cobbles of mixed lithology. Locally may also contain occasional boulders.		
Output Figures			
Maximum Penetration Depth		Maximum Offset	
10.7 m		5.3 m	
The maximum threat depth from airdropped weapons is considered to be:		Bombs	10.7 m
The maximum threat depth for smaller shells is considered to be:		AA Shells	3.0 m
Input figures based on the most common bombing methods and largest common bomb type Figures derived from computer simulation. All depths based on 1939 levels.			

Table 4: Weapon Strike Records (UK)

Source	Availability			
Archive	None	Non-specific	Specific	Extensive
In-house	None	Non-specific	Specific	Extensive
Anecdotal	None	Non-specific	Specific	Confirmed

Table 5: Anti-Aircraft Weapon Strike Indicators (UK)

Item	Increasing Potential level ⇒			
Site Location	Rural	Town	City	Military Site
Fixed Battery Location	None	General Area	Nearby	Onsite
Mobile Battery	Rural	Town	City	Military Site
Military Site: Airfield, Port, Radar, Barracks, Depots, Arsenal or Similar.				

Table 6: Abandoned Bomb Records (UK)

Item	Increasing Potential level ⇒		
In-house	None	Yes	On-site
Other	None	Yes	On-site

Table 7: Bomb Strike Density Assessment

Bombs & Mines	Manchester officially recorded 737 High Explosive (HE) bombs with a low-moderate regional bombing density of 27 bombs per 405 hectares (ha).
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Table 8: Opportunity to have detected Bomb or Shell Strikes (UK)

Increasing Potential level ⇒	
No bombs recorded	
Good ARP cover	
Significant development (carried out prior to WW2)	
No significant ground cover	
Bomb recorded within close proximity to Site boundary	
Moderate ARP cover	
Moderate development (across some areas of the site)	
Frequent public access	
Little ground cover	
Bombs recorded within Site boundary	
Poor ARP cover	
Minimal development limited to shallow excavations (within some areas of the site location)	
Infrequent public access	
Moderate ground cover	
Heavy bomb damage/total destruction	
No ARP cover	
Development limited to site clearance	
Controlled private access	
Heavy ground cover, vegetation, ploughing or body of water	

Table 9: Post Contamination Development Indicators (UK)

Nature of Post Contamination Development	Highlighted
	100% excavations of the entire site to below contamination depth.
	Significant development (across some areas of the site, pre WW2)
	Moderate development (across some areas of the site)
	Minimal development (across some areas of the site)
	No development

Table 10: Construction Activities Encounter Indicators

Activities	Highlighted
	Borehole Drilling
	Dynamic Sampling
	Shallow Trial Pit (within made ground)
	Services Trenching (within made ground)
	Bored (CFA) Piling
	Sheet Piling
	Shallow Excavations over extended area (within made ground)
	Deep Excavations over a limited area
	High Density Piles
	Deep Excavations over extended area
	Bulk Excavations

Risk Category Key	Mitigation Requirement
Green	No/Minimum Mitigation measures required (see document recommendations)
Amber	Medium risk of encountering items of UXO (or items there off) within the site boundary, mitigation required for safe systems of work.
Red	High risk of finding items of UXO (or items there off) within the site boundary, mitigation required for safe systems of work.